SEVENTH FRAMEWORK PROGRAMME
THEME 7: Transport (including Aeronautics)

TTG4 e-maritime: Clustered Research Projects

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Authors	Tony Morrall, David Griffiths, Takis Varelas, Takis Katsoulakos, Ioannis Koliousis, Salvador Furió, Gabriel Ferrús, Ørnulf Jan Rødseth.
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Description of the Task: Analysis and overview of the current State-of-the-Art for e-Maritime, proposals for cooperation and opportunities for implementation
Task 4.1: View of the clustered research projects related to e-Maritime: state of art, achievements, and opportunities for implementation
This task will provide a comprehensive list of EU and nationally funded research projects, (from FP6 for EU projects), for both current and completed projects. In order to activate and/or improve the network of experts, the main companies, research institutions, single experts, users that are the main actors in the area of the e-Maritime will be identified. In particular contacts with relevant national research projects will be established with the help of the Integration Group and with the Mirror Group of the WATER*BORNE* Technology Platform. Deliverable D4.1 will include an assessment of the state-of-the-art and opportunities for cooperation and implementation.

CONTENTS

Tables:

Figures:

1 Executive Summary

A general review of e-Maritime and e-navigation issues included a brief historical background, the objectives of the EU e-Maritime initiative, the e-Maritime Strategic Framework (EMSF), and IMO's e-navigation concept is given in Annex1. The role of SafeSeaNet, Port Community Systems (PCS) and the Single Window concept was also explained.

In order to form a comprehensive overview of the current state-of-the-art for e-Maritime, the projects and initiatives identified by the WP4 partners were initially categorised against four main focus areas: Ships Operation and e-Navigation, Port Operations, Logistic Chain and Regulations Management, and also by specific sub-topics. This facilitated a clustering of projects for a more detailed analysis of their results.

For the purpose of the above overview e-Maritime was defined as the use of information exchange technologies to establish more efficient, more secure and safer cooperation between ships as well as between a ship and onshore stakeholders, in order to facilitate sustainable maritime transport.

Research projects related to e-maritime/e-navigation projects covering the four main focus areas were identified from relevant European (from FP6 onwards), national, regional, and other RDI projects. These included projects funded under the EU Framework Programmes, DG MARE, EMSA, European Regional Development Fund, TEN-T, INTERREG, JRC, Marco Polo and nationally funded projects, as indicated in Figure 1 below:

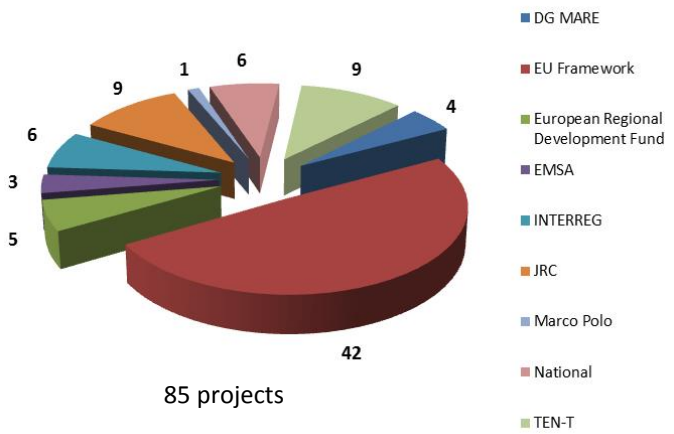


Figure 1: European e-maritime related projects from different funding sources

The main actors involved in the most important European and nationally funded projects related to e-maritime/e-navigation projects have been identified for each of the mainstream projects and are listed in Annex 2.

The main topics and areas of technologies identified from the European projects related to e-Maritime, particularly in those areas where a relevance to the current WATER*BORNE* priorities has already been established were analysed for the focus areas of to establish the State-of-the-Art.

The use of e-maritime or digital information services to facilitate the flow of goods by maritime transport has focussed primarily on shore-based facilitation and the development of electronic technology, processes and services for the ships that carry cargo. However, IMO's e-navigation initiative for exchanging maritime information makes use of the same electronic technology and

processes. The e-navigation initiative also supports vessel traffic management, which will be eventually realised through a global Marine Electronic Highway

A review of specific systems and applications of ICT technologies for exchanging information in the maritime domain developed Globally indicated that European applications were considered to be state-of-the-art and more advanced in some areas, such as in the logistics domain and in Port Community Systems.

Proposals for cooperation and information exchange in the network, and between current and future projects related to e-maritime and e-navigation have been considered. Several recent research projects related to e-maritime make use of the results from completed projects. The newly-established Digital Transport and Logistics Forum have also identified some possible issues for cooperation and information exchange across all transport modes, and these include: Electronic transport documents, Track & trace (supply chain visibility), and Logistic information pipelines.

A higher degree of systems automation, the availability of smart sensors and global networks for data transfer between ship and shore will promote remote controlled, and semi or fully autonomous operation of assets. Interconnectivity between sea-based operations and shore-based operation centres will enable increasing support and control from the shore. This will require secure systems and operations against cyber-attacks. Growing digitalisation in all waterborne sectors will result in the use of electronical data as a substitute for current legal paper documentation.

The rapid development in information and communication technologies will significantly increase digitalisation in all waterborne sectors. A higher degree of systems automation, the availability of smart sensors and global networks for data transfer between ship and shore will promote remote controlled, and semi or fully autonomous operation of assets. This will require secure systems and operations against cyber-attacks. Growing digitalisation in all waterborne sectors will result in the use of electronical data as a substitute for current legal paper documentation. It will also have a significant influence on how assets are designed and operated.

Proposal for updating an R&D Road Map for e-Maritime and suggestions for an implementation plan and technology gap analysis will be included in deliverable D4.2. However, the main directions and topics for further technology developments that are beginning to emerge are indicated below:

- **Smart Ships:** Vessels with reduced manning levels and automated information management and surveillance with shore-based assistance, protected from cybersecurity risks. Improved integration with shore support centres for technical operation and remote maintenance.
- **Smart Ports:** Digital infrastructure and ICT innovation for ports, including: Robotics and automation; autonomous vehicles; the Internet of Things and Big Data Analytics, simulation and virtual reality, and cybersecurity.
- **European Marine Digital Highway:** Shore-based marine information and communication infrastructure linked with the corresponding navigational and communication facilities aboard ships.
- **Innovation in Hinterland Connectivity**: Improved interconnectivity and integration between transport modes and established systems; safe and interconnected systems for data exchange and supply chain optimisation.

2 Strategic Analysis

2.1 Steps performed

The strategic goal of WP4: *Thematic Technology Group (TTG) 4 – e-maritime*, is to facilitate networking of the actors who are involved in the maritime technological area of the e-maritime, with the aim of improving cooperation between the stakeholders in that area and strengthening the effectiveness of their research and innovation capacities. In particular the aim of the e-maritime Thematic Technology Group (TTG) is to form a comprehensive overview of all projects and initiatives e.g. e-maritime, e-navigation, e-Freight, and the instruments of the related EU, EMSA, ERDF, INTERREG, JRC, TEN-T and national projects, to support the definition of the EU's e-maritime.

The objectives of Task 4.1: *View of the clustered research projects: state-of-the-art, achievements, and opportunities for implementation* are to provide an overview of the relevant research projects, including the state-of-art in Europe and globally, and the achievements and opportunities for implementation.

This task provided a comprehensive list of EU and nationally funded research projects relevant to e-maritime, both current and completed, (from FP6 for EU projects) and a list of their main actors; the **Network of Projects**. In order to form a comprehensive overview of the current state-of-the-art for e-maritime, the projects and initiatives identified were initially categorised against four main focus areas: Ships Operation and e-navigation; Regulations Management; Logistic Chain and Port Operations and also by specific sub-topics, in order to facilitate the clustering of projects and to allow a more detailed analysis of their results.

A comprehensive overview of the identified projects was made from an analysis of the results both achieved and under development, together with an assessment of the opportunities for further implementation. The analysis and the opportunities for implementation were initially made by TTG4 partners and these topics were subsequently discussed with an enlarged network of experts at TTG4's first workshop held on 5 March 2014. The overview of the content and results of the projects analysed, including the general state-of-the-art in Europe and globally, provided the **State of the Art.**

Proposals were made for cooperation and information Exchange between relevant projects related to e-maritime; the **Cooperation Potential.**

Deliverable D4.1: *State-of-the- art, achievements, opportunities for implementation*, provides a comprehensive list of EU and nationally funded research projects relevant to the technology area of e-maritime, an assessment of the state-of-the-art in Europe and globally, and opportunities for implementation. A summary of the State-of-the-art and key conclusions, the network of projects, achievements, and opportunities for implementation, are given in Chapter 7.

The Thematic Technology Group 4: e-maritime, decided to define e-maritime in a way that was more focussed to help form a comprehensive overview of all projects and initiatives related to e-maritime. It would also support the definition of the EU's e-maritime Framework, and help ensure that e-maritime research needs and priorities are incorporated in the WATER*BORNE*^{TP} research planning process.

e-maritime is defined as the use of information exchange technologies to establish more efficient, more secure and safer cooperation between ships as well as between a ship and onshore stakeholders, in order to facilitate sustainable maritime transport

This definition of e-maritime establishes that the "ship" is the principal focus of the interactions between stakeholders, including certain functions that may be performed by organisations onshore, as illustrated in Figure 2. This definition also limits the scope of Task 4.1 to issues that support more efficient cooperation and that improve the information management involving the ship, which is the central part of the maritime transport system. However, as well as information exchanges between ships and the shore parties and the ship, the shore-based organisations will also interact between themselves to support ship operations, and these interactions can also be enhanced by e-maritime.

This definition of e-maritime will also help promote an integrated approach to the development of Information and Communications Systems for maritime transport and ensure their relevance and benefit for all relevant stakeholders and to facilitate their take-up in the marketplace.

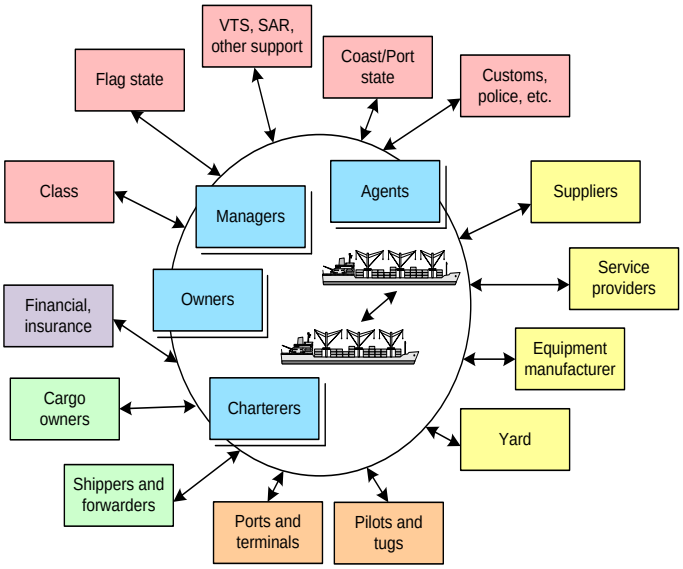


Figure 2: Illustration of some of the European e-maritime stakeholders

A review of the current state of plays for e-Maritime and e-navigation issues are given in **Annex 1** and a comprehensive list of EU and national research projects is given in **Annex 2.** The main actors involved in e-maritime covering the four main focus areas of TTG4: e-maritime, namely ship operation, including e-navigation, logistics chain, port operation, and regulation management, have been identified for the different funding sources. The main actors involved in the European and National funded research projects, by country, are listed in Tables 2 to 7 in **Annex 3**. A glossary for e-maritime/e-navigation is included in **Annex 4**, acronyms and abbreviations related to e-maritime in **Annex 5**, and acronyms and abbreviations related to e-navigation in **Annex 5**.

2.2 Summary of State-of-the-Art

2.2.1 Methodology

A general review of e-Maritime and e-navigation issues included a brief historical background, the objectives of the EU e-Maritime initiative, the e-Maritime Strategic Framework (EMSF), and IMO's

e-navigation concept. The role of SafeSeaNet, Port Community Systems (PCS) and the Single Window concept was also explained.

In order to form a comprehensive overview of the current state-of-the-art for e-Maritime, the projects and initiatives identified by the WP4 partners were initially categorised against four main focus areas: Ships Operation and e-Navigation, Port Operations, Logistic Chain and Regulations Management, and also by specific sub-topics, in order to facilitate the clustering of projects and to allow a more detailed analysis of their results.

For the purpose of this overview e-Maritime was defined as the use of information exchange technologies to establish more efficient, more secure and safer cooperation between ships as well as between a ship and onshore stakeholders, in order to facilitate sustainable maritime transport

An overview of the identified projects was then made from an analysis of the results achieved and those currently under development, together with an assessment of the opportunities for further implementation. The analysis and the opportunities for implementation were initially made by TTG4 partners and these were subsequently discussed with an enlarged network of experts at TTG4's first e-Maritime workshop held on 5 March 2014. The overview of the content and results of the projects analysed and the general state-of-the-art in Europe and globally provided the current State-of-the-Art. Proposals were also made for cooperation and information Exchange between relevant projects related to e-Maritime, the Cooperation Potential.

2.2.2 Network of Projects: Identification of relevant European projects

Research projects related to e-maritime/e-navigation projects covering the four main focus areas of TTG4: ship operation, including e-navigation, logistics chain, port operation, and regulation management was identified from relevant European (from FP6 onwards), national, regional, and other RDI projects. These included projects funded under the EU Framework Programmes, DG MARE, EMSA, European Regional Development Fund, TEN-T, INTERREG, JRC, Marco Polo and nationally funded projects.

The 85 projects identified were analysed in order to establish the current state-of-the-art and technological development of e-maritime. The list of projects related to e-Maritime is given in Table 1 and the number of projects for each funding source is indicated in Figure 3 below.

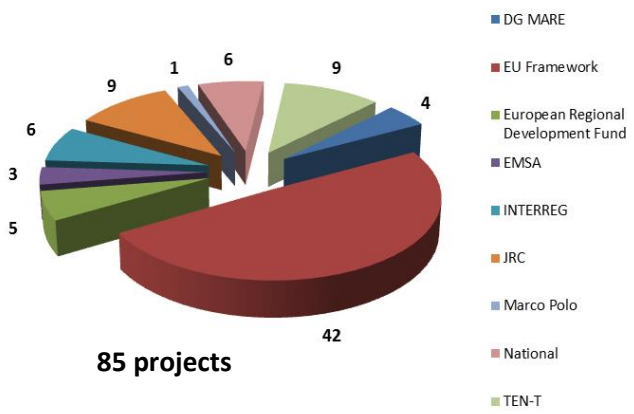


Figure 3: e-maritime related projects from different funding sources

Table 1: List of EU and National Research Projects related to e-maritime/e-navigation

Project Acronym	Project Title	Funding
EU Framework Projects:		
3SNET	Short sea shipping network	FP4
ADOPT	Advanced decision support system for ship design, operation and training	FP6
ARIADNA	Maritime assisted volumetric navigation system	FP7
AZIPILOT	Intuitive operation and pilot training when using marine azimuthing control devices	FP7
CASCADe	Model-based Cooperative and Adaptive Ship-based Context Aware Design	FP7
CyClaDes	Crew-centred Design and Operations of ships and ship systems	FP7
CONTAIN	Container Security Advanced Information Networking	FP7
DSS-DC	Decision support systems for ships in degraded condition	FP5
EcoHubs	**E**nvironmentally **co**herent measures and interventions to debottleneck **HUBS** of the multimodal network favoured by seamless flow of goods	FP7
e-Compliance	Integration and co-operation of regulatory compliance in the maritime domain	FP7
EfficientSea 2	Efficient, Safe and Sustainable Traffic at Sea	H2020
e-Freight	European e-Freight Capabilities for Co-modal Transport	FP7
EFFORTS	Effective Operations in Ports	FP6
eMAR	e-maritime Strategic Framework and Simulation based Validation	FP7
EMDM	European maritime data management	FP6
EUCISE2020	EUropean test bed for the maritime Common Information Sharing Environment in the 2020 perspective	FP7
EURIDICE	**EUR**opean **I**nter-**Di**sciplinary research on **I**ntelligent **C**argo for **E**fficient, safe and environment-friendly logistics	FP7
FAROS	Human Factors in Risk-Based Design Methodology	FP7
FLAGSHIP	European Framework for Safe, Efficient and Environmentally-friendly Ship Operations	FP6
FREIGHTWISE	Management Framework for Intelligent Intermodal Transport	FP6
Handling Waves	Decision Support System for ship operation in rough weather	FP6
HORIZON	Research into effects on cognitive performance of maritime watch-keepers under different watch patterns, workloads & conditions, with reality usage of ships bridge, engine & cargo control simulators	FP7
i-Cargo	Intelligent Cargo in Efficient and Sustainable Global Logistics Operations	FP7
INCASS	Inspection Capabilities for Enhanced Ship Safety	FP7
INTEGRITY	Intermodal Global Door-to-door Container Supply Chain Visibility	FP7
ITEA-DS	Intelligent tools for emergency applications & decision support	FP5
Logistics for Life	Logistics Industry coalition of Long-term ICT based Freight Transport Efficiency	FP 7 (CA)
MarNIS	Maritime Navigation and Information Services	FP 6
MUNIN	Maritime Unmanned Navigation Through Intelligence in Networks	FP7
NAVTRONIC	Navigational System for Efficient Transport System	FP7
SEABILLA	Sea Border Surveillance	FP7
SEAHORSE	Safety Enhancements in transport by Achieving Human Orientated Resilient Shipping Environment	FP7
SAFETOW	Strategic Aid for Escort Tugs at Work	FP6
SAFEWIN	Safety of winter navigation in dynamic ice	FP7
SAFEICE	Increasing the safety of icebound shipping	FP6
SKEMA	Sustainable Knowledge Platform for the European Maritime and Logistics Industry	FP7
SMART-CM	SMART Container Chain Management	FP7
SUPPORT	Security UPgrade for PORTs	FP7

TANGO	Telecommunications Advanced Networks for GMES Operations	FP6
TRITON	Trusted Vessel Information from Trusted On-board Instrumentation	FP7
SAFETOW	Strategic Aid for Escort Tugs at Work	FP6
SHOPERA	Energy Efficient Safe SHip OPERAtion	FP7
DG Mare		
BlueMassMed	Project for Maritime Surveillance of the Mediterranean Area and the Atlantic Approaches	IMP
IMP-MED	Integrated Maritime Policy for the Mediterranean	IMP
MARSUNO	Maritime Surveillance in the Northern Sea Basins	CISE
CoopP	Cooperation Project	IMP
Marco Polo:		
SHORTSEA-XML	Message Standard for Short Sea Shipping	Marco Polo
TEN-T Projects:		
AaNa (MIELE 2)	Advanced National Networks for Administration	TEN-T
B2MOS	Business to Motorways of the Sea	TEN-T
ITS Adriatic	ITS Multi-Port Adriatic Gateway	TEN-T
MoS4MoS	Monitoring and Operating Services for Motorways of the Sea	TEN-T
MIELE	Multimodal Interoperability E-services for Logistics and Environment sustainability	TEN-T
MIELE Extended	Multimodal Interoperability E-services for Logistics and Environment sustainability	TEN-T
MONALISA	Motorways & Electronic Navigation by Intelligence at Sea	TEN-T
MONALISA 2.0	Motorways & Electronic Navigation by Intelligence at Sea	TEN-T
PORTMOS	Integration of the Portuguese Ports and Maritime System in the Motorways of the Sea	TEN-T
INTERREG projects:		
ACCSEAS	Accessibility for Shipping, Efficiency Advantages and Sustainability	INTERREG
iTRACT	Improving Transport and Accessibility through new Communication Technologies	INTERREG
i Transfer	Innovative Transport Solutions for Fjords, Estuaries and Rivers	INTERREG
NS FRITS	North Sea Freight and Intelligent Transport	INTERREG
Port Integration	Multi-modal Innovation for Sustainable Maritime & Hinterland Transport	INTERREG
SESTANTE	ICT instruments for interoperable processes at Mediterranean ports	INTERREG
European Regional Development Fund projects:		
Efficensea	Efficient, Safe and Sustainable Traffic at Sea	
FREIGHT4ALL (MED project)	A distributed and open FREIGHT transport ICT solution 4 ALL stakeholders in the Mediterranean area	ERDF
FUTUREMED (on-going MED project)	Freight and passenger supporting info-mobility systems for a sustainable improvement of the competitiveness of port-hinterland systems of the MED area	ERDF
MEDITA (on-going MED project)	MEDiterranean Information Traffic Application; RFID solutions at ports and port terminals	ERDF
MEDNET (on-going MED project)	Mediterranean Network for Customs procedures and Simplification of Clearance in Ports	ERDF
EMSA Projects:		
Blue Belt Project	Blue Belt pilot project	EMSA
IMDatE	Integrated Maritime Data Environment -	EMSA
THETIS	Information system that supports the new Port State Control inspection regime	EMSA
JRC Projects:		

MASURE 2007, 2008	Maritime Surveillance	JRC
CONTRAFFIC 2009,2010,2011	Container Traffic Monitoring	JRC
VESCOSUR	Vessel and Container Surveillance	JRC
VESPO 2009, 2010, 2011	Vessel Surveillance and Port Security	JRC
National Projects:		
CEDEX INTERMODALIDAD	Maritime-rail integration	Spain
MariBrain	Research and Development of an automated data collection system through wireless sensor networks and knowledge management with remote monitoring and analysis of the status and performance of ships	Greece
MarSafe	Maritime Safety in High North	Norway
Shipping KPI	Shipping KPI	Norway
STIMULO	Simulation and real time prediction of trucks arrival to ports	Spain
TIMI	Intelligent Intermodal Freight Transport	Spain

2.2.3 The Main Actors:

The main actors involved in the most important European and nationally funded projects related to e-maritime/e-navigation projects covering the four main focus areas of TTG4 (ship operation, including e-navigation, logistics chain, port operation, and regulation management), have been identified for each of the mainstream projects. Consolidated lists of the main actors involved in the related European research projects, according to their funding source, are given in Annex 2 of this report.

The main actors involved in e-maritime are to be found mainly from the following three groups:

i. subject experts from research organisations and universities who are knowledgeable in e-maritime or e-navigation and who have probably published technical papers;

ii. those who have to practically implement the procedures and processes that e-maritime may affect, such as ship operators, ports operators, freight forwarders; Classification societies; European Maritime Associations;

iii. administrations such as Member States; Flag States; European Commission; EMSA; etc., whose requirements may be more easily complied with using e-maritime solutions.

2.2.4 General State-of-the-Art in Europe

The main topics and areas of technologies identified from the projects related to e-Maritime, particularly in those areas where a relevance to the current WATER*BORNE* priorities has already been established are indicated below for the areas of: Ship Operations, e-navigation, Port Operations and Logistics Chain.

Ship Operations:

i. Research projects have aimed at fostering a holistic and integrated approach for sea transportation. These have aimed at offering efficient quality shipping services fully integrated in the overall European transport system using an upgraded information management infrastructure

ii. ICT technologies have been used for the development of shipping services, such as Strategic Fleet Management, Personnel management and training systems, Chartering, Ship condition monitoring, maintenance and emergency support systems, loading planning and optimisation, and Voyage management systems.
iii. Electronic documentation, e-compliance, e-recruitment, e-drawing, e-purchasing, and e-voyage planning have also been covered within the innovative single window architecture.

e-navigation:

i. e-navigation encompasses all aspects of ship operation for safe navigation, including weather routing, minimising fuel consumption and emissions, and reducing maintenance costs, as well as effective VTS and ship-port communication for optimised port entry and cargo handling.
ii. EU research related to e-navigation has covered eight main areas: e-navigation architecture; human element; conventions and standards; position fixing; electronic navigation charts (ENC); equipment standardisation; and scalability. Research has also taken place on unmanned vessels
iii. The key technologies involved relate to the navigation (e.g. ECDIS electronic charts, radar, and sonar), condition monitoring (e.g. hull stress sensors), vessel tracking, (e.g. AIS, LRIT), satellite imagery and communications, and computer software

Port Operations:

iv. EU research projects related to ports have focussed on three main areas: port management and operations, infrastructures, and multi-modal traffic in port terminals. The common objective was to help achieve higher levels of efficiency in ports
v. This research has provided important information for logistics and multimodal transport operations and processes, or how they can be improved, through the application of new support technologies, such ICT and simple data exchanges
vi. ICT is the main technology and recent research has focused on integrating web-based systems for multimodal transport logistics and port networking, within the e-maritime framework

Logistics chain:

vii. European research in transport and logistics services sectors has mainly addressed the issues of information flow in the supply chain.
viii. Recent European projects have focused improving the efficiency of the transport interfaces, logistical planning throughout the value chain, inland port interface, and improving the monitoring of cargo flows
ix. Current research effort has gone beyond simple information exchange and includes full scale profiles, risk based management and efficient flows of cargo with minimised downtime and waiting
x. Research has also aimed to develop and implement decentralised ICT infrastructure for new planning services, including CO2 calculation capabilities and for existing systems to co-exist and co-operate efficiently

Regulation Management:

xi. The main areas covered by the various research projects and other initiatives reviewed have been information sharing and integration, interoperability of disparate “legacy” systems, and re-use of information.

xii. Much of the e-maritime activity in the area of regulations management has been promoted by various EU policies, directives and international regulations that determine information exchange requirements between businesses and administrations in the maritime sector. e-navigation activity on the other hand is an IMO concept.

xiii. A recently impetus has come from the need to meet the deadlines for compliance with the EU Directive on reporting formalities (2010/65/EU). The single window will be the place where all information is reported once and made available to various competent authorities and the EU countries. Another objective has been to assist in the implementation of the New Inspection Regime (NIR) for Port State Control.

2.2.5 General State-of-the-Art Globally

The use of e-maritime or digital information services to facilitate the flow of goods by maritime transport has focussed primarily on shore-based facilitation and the development of electronic technology, processes and services for the ships that carry cargo. However, IMO's e-navigation initiative for exchanging maritime information makes use of the same electronic technology and processes. The e-navigation initiative also supports vessel traffic management, which will be eventually realised through a global Marine Electronic Highway.

Maritime and transport industries worldwide have developed specific systems and applications of ICT technologies for exchanging information in the maritime domain and many of which are comparable to what has been developed in Europe. European applications for ship operations and maritime transport are nevertheless considered to be state-of-the-art and more advanced in some areas such as in the logistics domain and Port Community Systems. Furthermore, it is only in Europe that there has been an over-arching initiative to link up the various elements of e-maritime, in order to achieve the fullest benefit from information exchanges.

Ship Reporting Systems

An example of a European e-maritime development for shipping operations is the range of services made available by ShipServ[1]. This claims to offer the largest online trading platform, the most used supplier search engine, the leading ordering guide, and the first online advanced network.

The Singapore APL shipping company have introduced an Electronic Data Interchange (EDI) computer-to-computer information exchange services for companies to exchange business documents, such as bookings, shipment Instructions and invoices, thus eliminating the need for sending paper documents by traditional means. Currently there are several integrated e-solutions covering all the aspects of shipping operations that have been developed in Europe as well as in the rest of world, which are utilised worldwide and are considered as the global stated-of-the-art.

e-navigation

Europe seems to have a higher activity level in the area of e-navigation than the rest of the world. One exception is South Korea which is more active in the area than most others. South Korea has launched its "Smart Navigation Project" with a funding of about 114 million USD. The project is running from 2016 to 2020 and has a strong focus on e-navigation support for smaller vessels, such as fishing boats.

International work on e-navigation can be divided into two main groups:

[1] http://www.shipserv.com/

i. *"Traditional" e-navigation* with most emphasis on improved information quality and access. This includes weather or tide information, improved chart quality and other similar issues. Australia and Canada have done much in this area as has many others. Under keel clearance can normally be said to be in this group.
ii. *New e-navigation* systems focusing more on new technology and procedure developments. Examples of this are active traffic management strategies and new communication systems. South Korea and Singapore has been relatively active in these fields.

Port Community Systems

The most advanced concepts using ICT to support the modernisation of the ports and trade facilitation are the "Single Window (SW)" and the "Port Community System (PCS)".

Europe is home to some of the most efficient Port Community Systems in the world. European ports were pioneers in developing PCSs and they are still working on systems improvement because these kinds of projects are always open to be upgraded. The first PCSs began to operate in the late 70s or early 80s in Germany, France and UK. Countries such as the Netherlands and Spain started their PCSs in the 1990s or at the turn of the century. This places Europe as the home to some of the most efficient Port Community Systems in the world.

Logistics Chain

The adoption of ICT technologies has led to significant improvements in exchanging information in the maritime domain worldwide. The systems used by large companies appear to have proven their value with a significant return on the investment. For example, the ICT systems used to integrate the Container Shipping lines with the Container Terminals and ultimately with the Truck Companies, have significantly improved the efficiency of the end-to-end supply chain. To this extent, ship operations and maritime transport have reduced the costs and the value to the end customer has increased.

The European applications of ICT in the logistics domain are considered to be state-of-the-art. Many Open Source Systems that have widespread use are developed within the EU28. Nevertheless, more investment is still needed so that further improvements in digital transport, logistics and waterborne transport are realised.

Regulator Management

Smart software technologies and ICT systems can significantly ease the burden on the crew, and automate data collection, processing and reporting, protect assets, save costs, and reduce risk. Commercial solutions are now being provided to reduce these administrative burdens. For example, lnterManager is actively working with state authorities across Europe to achieve the "paperless ship", and sees the EU's Maritime Single Window as a way to achieve this. The ultimate aim would be to create a paperless ship and a virtual vessel on a server with all the required data, updated with the latest information and with all relevant parties notified.

Strategic guidance on some of the aspects of e-Maritime policy (now being addressed at the European level by the Forum on Digital Transport and Logistics) is also being given internationally by the International Maritime Organisation, which, like the Forum, is seeking to overcome the obstacles that prevent the full exploitation of the vast amount of data that is available in the maritime transport sector and which could support new business opportunities, as well as improve the use of existing resources.

For example, one of the key initiatives of the IMO's e-navigation project (also covered above) is automated ship reporting, under which many forms currently required for customs, immigration,

cargo manifest and dangerous goods, for example, will be made and submitted electronically in a harmonized format for all ports.

2.2.6 Cooperation Potentials

The newly-established Digital Transport and Logistics Forum have identified some possible issues for cooperation and information exchange across all transport modes, and these include: Electronic transport documents, Track & trace (supply chain visibility), Data value chain (data liability and quality), and Logistic information pipelines. Although this Forum will be focused on freight transport and logistics, across all transport modes, they will have some possible maritime topics for consideration, including: Optimised sea routeing, Optimised port services (including port clearance and national reporting obligations), Maritime clouds, Electronic ship certificates and Cybersecurity.

Many of the more recent research projects related to e-maritime make use of the results from completed projects. This is a good illustration of actual cooperation and information exchange between projects. Some more general proposals for cooperation and information exchange in the network, and between current and future projects related to e-maritime and e-navigation, are given below:

i. ***Ship operations:***
   The e-maritime Strategic Framework (EMSF) developed by the eMar project provides an architectural framework for integration of systems and services in the e-maritime domain.
   The e-maritime Ecosystem and its cloud services provide a platform to publish software services related to shipping; it also acts as a kind of proxy for these services and it could be used for implementing different applications for ship operations.

ii. ***e-navigation:***
   e-navigation requires improved integration between the parties and systems and a key element is standards for communication e.g. on-board networks, integration between networks on-board and the integration between ship and shore; cooperation between projects in this area would be beneficial.
   Accseas has contributed to the general development of the concept of e-navigation testbeds, which has been taken up by IMO. Other EU projects working in this domain are strongly encouraged to adopt the use of test-beds and simulation facilities to analyse the performance of systems.

iii. ***Port operations:***
   MIELE is designing an ICT platform to interface existing systems for ship reporting formalities, in order to make them fully interoperable. Similarly, ITS Adriatic project have boosted the development of an EDI platform able to provide information interoperability and integrating in one network of the four ports of the NAPA community (Venice, Trieste, Koper and Rijeka).

   FUTUREMED, STIMULO and MEDITA are related to the use of information arising from and provided to other elements in the multimodal transport related to port operations.

iv. ***Logistics:***
   3SNET, FREIGHTWISE, EURIDICE, eMAR, CONTAIN, SHORTSEAXML, iCARGO and INTEGRITY have contributed to the development of communication systems, protocols, standards and ICT. Integrating and streamlining the data models and requirements will lead to better adoption of these messages by more logistics stakeholders.

INTEGRITY, CONTAIN and eMAR have developed security elements for the container based cargo flows. L4L, ECOHUBS and iCARGO have efficiency improvement elements (both energy and environmental). SMART-CM, eMAR, iCARGO, EURIDICE and NSFRITS has developed modules for the transport planning process, each addressing different aspect of the process.

v. ***Regulation management:***

eMAR and AnNa, together with DG Taxud and others, are currently cooperating on various issues related to Maritime reporting documentation, such as the introduction of the electronic customs goods manifest (e-Manifest) into EU Custom's law.

The e-Compliance project will build upon strengths created across numerous EU projects, including FLAGSHIP, to help reduce the administrative burden on maritime stakeholders resulting from the fragmented nature of regulations in the maritime domain.

2.2.7 Main lines of future development

Improving competitiveness, safety, and security of European shipping is a major objective of the EU Maritime Transport Strategy, which in turn shapes the requirements for upgraded maritime transport information management. Advances in ICT have created a demand for new forms of surveillance and information management systems; these are increasingly driven by policy and governance addressing safety, security, and sustainability. This is reflected in the emergence of the IMO's e-navigation concept and the more embracing European Commission's e-Maritime framework, established for measurable economic, social and environmental benefits.

The rapid development in information and communication technologies will significantly increase digitalisation in all waterborne sectors. A higher degree of systems automation, the availability of smart sensors and global networks for data transfer between ship and shore will promote remote controlled, and semi or fully autonomous operation of assets. Interconnectivity between sea-based operations and shore-based operation centres will enable increasing support and control from the shore. This will require secure systems and operations against cyber-attacks. Growing digitalisation in all waterborne sectors will result in the use of electronical data as a substitute for current legal paper documentation. It will also have a significant influence on how assets are designed and operated.

Proposal for updating an R&D Road Map for e-Maritime and suggestions for an implementation plan and a technology gap analysis, are to be addressed in deliverable D4.2 TTG4 e-Maritime: Proposals for R&D Road Map. However, the likely main directions of further technology developments for e-Maritime and e-navigation are indicated below:

Ship Operations:

- **Smart ships:** vessels with reduced manning levels, real-time monitoring of ship performance with automated information management and surveillance. Improved integration with shore support centres for technical operation and remote maintenance. As data networks, data management, and sensors become more vital for ship operation, these systems will need to be carefully protected from cybersecurity risks.

Port Operations:

- **Smart Ports:** Integration of national single windows with trade portals and port community systems: providing one entry point for all logistics, operational and administrative information. Digital infrastructure and ICT innovation: Robotics and automation; autonomous vehicles; the Internet of Things and Big Data Analytics, simulation and virtual reality, cybersecurity.

e-navigation:

- **European Marine Digital Highway:** Integration of navigation technologies with shore based data networks and centres (SafeSeaNet, (AIS, LRIT), GNSS, National Single Window, VTS, route planning etc.) with the corresponding navigational and communication facilities aboard ships to provide an accurate, safe and secure "e-Navigation-based" ship operation management system for a marine digital highway.

Logistics Chain:

- **Innovation in Hinterland Connectivity**: Improved interconnectivity and integration between transport modes and established systems, such as: Maritime national Single Windows, RIS, e-Customs, TAF, rail one stop shop, "access points", "data pipelines"; digitalisation of transport documents and acceptance of e-transport documents. Safe and interconnected systems for data exchange

Regulations Management:

- Information sharing in the maritime domain, for policy areas such as: Maritime Policy; Marine Strategy Framework Directive; Common Fisheries Policy; Integrated Coastal Zone Management; Maritime Transport; Ports; e-Maritime; Maritime Safety.

3 State-of-the-Art in Europe and Globally

3.1 Introduction

The world has become more interconnected due to global communications and transportation and more interdependent due to the growth of international trade, investment, and finance (UN, 2000)[2]. The transportation of cargo and containers by sea underpins the world trading system and global economic prosperity (OECD, 2003)[3]. The number of containers handled globally in 2014[4] was 679.4 million TEU containers, and European ports handled 119.1 million containers.

With the growth of world trade information communication technologies (ICT) has increasingly been used in the international transport for supply chain management and for global logistics. Many governments have developed national plans to upgrade their management systems to improve cargo logistics in their countries in order to cope with the growing global logistics demands. Numerous international carriers are endeavouring to provide global logistics services, but the different types of management systems are not interoperable and there are regional disputes over different port and customs related procedures. Web-portals for information integration in port and shipping communities have been introduced in a number of counties, to provide administration to administration (A2A), administration to business (A2B), business to administration (B2A), and business to business (B2B) services.

[2] OECD, (2003) Security in Maritime Transport: Risk Factors and Economic Impact, Maritime Transport Committee, July.

[3] United Nations, (2000) United Nations Millennium Declaration, General Assembly

[4] Drewry Maritime Research, Global Container Terminal Operators, Annual Report 2015.

The increasing use of IT in ship management solutions, is driven by the need to cut costs and increase efficiency, and made possible by developments such as the "connected ship" concept and more cost-effective satellite communications. As well as improved vessel operating efficiency, including fuel cost control, and better crew management, ship-owners are looking to benefit from streamlined reporting. An ongoing goal is to reduce the time that seafarers sit at a computer and enter data.

The use of e-maritime or digital information services to facilitate the flow of goods by maritime transport has focussed primarily on shore-based facilitation and the development of electronic technology, processes and services for the ships that carry cargo. However, IMO's e-navigation initiative for exchanging maritime information makes use of the same electronic technology and processes. The e-navigation initiative also supports vessel traffic management, which will be eventually realised through a global Marine Electronic Highway.

Maritime and transport industries worldwide have developed specific systems and applications of ICT technologies for exchanging information in the maritime domain and many of which are comparable to what has been developed in Europe. European applications for ship operations and maritime transport are nevertheless considered to be state-of-the-art and more advanced in some areas such as in the logistics domain and Port Community Systems. Furthermore, it is only in Europe that there has been an over-arching initiative to link up the various elements of e-maritime, in order to achieve the fullest benefit from information exchanges. Further incremental improvements in digital waterborne transport and logistic are however still needed to improve competitiveness by using the latest technologies, such as the Maritime Cloud, the Internet of Things and Big data analytics.

3.2 Ship Reporting Systems

An example of a European e-maritime development for shipping operations is the range of services made available by ShipServ[5]. This claims to offer the largest online trading platform, the most used supplier search engine, the leading ordering guide, and the first online advanced network.

The Singapore APL shipping company have introduced an Electronic Data Interchange (EDI) computer-to-computer information exchange services for companies to exchange business documents, such as bookings, shipment Instructions and invoices, thus eliminating the need for sending paper documents by traditional means. The Port of New York and New Jersey have also introduced a central web portal for checking container availability, export booking status and other information. This web-portal is part of a port community system for online sharing of information.

Currently there are several integrated e-solutions covering all the aspects of shipping operations that have been developed in Europe as well as in the rest of world, which are utilised worldwide and are considered as the global stated-of-the-art. The dominant e-solution is the Veson Nautical from USA (www.veson.com) which claims to enable commercial maritime companies to make better business decisions and more strategic and effective use their resources. Veson Nautical serves over 7,000 users at more than 200 prominent maritime organisations worldwide. Another Enterprise Resource Planning (ERP) package developed by the Norwegian company SPECTEC (www.spectec.net), known as AMOS Enterprise Management Suite (A EMS), delivers a total

[5] http://www.shipserv.com/

solution, combining leading edge maintenance and purchasing with a unique and holistic approach to compliance management.

European information exchange services for shipping operations are the state-of-the-art and recognised worldwide. These services include the DNV-GL Ship manager integrated solution (www.dnvgl.com) and the Danaos ERP system (www.danaos.gr), which are installed on more than 2,000 ships and supporting 600 plus maritime clients worldwide. The Danaos system is also available on the maritime cloud, the first to be materialised within the e-Maritime strategic framework (EMSF). The dominant crew training companies worldwide are MARLINK, SEAGULL and VIDEOTEL, of which the latter two are European companies.

3.3 e-navigation

The IMO has put e-navigation back on the high-level action plan of the Maritime Safety Committee. The programme was to finish this year, but the outcomes achieved at MSC 95 in October 2015 mean that work will continue for at least four more years. Five of the six planned work items were approved with the opportunity to re-present the sixth next year.

According to John Erik Hagen, Regional Director at the Norwegian Coastal Administration and leader of the e-navigation correspondence group at IMO, “As technology develops, many new systems are being introduced such as the under-keel clearance system in the Torres Strait and another in the St Lawrence Seaway. If e-navigation is to work around the world, these innovative systems must be harmonized as far as possible for ships to be able to use e-navigation globally.”

International work on e-navigation can mainly be divided into two groups:

1. *"Traditional" e-navigation* with most emphasis on improved information quality and access. This includes weather or tide information, improved chart quality and other similar issues. Australia and Canada have done much in this area as has many others. Under keel clearance can normally be said to be in this group.
2. *New e-navigation* systems more focusing on new technology and procedure developments. Examples of this are active traffic management strategies and new communication systems. Korea and Singapore has been relatively active in this.

Some of the countries and the more widely published activities are tabulated in Table 2 below. This list does not include European projects which have been discussed elsewhere in this report.

Table 2: Some countries with published activities in e-navigation

Canada	Information distribution	http://www.ccg-gcc.gc.ca/e-Navigation
Singapore	Ship Traffic Management in the Straits of Malacca and Singapore	http://straits-stms.com/
South Korea	Communication systems, Information models, shipping efficiency	IMO papers: NCSR 1/INF.7 NCSR 2/INF.9, NCSR 2/INF.10
Japan	More efficient shipping: Smart Ship Application Platform	http://www.e-navigation.net/index.php?page=ssap-smart-ship-application-platform
China	General ship communication and information exchange	http://www.e-navigation.net/index.php?page=yangshan

In general, Europe seems to have a higher activity level in the area of e-navigation than the rest of the world. One exception is South Korea which is more active in the area than most others. South Korea has launched its "Smart Navigation Project" with a funding of about 114 million USD where about 56 million goes to infrastructure and the rest to R&D. The project is running from 2016 to 2020 and has a strong focus on e-navigation support to smaller vessels, typically fishing boats.

3.4 Port Community Systems

The most advanced concepts using ICT to support the modernisation of the ports and trade facilitation are the “Single Window (SW)” and the “Port Community System (PCS)”.

A port is like a virtual enterprise where a cluster of companies comes together to provide a single face to the customer. The effective coordination and collaboration of the various departments (stakeholders) of such a ‘virtual’ company is essential for the proper functioning of the supply chain. This coordination can be achieved by means of a PCS: a neutral and open electronic platform that optimises manages and automates smooth port and logistics processes through a single submission of data, enabling intelligent and secure exchange of information between public and private stakeholders.

While the SW deals with G2G and B2G processes and has a national scope, PCS deals mainly with B2B and B2G processes and has a more local scope. PCS is ideally placed to become a backbone component of the ‘Single Window’ environment. A PCS provides for the electronic exchange of information between all port and logistics sectors and is acknowledged as the most advanced method for the exchange of information within a single or national port community infrastructure.

Key drivers for the establishment of PCS are, on the one hand, the need for a standardised communication platform in order to improve the systems in terms of punctuality, reliability or costs and, on the other hand, the need to increase competitive position among ports. The main difficulties in their implementation are frequently related to governance and coordination problems and not so much to technological barriers.

Current policies and initiatives overseas and especially in Europe are fostering the adoption of Single Window environments and PCSs. These are both becoming widespread not only in big ports but also in medium sized ports. Most of regions and countries are working on Single Windows environments and PCSs adapted to their own particularities and examples of good practices can be found all over the world (Europe, Singapore, USA, Korea, etc.).

Europe is home to some of the most efficient Port Community Systems in the world. European ports were pioneers in developing PCSs and they are still working on systems improvement because these kinds of projects are always open to be upgraded. The first PCSs began to operate in the late 70s or early 80s in Germany, France and UK. Countries such as the Netherlands and Spain started their PCSs in the 1990s or at the turn of the century. This places Europe as the home to some of the most efficient Port Community Systems in the world.

Nowadays, the International Port Community Systems Association (IPCSA) represents the interest of most of the PCS Operators around the world. IPCSA is the successor to the European Port Community Systems Association (ECPSA), which was launched in 2011 by six founding members, all European-based Port Community System operators. IPCSA and its members play a vital role in global trade facilitation; the electronic communications platforms provided by PCSs ensure smooth transport and logistics operations at hundreds of seaports.

The vast majority of PCSs operating in an international context are port specific. Only two countries developed National PCSs, such as India and South Africa. On the other hand, there are numerous examples of PCSs covering two or more ports. This is the case of PortBase (ports of Rotterdam and Amsterdam) or valenciaportpcs.net (ports of Valencia, Sagunto and Gandia).

Other examples of PCS Operators are DAKOSY and dbh in Germany, SOGET and mgi in France, MCP plc and CNS in United Kingdom, APCS in Antwerp (Belgium), KL-NET in Korea, IPCS in Israel, 1-stop in Australia, etc.

3.5 Logistic Chain

The Logistics sector in the European Union but also beyond seems rather isolated in terms of extending and/or sharing the information upstream or downstream both the supply and the value chain. The use of specific software systems for transport and logistics management includes:

- Cargo Handling systems,
- Fleet Control Systems,
- Maintenance Management Systems
- Telematics systems,
- Intelligent Transport Systems,
- Electronic workflow systems (basic systems)
- Document management systems,
- e-Ticketing systems (for passenger carriers)
- e-Invoicing,
- Warehouse Management Systems (logistics / warehousing companies only) and
- Intermodal Transportation Management Systems.

Nevertheless, these systems are mainly used by large transport and logistics companies. In order to acquire information and improve the procedures by adding intelligence and automation, the transport and logistics companies are using Enterprise Resource Planning (ERP) applications that handle customer information, material planning forecasts, pricing information. The supplier relationship management (SRM) and Customer relationship management (CRM) systems handle procurement processes and sales and most of them rely on the legacy EDI standards for message exchanging. Although most ERP systems integrate data and processes of an organisation into a unified system, this information and knowledge remains strictly within the company. Thus, regarding the e-business standards only a fraction of the companies communicate one another based on EDI standards.

e-Commerce and e-marketing in the transport and logistics industry is still lagging behind because of the level of investment and due to the constraints of information sharing within the transport/supply/value chains. In the freight transport and logistics industries, ecommerce includes initiating, tracking, and acknowledging shipments online. Again, only large companies are using such systems and provide end-to-end visibility.

Furthermore, the industry is also adopting (with small steps though) RFID technologies as well as digital signatures and the like. Nevertheless, the same problems seem to prevail, including wider adoption, limitation in the information sharing and lack of investment willingness.

As a conclusion, it has to be noted that the adoption of ICT technologies has led to significant improvements in exchanging information in the maritime domain worldwide. For systems used by

large companies, it seems that they have proven their value and have also had a significant return on the investment. For example, the ICT systems used to integrate the Container Shipping lines with the Container Terminals and ultimately with the Truck Companies, have improved considerably the efficiency of the end-to-end supply chain. To this extent, ship operations and maritime transport have reduced the costs and the value to the end customer has increased. The European applications of ICT in the logistics domain are considered to be state-of-the-art and also, many Open Source Systems that have widespread use, are developed within the EU28. Nevertheless, more investment is still needed so that further improvements in digital transport, logistics and waterborne transport are realised.

3.6 Regulatory management

Smart software technologies and ICT systems can significantly ease the burden on the crew, and automate data collection, processing and reporting, protect assets, save costs, and reduce risk. The utilisation of smart vessel reporting can mean that it is easier to carry out administrative functions, for example onboard reporting assisted by software to reuse available data and pre-fill many necessary forms, integrated information evaluation to enhance the operating economy of ship, automated data processing and interchange.

Commercial solutions are now being provided to reduce these administrative burdens. For example, lnterManager is actively working with state authorities across Europe to achieve the "paperless ship", and sees the EU's Maritime Single Window as a way to achieve this. The ultimate aim would be to create a paperless ship and a virtual vessel on a server with all the required data, updated with the latest information and with all relevant parties notified.

IT companies are also incorporating into maintenance and compliance software packages solutions for the reporting and accountability requirements of new legislation such as the forthcoming US Coast Guard's proposed Subchapter M guidelines for the inspection of tugs and towboats[6].

The United States Coast Guard's Notice of Proposed Rulemaking (NPRM), which was published in August, 2011, is considered likely to have a significant impact on electronic recordkeeping (e-logbooks) and Software as a Service (Saas), as the Sub-M Final Rule allow for the use of an "electronic record" to meet those statutory recordkeeping requirements onboard in the same way as a vessel logbook.

Although it is not enough that only one segment of U.S.-flagged vessels will enjoy the opportunity to tackle the overwhelming burden of recordkeeping with the assistance of software based solutions, it is likely that this approach will follow throughout the other Sub-Chapters of NPRM.

Historically the USCG has provided for the overall regulatory framework for shipboard recordkeeping in the Code of Federal Regulations, various NVICs, and Commandant Instructions but has left to the marine industry the development of detailed means of how to accomplish the marine operators' regulatory and commercial recordkeeping requirements. Now, with the Sub-M language, a vast and loosely regulated environment will exist for onboard electronic recordkeeping solutions.

This approach presents an opportunity for marine operators to streamline their entire shipboard and shore side operations with respect to recordkeeping requirements[7].

[6] Data overload. Maritime Executive, July/August 2015

The Transas Electronic Logbook (e-Logbook), which is designed to replace traditional paper logbook and to record all data in full detail with a minimum input from a user, has been confirmed by the Panama Marine Authority, the largest shipping flag state, as equivalent to the paper version for use on board the ships registered under the Panamanian Flag[8].

At the international level, a revised version of the IMO Convention on the Facilitation of International Maritime Traffic (FAL) is set to be adopted in April 2016. It will include an important new standard relating to the obligation of public authorities to establish systems to exchange arrival and departure information electronically when ships enter or leave port. An IMO project is underway to develop a so-called "single window" for such exchanges, and it was presented at the first Logistics Information Standardization Forum by IMO's Julian Abril. Held on Jeju Island, Republic of Korea (9 Sept 2015), the forum was organised by the Korea Maritime Institute and attended by participants from China, Japan and the Republic of Korea[9].

With regard to information sharing and integration to improve safety and reduce accidents, one example of transnational/international cooperation on information sharing is from and between regional Port State Control bodies, such as the Paris Memorandum of Understanding on Port State Control (Paris MoU). The Paris MoU is a voluntary agreement in which the participating authorities have agreed to maintain an effective system of port state control and to carry out a certain number of inspections on merchant ships of certain priority calling at one of its ports of anchorage. Additionally, the authorities have agreed to consult, cooperate and exchange information with other authorities in order to further the aims of the MoU, and the detailed rules for the sharing of information among authorities are specified in section 5 of the Memorandum.

There is also cooperation and information sharing and between regional Port State Control bodies, for example between the Paris MoU and the Tokyo MoU, on dedicated Concentrated Inspection Campaign (CIC) aimed at checking procedures etc.

Moves towards improved and wider information sharing and integration to enhance maritime surveillance through better maritime data exchange are taking place through a number of national, transnational and international initiatives, under bodies such as NATO, in addition to the various actions and initiatives aimed at establishing a Common Information Sharing Environment (CISE) for the surveillance of the EU maritime domain.

Nationally, many EU Member States are beginning to focus on integrating information sharing across user communities, and some have already established national coordination centres and information sharing environments. Others are in the process, or plan to do so. According to a study for DG MARE by COWI[10], there is an on-going trend of establishing national or cross-sectorial information sharing environments. This trend also means existing IT surveillance systems are being consolidated to an increasing extent, and that Member States therefore are moving towards a higher degree of integration of maritime surveillance information across fewer systems

Various administrations have recognised the need to provide guidance and assistance to the shipping industry to help compliance with regulatory requirements. The United States Coast Guard

[7] E-Logs and Saas Poised to Transform U.S.-flagged Shipboard Recordkeeping by Dean Shoultz. gCaptain, September 14, 2015
[8] Transas e-Logbook Gets Panama Flag Approval by Joseph R. Fonseca. MarineLink, September 21, 2015
[9] IMO press briefing, 11/09/2015
[10] The development of the CISE for the surveillance of the EU maritime domain and the related Impact Assessment

(USCG) have developed the Electronic Notice of Arrival/Departure (eNOAD) application on the World Wide Web to provide the representative of a vessel with the means of fulfilling the arrival and departure notification requirements of the USCG and Customs and Border Protection (CBP), online. The Maritime & Port Authority of Singapore has also developed an electronic reporting system for the pre-arrival notification of security submission (ePANS).

Support for regulatory compliance is also being provided by specialised IT companies. One example is Regs4ships[11], which offers products and services designed to keep all commercially operating vessels, super yachts, shore-based support and regulatory organisations, compliant with maritime regulations, technical and operational information.

Strategic guidance on some of the aspects of e-Maritime policy (now being addressed at the European level by the Forum on Digital Transport and Logistics) is also being given internationally by the International Maritime Organisation, which, like the Forum, is seeking to overcome the obstacles that prevent the full exploitation of the vast amount of data that is available in the maritime transport sector and which could support new business opportunities, as well as improve the use of existing resources.

For example, one of the key initiatives of the IMO's e-navigation project (also covered above) is automated ship reporting, under which many forms currently required for customs, immigration, cargo manifest and dangerous goods, for example, will be made and submitted electronically in a harmonized format for all ports.

The drive to reduce the administrative burden of reporting the same information to multiple shore authorities has been recognized by the IMO by prioritizing the revision of the guidelines and criteria for ship reporting systems (resolution MSC.43(64), as amended) relating to standardized and harmonized electronic ship reporting and automated collection of onboard data for reporting.

A revised version of the IMO Convention on the Facilitation of International Maritime Traffic (FAL) is set to be adopted in April 2016. It will include an important new standard relating to the obligation of public authorities to establish systems to exchange arrival and departure information electronically when ships enter or leave port. An IMO project is underway to develop a so-called "single window" for such exchanges, and it was presented at the first Logistics Information Standardization Forum by IMO's Julian Abril. Held on Jeju Island, Republic of Korea (9 Sept), the forum was organized by the Korea Maritime Institute and attended by participants from China, Japan and the Republic of Korea[12].

3.7 Cyber security

Maritime cyber-security is an important issue that has received much attention in the public discussion and which has been an issue in many projects mentioned in this report. As examples we have selected the following projects:

- *MUNIN:* The danger of cyber-attacks on fully or partially unmanned ships.
- *MONALISA:* The danger of tampering with open data broadcast between ship and port where sensitive sailing instructions or maritime safety information is involved.

[11] Regs4ships (http://www.regs4ships.com/)
[12] IMO press briefing, 11/09/2015

- *SUPPORT:* Attack on port systems to tamper with cargo data (smuggling) or to determine targets for pirate attacks.
- *iPATCH:* Risk of cyber threat as transmission or GPS spoofing, intrusion into information system that could be a new course of action.
- *e*Compliance: Authentication of electronic certificates.
- *eMar:* Authentication of electronic ship reporting.

Currently IMO and other maritime organisations are also looking into this issue. So far, it is mainly physical and organizational safety issues that have been addressed, e.g. avoiding using unchecked USB sticks to transfer electronic chart data to the ECDIS chart plotter. The problem of establishing systems and infrastructures for electronic certificates has also been an issue in the FAL Committee.

The maritime sector faces some special constraints that make it somewhat difficult to adopt mainstream security approaches. Among these are:

- There is normally no crew on-board that has sufficient expertise in network and computer management to effectively maintain a good security regime on the ship. Remote support is possible, but is expensive and awkward due to limited bandwidth and high communication costs.
- It is a highly international business that requires international standards that work all over the world. This includes technology as well as infrastructure, e.g. for public key management.
- It is a very cost sensitive business that requires extremely cost-effective technology and infrastructures.
- Ships are not always on-line and solutions need to support authentication mechanisms that are not dependent on direct Internet access.
- Message sizes, e.g. for VHF data transmissions and some forms of documents must be small and the technology cannot require large overhead on data transmissions.

On the other hand, it is not conceivable that the maritime business will develop technology and solutions only for use in that domain. It needs to use or adapt solutions that have similar constraints, e.g. from ITS or aerospace industries.

It may be argued that the development of maritime cyber-security technology is not necessarily research as such. A better way of finding acceptable solutions would be to participate in the decision making process at IMO and in international standards organizations. On this basis maritime cyber security may not be a suitable theme for a conventional Research and Development project, but the fact remains that this issue has to be addressed and that resources have to be allocated. One possible solution would be to use the CSA mechanism and ask Research and Development projects where maritime cyber-security is an issue to coordinate efforts through that CSA.

4 Network of Projects

The lists of current and previous research projects related to e-maritime are given in Table 3 and Annex 2. These include projects those funded under the EU Framework Programmes, DG MARE, EMSA, European Regional Development Fund, TEN-T, INTERREG, JRC, Marco Polo and nationally funded projects. All of these 85 projects have been considered and analysed in order to establish

the current state-of-the-art and technological development of e-maritime. The number of projects for each funding source is indicated in Figure 4.

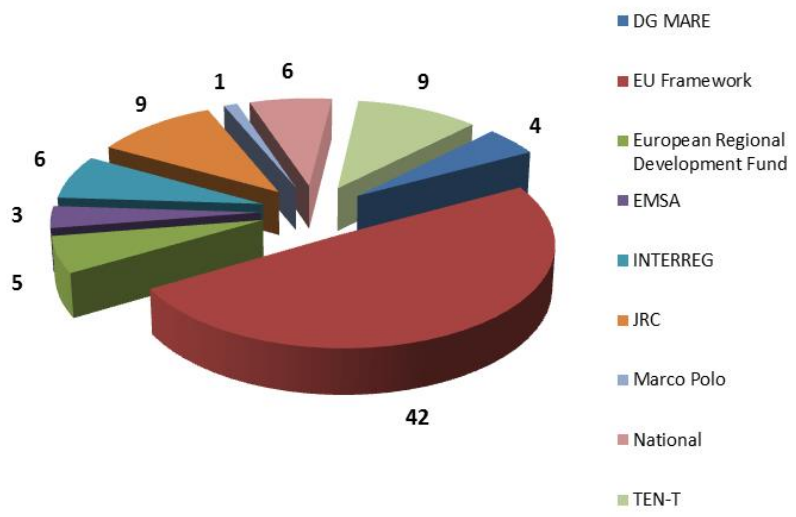


Figure 4: e-maritime related projects from different funding sources

Table 3: List of EU and National Research Projects related to e-maritime/e-navigation

Project Acronym	Project Title	Funding
EU Framework Projects:		
3SNET	Short sea shipping network	FP4
ADOPT	Advanced decision support system for ship design, operation and training	FP6
ARIADNA	Maritime assisted volumetric navigation system	FP7
AZIPILOT	Intuitive operation and pilot training when using marine azimuthing control devices	FP7
CASCADe	Model-based Cooperative and Adaptive Ship-based Context Aware Design	FP7
CyClaDes	Crew-centred Design and Operations of ships and ship systems	FP7
CONTAIN	Container Security Advanced Information Networking	FP7
DSS-DC	Decision support systems for ships in degraded condition	FP5
EcoHubs	**E**nvironmentally **co**herent measures and interventions to debottleneck **HUBS** of the multimodal network favoured by seamless flow of goods	FP7
e-Compliance	Integration and co-operation of regulatory compliance in the maritime domain	FP7
EfficientSea 2	Efficient, Safe and Sustainable Traffic at Sea	H2020
e-Freight	European e-Freight Capabilities for Co-modal Transport	FP7
EFFORTS	Effective Operations in Ports	FP6
eMAR	e-maritime Strategic Framework and Simulation based Validation	FP7
EMDM	European maritime data management	FP6
EUCISE2020	EUropean test bed for the maritime Common Information Sharing Environment in the 2020 perspective	FP7

EURIDICE	**EUR**opean **I**nter-**Di**sciplinary research on **I**ntelligent **C**argo for **E**fficient, safe and environment-friendly logistics	FP7
FAROS	Human Factors in Risk-Based Design Methodology	FP7
FLAGSHIP	European Framework for Safe, Efficient and Environmentally-friendly Ship Operations	FP6
FREIGHTWISE	Management Framework for Intelligent Intermodal Transport	FP6
Handling Waves	Decision Support System for ship operation in rough weather	FP6
HORIZON	Research into effects on cognitive performance of maritime watch-keepers under different watch patterns, workloads & conditions, with reality usage of ships bridge, engine & cargo control simulators	FP7
i-Cargo	Intelligent Cargo in Efficient and Sustainable Global Logistics Operations	FP7
INCASS	Inspection Capabilities for Enhanced Ship Safety	FP7
INTEGRITY	Intermodal Global Door-to-door Container Supply Chain Visibility	FP7
ITEA-DS	Intelligent tools for emergency applications & decision support	FP5
Logistics for Life	Logistics Industry coalition of Long-term ICT based Freight Transport Efficiency	FP 7 (CA)
MarNIS	Maritime Navigation and Information Services	FP 6
MUNIN	Maritime Unmanned Navigation Through Intelligence in Networks	FP7
NAVTRONIC	Navigational System for Efficient Transport System	FP7
SEABILLA	Sea Border Surveillance	FP7
SEAHORSE	Safety Enhancements in transport by Achieving Human Orientated Resilient Shipping Environment	FP7
SAFETOW	Strategic Aid for Escort Tugs at Work	FP6
SAFEWIN	Safety of winter navigation in dynamic ice	FP7
SAFEICE	Increasing the safety of icebound shipping	FP6
SKEMA	Sustainable Knowledge Platform for the European Maritime and Logistics Industry	FP7
SMART-CM	SMART Container Chain Management	FP7
SUPPORT	Security UPgrade for PORTs	FP7
TANGO	Telecommunications Advanced Networks for GMES Operations	FP6
TRITON	Trusted Vessel Information from Trusted On-board Instrumentation	FP7
SAFETOW	Strategic Aid for Escort Tugs at Work	FP6
SHOPERA	Energy Efficient Safe SHip OPERAtion	FP7
DG Mare		
BlueMassMed	Project for Maritime Surveillance of the Mediterranean Area and the Atlantic Approaches	IMP
IMP-MED	Integrated Maritime Policy for the Mediterranean	IMP
MARSUNO	Maritime Surveillance in the Northern Sea Basins	CISE
CoopP	Cooperation Project	IMP
Marco Polo:		
SHORTSEA-XML	Message Standard for Short Sea Shipping	Marco Polo
TEN-T Projects:		
AaNa (MIELE 2)	Advanced National Networks for Administration	TEN-T

B2MOS	Business to Motorways of the Sea	TEN-T
ITS Adriatic	ITS Multi-Port Adriatic Gateway	TEN-T
MoS4MoS	Monitoring and Operating Services for Motorways of the Sea	TEN-T
MIELE	Multimodal Interoperability E-services for Logistics and Environment sustainability	TEN-T
MIELE Extended	Multimodal Interoperability E-services for Logistics and Environment sustainability	TEN-T
MONALISA	Motorways & Electronic Navigation by Intelligence at Sea	TEN-T
MONALISA 2.0	Motorways & Electronic Navigation by Intelligence at Sea	TEN-T
PORTMOS	Integration of the Portuguese Ports and Maritime System in the Motorways of the Sea	TEN-T
INTERREG projects:		
ACCSEAS	Accessibility for Shipping, Efficiency Advantages and Sustainability	INTERREG
iTRACT	Improving Transport and Accessibility through new Communication Technologies	INTERREG
i Transfer	Innovative Transport Solutions for Fjords, Estuaries and Rivers	INTERREG
NS FRITS	North Sea Freight and Intelligent Transport	INTERREG
Port Integration	Multi-modal Innovation for Sustainable Maritime & Hinterland Transport	INTERREG
SESTANTE	ICT instruments for interoperable processes at Mediterranean ports	INTERREG
European Regional Development Fund projects:		
Efficensea	Efficient, Safe and Sustainable Traffic at Sea	
FREIGHT4ALL (MED project)	A distributed and open FREIGHT transport ICT solution 4 ALL stakeholders in the Mediterranean area	ERDF
FUTUREMED (on-going MED project)	Freight and passenger supporting info-mobility systems for a sustainable improvement of the competitiveness of port-hinterland systems of the MED area	ERDF
MEDITA (on-going MED project)	MEDiterranean Information Traffic Application; RFID solutions at ports and port terminals	ERDF
MEDNET (on-going MED project)	Mediterranean Network for Customs procedures and Simplification of Clearance in Ports	ERDF
EMSA Projects:		
Blue Belt Project	Blue Belt pilot project	EMSA
IMDatE	Integrated Maritime Data Environment -	EMSA
THETIS	Information system that supports the new Port State Control inspection regime	EMSA
JRC Projects:		
MASURE 2007, 2008	Maritime Surveillance	JRC
CONTRAFFIC 2009,2010,2011	Container Traffic Monitoring	JRC
VESCOSUR	Vessel and Container Surveillance	JRC
VESPO 2009, 2010, 2011	Vessel Surveillance and Port Security	JRC

National Projects:		
CEDEX INTERMODALIDAD	Maritime-rail integration	Spain
MariBrain	Research and Development of an automated data collection system through wireless sensor networks and knowledge management with remote monitoring and analysis of the status and performance of ships	Greece
MarSafe	Maritime Safety in High North	Norway
Shipping KPI	Shipping KPI	Norway
STIMULO	Simulation and real time prediction of trucks arrival to ports	Spain
TIMI	Intelligent Intermodal Freight Transport	Spain

4.1 Main Actors

The main actors involved in e-maritime will be found mainly from the following three groups:

a. Firstly, subject experts from research organisations and universities who are knowledgeable in e-maritime or e-navigation and who have probably published technical papers;
b. Secondly, those who have to practically implement the procedures and processes that e-maritime may affect, such as ship operators, ports operators, freight forwarders; Classification societies; European Maritime Associations;
c. Thirdly, administration such as Member States; Flag States; European Commission; EMSA; etc., whose requirements may be more easily complied with using e-maritime solutions.

The main actors involved in the most important European and nationally funded projects related to e-maritime/e-navigation projects covering the four main focus areas of TTG4 (ship operation, including e-navigation, logistics chain, port operation, and regulation management), have been identified for each of the mainstream projects. Consolidated lists of the main actors involved in the related European research projects, according to their funding source, are given in Annex 2 of this report; these lists are for:

- **EU Framework Projects**: The main actors that participated in the mainstream EU Framework funded projects related to e-maritime, are listed in **Table 2 in Annex 3**. The projects are: ARIADNA, e-Compliance, EFFORTS, eMar, MarNIS, MUNIN, and SKEMA.
- **TEN-T Projects:** The main actors that participated in the mainstream EU TEN-T funded projects related to e-maritime, are listed in **Table 3 in Annex 3**. The projects are: AnNa, MIELE, MONALISA, MONALISA 2.0, Port Integration, and PORTMOS
- **INTERREG projects:** The main actors that participated in the mainstream INTERREG funded projects related to e-maritime are listed in **Table 4 in ANNEX 3**. The projects are: ACCSEAS, iTract, and iTranfer.
- **European Regional Development Fund projects:** The main actors that participated in the mainstream European Regional Development Fund projects related to e-maritime are listed in **Table 5 in Annex 3**. The projects are: Efficensea, FREIGHT4ALL, and MEDNET.
- **DG Mare funded projects**: The main actors that participated in the mainstream DG Mare funded projects related to e-maritime are listed in **Table 6 in Annex 3**. The projects are: BlueMassMed, IMP-MED, MARSUNO, CoopP and EU CISE 2020.

- **National Funded projects:** The main actors that participated in the mainstream National funded projects related to e-maritime are listed in **Table 7 in Annex 3**. The projects are: MARIBRAIN, Marsafe and Shipping KPI.

5 Detailed Analysis of clustered projects

5.1 Ship Operations: Overview of research status and technology achievement to date

From the beginning of this century the EU has co-funded several research projects aimed at fostering a holistic and integrated approach in sea transportation. The vision was to incorporate all relevant stakeholders into systems focused on the relations and interactions among entities instead of entities themselves.

The ship is one of the important nodes and its operation is one of the core and multivariable activities of the maritime ecosystem. Integrated projects such FLAGSHIP and eFREIGHT were aimed at establishing an EU framework for safe, efficient and environmentally-friendly ship operations as well as EU competitiveness.

The results of completed projects have been utilized in the development of commercial services in all aspects of a ship operation, such as crew training and performance optimization, energy efficiency, operation risk management and assessment and technical management.

In recent years the European Commission's e-maritime initiative has been matured and has adopted projects in this direction, some of which have concluded while others are still in progress.

Upgraded e-maritime solutions should facilitate decision making and information exchange between different stakeholder groups involved in:

- Improving the safety and security of maritime transport services and assets and environmental protection.
- Increasing the competitiveness of the EU maritime transport industry and strengthening the EU presence on the international scene.
- Integrating sustainable waterborne transport services into efficient door-to-door transport services in Europe and beyond.
- Reinforcing the human factor particularly supporting competence development and welfare for seafarers.

Electronic documentation, e- compliance, e-recruitment, e-drawing, e-purchasing, and e-voyage planning are covered with the innovative single window architecture.

Overview of research status and technology achievements	*Reference project:*
▪ FLAGSHIP has successfully developed the first intelligent regulatory search and automated form filling system known as FLAGSHIP-RCS (Regulatory Compliance Support). The system could significantly reduce the regulatory compliance and administrative burden ship owners and operators currently experience with estimates indicating a 50% time saving, compared with conventional text based search methods. If every European ship adopted automated form filling this could lead to a total time cost saving in the region of €8.94 million per year	FLAGSHIP

▪ FLAGSHIP has achieved major advances in accurately measuring on-board power requirements and thereby enabling a reduction in fuel consumption through the development of FLAGSHIP-EEM (Energy Efficiency Monitoring). The system enables data acquisition and analysis to continuously evaluate power requirements at every stage of a vessel's voyage. The system provides information that enables improved fuel consumption that can reduce both operational costs and its environmental impact ▪ Flagship developed a monitoring system that applies the Technical Condition Indexing scheme (TCI) to help a ship's crew monitor and improve the technical condition of the engines. The deployment of the FLAGSHIP-TCI system can help a ship's crew to enhance voyage safety, lower fuel consumption and reduce the emission of air pollutants ▪ Flagship developed a decision support tool for alarm management system.	
▪ MarNIS has essentially addressed the maritime transport 'reporting' issue both from the point of view of improved efficiency of the ship reporting processes and from the way the information is used by authorities in enhanced safety and environmental risk management. In the context of e-maritime, MarNIS outputs address an integrated approach to Information Management for Maritime Safety Security and Environmental Risk Management. The overall purpose of such a system would be to enable authorities to better monitor/control maritime traffic in European waters which is in line the modified 2002/59/EC VTM Directive aimed at establishing a Community vessel traffic monitoring and information system.	MarNIS
The two main MarNIS outputs were:	
▪ **MOS: Maritime Operational Services** addressing the integration of emergency related processes. MOS promotes proactive services to avoid incidents occurring and to minimize their impact once detected. Functions such as SAR, VTS, enforcement, oil pollution response, risk determination, use of places of refuge through the use of temporary Maritime Assistance Services (MAS) and sending Emergency Towing Vessels (ETV) are combined in a MOS centre; people responsible for one or more of these tasks can share the same information and equipment and co-operate in performing their tasks. MOS centres combine seamlessly information such as ETAs, AIS tracks, Risk Indices, meteorological information, surveillance info in order to support the operation of dynamic MARAs (MarNIS Risk Areas). MOS is aimed at supporting pro-active vessel traffic management to ships not only in their Territorial Sea but beyond and through into the boundaries of their Economic Exclusive Zone (EEZ).	MarNIS
▪ **MIM: Maritime Information Management** addressing the adoption of National Single Windows by all member states improving the manner in which data is reported to the authorities but also the way in which this data is distributed and made available to the various authorities, these being not only the "traditional" maritime authorities but also authorities such as	

customs, immigration and health. MarNIS has established specifications for Port Entry Profiles and Port Exit Profiles (PEPs) generated by the NSW to support decision making before the vessel arrives at port thus increasing clearance efficiencies. PEPS are designed for approximately 10 roles with emphasis on inspection reports and coordination of inspections. PEPS can be combined to suit the different ways maritime authorities are organized in different Member States.	
The eFreight project is aimed at supporting, from a transport perspective, the three pillars of European policy: ▪ Strengthening of the internal market and competitiveness; ▪ Improving regulation to create a more dynamic business environment; ▪ Promoting sustainable development. Specifically e-freight will contribute to the goals of the Freight transport Logistics Action Plan and ITS Action Plan pertaining to the development of: ▪ A standard framework for freight information exchange covering all transport modes; ▪ A European Single Transport Document for carriage of goods with all the necessary legislative support; ▪ A Single Window for administrative procedures; ▪ Simple, harmonized border crossings for all modes of transport ;) Simple procedures and the necessary infrastructure for establishing secure and efficient transport corridors between Europe, USA and Asia.	eFreight
Key elements of the eMAR shipping operations include: ▪ *Strategic Fleet Management* addressing both traditional strategies such as market segment focus, purchase and sale of ships, new buildings, fleet scheduling and business networking including cooperative planning of resources. Emphasis will be placed on Green Shipping strategies such as monitoring CO2 operational index, and improved ship environmental monitoring and control which in the future could be connected to emission trading; benchmarking to compare ships with same or similar technical systems ▪ *Personnel management and training systems* addressing setting terms of employment for sea-going personnel, coordinating recruitment and assigning crews to a company's vessels, coordinating training enabling fast familiarization. ▪ *Chartering* addressing particularly monitoring chartering rates and trends from brokers, brokers' reports, and publications, negotiation of charter party terms and monitoring communications between charterers and vessels, and alerting company to possible problems; ▪ *Ship condition monitoring, maintenance and emergency support systems* addressing automated generation and dissemination of ship efficiency monitoring and environmental reporting, certification and surveys management and services to support Class in identifying areas of concern	eMar

upon which planned surveys should concentrate, synchronization of maintenance schedules with purchasing, stock positioning, crewing and inspection plans, integration of information from different proprietary ship maintenance systems and manufacturers, alert services on what has to be done and information on 'what has changed since specific dates, 'intelligent' services to self-organize following deployment or failure and co-ordination of remote operations; ▪ *Loading planning and optimization* particularly interaction with routing, port systems and cargo monitoring systems; ▪ *Voyage management systems* addressing contract reviews, appointment of agents and surveyors, bunkering, operational supplies, voyage instructions to Masters, voyage monitoring, compliance management and completion activities.	

5.2 e-navigation: Overview of research status and technology achievements to date

e-navigation is an IMO initiative that was started at MSC 81 (Maritime Safety Committee) in December 2005 by a proposal from seven different countries. The goal was to develop a more holistic approach to the use of information technology and new electronic tools onboard the ship and on shore. In 2009 the strategy was adopted by MSC 86 with the following definition of e-navigation:

"*e-navigation is the harmonized collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment.*"

Thus, e-navigation should be understood as those activities that directly address safety, security and environmental protection, while e-maritime can be said to also encompass commercial, logistical and more general efficiency measures.

The following overview will concentrate on issues that by the above definitions have contributed to e-navigation or are still to be developed. The topics have been taken from the strategy document from IMO (MSC 85/26Add.1, Annex 20).

Most projects described are from FP6 and FP7, but some older projects of particular importance have also been included.

Overview of research status and technology achievements	*Reference project:*
1. Architecture The MarNIS projected contributed significant work to e-navigation architectural definitions. Later projects working in this or adjacent areas are Flagship (shipboard network architecture, ship-shore communication), MUNIN (further contributions to ship-board and secure ship/shore communication systems). MUNIN, at its termination in August 2015, will have contributed to standards for	MarNIS Flagship MUNIN ITEA-DS DSS_DC Monalisa

ship-shore communication for autonomous ships as on-ship data networks and interfaces to integrated communication systems (draft ITU report on communication, IEC 61162-460 and draft IEC 62940 respectively). Background information can be found in public reports from MUNIN. Projects ITEA-DS, Flagship and DSS_DC also contributed to communication architectures for emergency management. INTERREG projects Monalisa and Accseas have also worked directly with the e-navigation architecture. Accseas finished in February 2015 and have demonstrated a long range of e-navigation possibilities. This includes notices to mariners, no-go areas, and exchange of routes between ships, vessel cooperation tools and developments of the Inter-VTS messaging format (IVEF). They have also provided a draft specification for a "maritime cloud" which has been proposed to IMO as a communication framework for e-navigation. eMar is also an important part of this picture, particularly in integrating e-navigation with e-maritime frameworks. The e-maritime Strategic Framework (EMSF) has been developed by eMar and this model will in many cases overlap with or interface to the e-navigation architecture. This framework has been developed as an UML model and is documented in an open report from eMAR (D1.3). Also the eMAR Ecosystem (D2.1) may be of interest in the context of the e-navigation architecture. It is a cloud based implementation of a cooperation framework for the e-maritime participants. eMar has also contributed input to the single window which is also of interest to e-navigation (D3.5). See also D.5.7.11 which is a brief statement on the relationship between eMar and e-navigation. The AnNa project should also be mentioned as it is concerned with the maritime single window in Europe. It aims at developing a prototype MSW according to the reporting directive. It will finish at the end of 2015. IMO, IALA and IHO have also worked in this area and one can say that much of this has been covered. However, improved integration of the different layers of the architecture and more detailed developments are still needed.	Accseas eMar AnNa
2. Human element This has to be a part of all projects introducing new ways that humans interact with systems. Thus, most projects mentioned elsewhere have investigated this issue. In the 7th FP, we can mention projects like FAROS (Human Factors in Risk-Based Design Methodology), CyClaDes (Crew-centred Design and operations of ships and ship systems) as well as CASCADe (model-based Cooperative and Adaptive Ship-based Context Aware Design). HORIZON investigates fatigue in various realistic seagoing scenarios using bridge, engine-room and cargo simulators. AZIPILOT has investigated training of pilots for ships with special propulsion systems. SEAHORSE investigates transfer of methods and knowledge from the aeronautics sector to shipping with emphasis on resilience in the system designs to avoid errors related to human factors. ADOPT (FP6) has also looked into decision support systems for training and assisting crew in demanding ship operations. A special project here is SAFEGUARD which has looked at human behaviour in crisis situations for better planning of emergency management situations, in this case for passenger ships. MUNIN has worked extensively with	FAROS CyClaDes CASCADe HORIZON AZIPILOT SEAHORSE ADOPT SAFEGUARD MUNIN

the human factor part of a shore control centre for autonomous ships. This is not directly applicable to current e-navigation thinking, but can certainly be relevant for, e.g., VTS and other shore installations. Several deliverables are available to describe these issues. This is a main element in a number of projects. It is more or less inexhaustible as it has to be revisited each time a new concept, equipment or work procedure is introduced.	
3. Conventions and standards Availability of standards is a critical element in all ICT related research. The amount of information being made available and the volumes being transmitted makes it next to impossible to develop new integrated applications without also considering standards for representation and transmission. This is also heavily linked to the architectural work. Projects like ATOMOS, PISCES and DISC (4/5 FP) started this work around 2000 and other projects mentioned under architecture continued the developments, particularly in network standards. For information standards there are also some projects, perhaps most notably Flagship, Efforts and MarNIS that had a relatively large activity on standards. As mentioned in the architecture section, MUNIN has also contributed to a number of new standards in this area.	MarNIS Efforts Flagship MUNIN
A special area here is reporting from ship to shore through FAL forms, SafeSeaNet and other mechanisms. This is also something that has been the theme of numerous projects like Efforts, MarNIS, e-Freight, e-Compliance, e-Mar and others. This also includes handling certificates and other documents needed to be kept onboard the ship. European maritime data management (EMDM – FP6) looked at data management for VDR and electronic log books. This is also an inexhaustible area as new standards are needed each time new information is produced or used.	MarNIS Efforts e-Freight e-Mar e-Compliance EMDM
4. Position fixing This theme is also a large area in EU, particularly when considering the emerging GALILEO system. Again, a huge number of projects have had elements of this. This includes issues like accurate manoeuvring in channels or ports, resilient position and time keeping systems, including avoiding spoofed or jamming as well as verifiable position fixes. Projects like MUNIN, Accseas, and Monalisa all have one or more of these elements. Accseas has in particular done extensive work on a multi-source positioning service. Documentation is available from their web site. MUNIN has done some work on cybersecurity related to position fixing (GNSS jamming and spoofing) in addition to development of an autonomous deep sea navigation module. The security work is limited to a risk analysis and guidelines to reduce risks. The TRITON project is directly addressing reliable positioning for ships.	Accseas Mona Lisa Efforts MUNIN TRITON
Efforts included navigation in very constrained waters. ARIADNA looks at volumetric navigation which is also related to this area. The TEN-T project	ARIADNA

MOS4MOS (Monitoring and Operating Services for Motorways of the Sea) is also working on new concepts for interfacing positing systems to port alert systems, although this project is more in the e-maritime domain. DOCKINGASSIST will look at this problem in ports.	MOS4MOS DOCKINGASSIST
5. Communication technology and information systems Communication is still a problem for shipping. This is due to the low number of customers at high seas and a corresponding high price and/or low service level. However, several projects are looking into this, including most of those mentioned under architecture. Communication can in principle be divided into the following areas: 1. *Onboard safety related data networks:* Flagship, PISCES, DISC, ATOMOS, ITEA-DS. Standards normally in the IEC 61162-series. MUNIN has contributed to the IEC 61162-460 standard and the draft IEC 62940 on integrated communication systems (ICS). 2. *Onboard safe integration with shore or other systems:* Flagship, MUNIN. See previous item on ICS. 3. *Ship to shore communication for high volumes:* Flagship, MUNIN. For MUNIN this turns out to be a manageable problem. Also, as pointed out earlier, as demand increases it is likely that service providers will put new satellites or transponder into service to cater for these demands. However, there will likely be a gap between demand and service provision for the foreseeable future. 4. *Ship to shore for safety communication, also in Arctic:* Accseas, Mona Lisa. This is an issue with the Accseas maritime cloud suggestion and has been highlighted as one, but no solution has been proposed. Note also that the security problem is different between public services (as in Accseas) and private and dedicated services as in MUNIN. MUNIN has investigated the problem of private data exchanges and identified vulnerabilities, e.g. in the shore segment. This has to be handled by strong encryption and access control. Accseas are in general more concerned about proper authentication of broadcast messages to all ships in an area. 5. *Data models for safety purposes:* MUNIN, Accseas, Monalisa. Standards should be based on IMO S-100.Accseas terminated in 2015 has developed draft S-100 based specifications for several of its new services (see architecture). MUNIN has collected information on data elements required for remote control of an autonomous ship, but this has not been put into a format useful for standardisation as the S-100 initiative at writing is not developed enough for operational data to warrant the effort. This is also an area where more research is needed.	PISCES ATOMOS DISC, DISC II ITEA-DS, DSS_DC Flagship MUNIN
6. Electronic Navigation Charts (ENC) Within e-navigation it is the distribution, coverage and quality that are the main worries. However, in research it is also extended use of the ENC platform for more advanced decision support and efficient rendering of information to mariners. Many projects has this as one of their objectives and one can	Efforts

tentatively group the projects as follows: 1. *Port ECDIS:* Special attention on highly detailed ENC for navigation or maintenance of ports. Efforts project. 2. *Overlay of maritime safety information:* Maritime information objects like ice, whales, weather and other. This has been an important issue in Accseas and new proposals have been created within the S-100 framework. This includes maritime safety information, no-go areas and route exchange data. 3. *New ways of using ECDIS stations:* For route exchange or emergency management, projects Accseas and Mona Lisa. Accseas have also demonstrated this based on the proposed S-100 specifications. An important element in the e-navigation standard is the development of the S-100 standard for next generation ECDIS which can accommodate more information types that the older S-57 standard.	Accseas Mona Lisa
7. Equipment standardization For our purpose, this heading covers new types of equipment for use on board or on shore. Examples of this may be head-up displays, wireless information devices for use on bridge or elsewhere, improved alarm systems, emergency management systems, improved coordination between ship and shore (VTS or port systems) etc. Many projects have contributed to this, e.g., Flagship, Accseas and others in the nautical domain. Also projects like NAVTRONIC provides new voyage planning systems to reduce fuel consumption and emissions. However, none of these projects have contributed suggestions to standards organisations such as IMO and IEC.	Flagship Accseas NAVTRONICS
8. Scalability This item covers providing new and improved solutions to non-SOLAS vessels. This can include leisure crafts, fishing vessels, inland waterway vessels or smaller ships in national traffic. One can also include efforts to include shipping in particularly demanding waters here, for instance in the Arctic. SAFEICE (FP6) is one project that could be mentioned as it also looks at traffic management in these areas. SAFEWIN is also in this area, with more focus on forecasting nautical performance for bulk carriers. EXTREME SEAS can also be mentioned here as it among other things looks at better weather forecasts for extreme sea conditions. HANDLING WAVES (FP6) looked into ship operations in heavy weather.	SAFEICE SAFEWIN EXTREME SEAS HANDLING WAVES

5.3 Logistics Chain: Overview of research status and technology achievement to date

The main challenges that the European and the Global Transport and logistics service providers face, which are already reflected in the related research projects, include the following:

1. The transport and logistics services sectors are heterogeneous and fragmented. The market players operate separately having their own strategies and operational plans and in isolation one another. This prevents integration of services and combination of resources, especially in "door to door" logistic chains.
2. Transport companies have not traditionally invested in information systems primarily because ICT is not viewed as a bottom line item compared to other industries, thus information sharing is limited and inefficiencies in planning and execution of services are often a reality.

3. The transport sector is heavily regulated in many different aspects (safety, security, environmental protection, competition, customs and labour laws to name a few) and as such the companies often appear to not meeting the standards and/or falling behind.

The European Research addresses primarily the issues of information flow in the supply chain. The modern business operations require an unbroken logistics chain from production to consumption, where all relevant information is available and at hand throughout the chain. Currently, the research effort goes beyond simple information and requirements include full scale profiles, risk based management and efficient flows of cargo without any (if possible) downtime and waiting. All systems reviewed attempt to capture information and exchange throughout the chain, based on specific rights and on specific terms.

The projects have focused their contributions on Transport, namely, improving the efficiency of the transport interfaces, improving the Logistical planning throughout the value chain, improving the port inland interface and last but not least improving the monitoring of the cargo flows. Additionally, the research aims to design and implement decentralized ICT infrastructure to allow real world objects, new planning services including CO2 calculation capabilities and existing systems to co-exist and efficiently co-operate. Intelligent and automated decision-making systems are set up to support:

- synchronize operations (transport and logistics) across various modes and actors,
- adapt to changing business conditions through dynamic planning,
- combine services, resources and information from different stakeholders,
- develop an ecosystem of actors, agents, stakeholders, services and improve the collaboration among them.

The need is to develop concepts, processes, standards and technologies that will enable networking and ICT supported co-operation among the main transport stakeholders in order to:

- Improve the safety and security of the transport sector
- Increase the competitiveness of the EU transport industry and strengthen the EU presence on the international scene
- Integrate sustainable transport services into efficient and secure door-to-door transport services in Europe and beyond.
- Reinforce the human factor particularly supporting competence development and welfare for seafarers.

The following table gives an overview of the main research results and the status.

Overview of research status and technology achievements	*Reference project:*
Transport Transport, is an integral part of the Logistics Chain. As such, most of the research projects reviewed are innovating in terms of new procedures, of new methods of sharing / fusing information to the relevant stakeholders upstream and downstream the value/supply chain and of new ICT Technologies to support them.	
Following closely the former, a key pillar is to create a platform where all stakeholders sit together and share information on business services and cargo flows. The project	L4L

LogistcsforLife (L4L) has created a multi-disciplinary network of logistic companies, technology providers and researchers. To this extent L4L created and established a reference framework to produce a set of services and ICT solutions that can be retrieved by the broader logistical and transportation community. An important trend in the Transport sector is Asset-less transport and logistics services providers acting as brokers between transport demand and supply. This market niche has an increasing share; however, the challenge is to disseminate information appropriately and effectively to all relevant stakeholders. Asset-less operations is a low margin business model which necessitates investment on ICT infrastructure and the collaborative freight management model proves to be a great opportunity. These systems allow the integration of the different supply chain actors; they boost efficiency and improve customer service. However, the interoperability cost and burden is too high for small players and advanced systems should be relatively cheap in order to capture as much market share as possible. Last but not least, all of the projects refer to data transparency and data ownership,	
Similarly, the INTERREG funded project NS FRITS has developed low-end ITS systems for the road transport sector. More precisely, the project developed fleet management systems and data capturing systems to enable better decision making. These systems apply to the entire market, including bottom line carriers and one of the strong points is that of minimum financial commitment requirements, since it operates as a cloud based service. The developed system is able to attract SMEs and micro companies as opposed to mainstream systems that are mainly addressed to larger companies, due to the complexity and the costs. This is also evident by the participants' feedback which included requests for: ▪ operational and low tier decision making (e.g. 'Turn by turn' satellite navigation functionalities) ▪ Platform agnostic oriented (e.g. 3G/4G/GPRS, web, etc.) so that no transfer costs are occurred ▪ Easy integration with existing company systems ▪ Additional information specific for road hauliers and drivers.	NS FRITS
In terms of improving the efficiency of transportation services, especially considering environmental efficiency, ECOHUBS provides models and capabilities for cooperation and communication between multimodal terminal network stakeholders. The development of a repository of services, the "Common Value Added Services", facilitate end-to-end co-modal, low-CO^2 transport solutions that maximise utilisation of terminal, transport and logistics resources. The ECOHUBS Cooperative Model for Green Hubs enables low-carbon, resource-efficient and secure transportation services by developing an Ecosystem for electronically connecting multimodal terminal network stakeholders and amplifying their joint transportation capabilities. The improved communications, shared resources and synchronised actions not only improves transport execution (visibility of supply chains) but also improves service offerings.	ECOHUBS
Similar to ECOHUBS, iCARGO aims to design and implement a decentralized ICT	iCARGO

infrastructure to allow real world objects, new planning services including CO_2 calculation capabilities and existing systems to co-exist and efficiently co-operate. iCargo's intelligent automated reactive decision-making integrates information obtained from on-going execution (from all modes) and enables improved planning processes. The iCARGO system achieves the following: ▪ synchronize vehicle movements and logistics operations across various modes and actors to lower CO2 emissions, ▪ adapt to changing business conditions through dynamic planning methods involving intelligent cargo, vehicle and infrastructure systems and ▪ combine services, resources and information from different stakeholders, taking part in an open freight management ecosystem.	
The MIELE project designed the architecture of an ICT platform ("MIELE middleware") able to interface existing systems for ship reporting formalities (such as national/port "single windows" or proprietary port community systems), in order to make them fully interoperable, as required by the Directive 2010/65 EU. The platform was tested through pre-deployment pilots in Italy, Cyprus, Germany, Portugal and Spain (the "National Vertical Pilots"), where the local ICT systems for ship reporting are made interoperable by interfacing with the MIELE Middleware. The National Vertical Pilots are demonstrators of both the feasibility of a national single interface ("single windows") and of their interoperability, as requested by the Directive. To this extent, interfaces for transport companies were also prepared and tested within this pilot action.	MIELE
Logistical planning	
One of the most important issues in Logistics operations is a seamless flow of information to all the chain actors. INTEGRITY has set up a so-called Shared Intermodal Container Information System (SICIS) allowing authorised companies and authorities to access planning and status information of selected consignments. Proactive planning following the Supply Chain Event Management (SCEM) approach allows to forecast problems in advance and adjust planning and operations accordingly. Matching logistics data with security information, e.g. from electronic seals, container security devices, and scanning equipment together with the integration of the AEO (authorised economic operator) approach allow to satisfy both the logistics industry and Customs Authorities fulfilling their obligations and creating value. The INTEGRITY supply chain visibility (SCV) system improves the collaboration in intermodal container chains ("security tracing") on a door-to-door basis. It fuses information from various types of sensors and other information sources to the relevant decision makers partially (pre-) processed by intelligent algorithms. Through the INTEGRITY system, a neutral system is put into action to improve capacity planning and enhance security. To this extent, and as will be further explained in the following paragraphs, CONTAIN also offers improved visibility, since the Situational Awareness platform, enables security stakeholders understand, measure, assess and decide on the risks which in turn improves logistical planning in end-to-end supply chains. Turning back to INTEGRITY, the system proposes a technology and entity agnostic	INTEGRITY

platform that can be adopted by any trade lane worldwide, enabling upgraded interfacing possibilities to any other system, including interfacing with similar EU Funded research oriented platforms like SmartCM and CHINOS. The business value that the INTEGRITY platform brings include: ▪ Terminal capacity planning and allocation ▪ Terminal efficiency assessment ▪ Working conditions in ports ▪ improving capacity utilization and demand management vis-à-vis vessel arrivals ▪ Waiting times for hinterland modes/operators ▪ Efficiency of information exchange The INTEGRITY Platform architecture includes the following elements: - The SICIS platform, which entails user management, data access governance, middleware (data feeds to/from other systems), - Trade lane Templates to model supply chain activities, trade lane milestones and target/KPI values, exception alerts generation, - Tracking Services, including real time tracking of containers and tracking of consignments, - Reporting services: real-time milestone reporting provides the milestone data collected in the supply chain for each container, - Exception alert services - Prediction services	
For disambiguation purposes, and in terms of logistics stakeholders, all projects identify the following broad categories based on their activities: – Shipper (usually the exporter) – Consignee (usually the importer) – Forwarder – Shipping line agent/logistics service – Ship broker – Inland Carrier – Shipping line/sea carrier – Terminal operator – Empty container depot – Customs – Regulatory authorities	L4L
The issue of a stakeholder and services repository is also tackled by 3SNET. The 3SNET project developed a database of all relevant shipping services, including links to intermodal railway services with a regular updating of the database. This database is available as an information tool for the logistics stakeholders and increases the services awareness of the sector.	3SNET
In order for the above schemes to be further elaborated, there is a strong drive in the LSP community to include as many services as possible. Partially, this may be fulfilled by the feeding of information from the various stakeholders. In order for this to materialize, a common framework is needed. Shortsea XML solves this problem by creating standard messages for exchange of data between parties in a shortsea	SHORTSEAX ML

transport chain. Its aim is to reduce administrative work and costs and therefore encourage more freight to be transferred from road to shortsea shipping. The Shortsea XML standard is promoted the European Shortsea Network and some of the individual participating Shortsea Promotion Centres. The XML standard is open to all interested parties, shippers, shipping lines, ports, forwarders, road hauliers or any other relevant organisation. The Shortsea XML is based on the UN CEFACT and is built on UN Core Components. The benefits, as addressed by the consortium include: ▪ Simplification and streamlining of administrative processes ▪ Reduction in administrative errors ▪ More transparency ▪ Improved customer service ▪ Saving of man hours ▪ Better vessel utilisation ▪ Easier to meet the reporting requirements of the authorities ▪ Reduced EDI implementation costs ▪ Neutral message management	
Furthermore, the MIELE project is also developing middleware in order to ▪ Map the needs of relevant stakeholders in order to design and develop the MIELE Middleware, ▪ Adapt, upgrade and integrate existing ICT systems including maritime single windows, port single windows, port communities, private operators' ICT systems) in order to improve interoperability.	MIELE
In terms of inclusion of the different logistics chain stakeholders, FREIGHTWISE developed a platform promoting interoperability in intermodal chains as well as practical solutions for a user community of intermodal operations. The FREIGHTWISE Framework architecture and the business models, the so-called Virtual Transport Network, facilitate overview, access and implementation of available services as well as business guidelines for the implementation of intermodal transport services.	FREIGHTWISE
This "inclusion", the holistic approach, typically requires several services to be combined either simultaneously, or in a specific order or in a combination of both. EURIDICE described indicative schemes for the combination of services which can become applications with the cargo centric approach. This approach is based on the concept of service oriented architecture.	EURIDICE
Logistics optimisation was achieved with the development of an eMAR-enabled Optimisation and Simulation (EOS) system which showcased how data that is captured by the eMAR framework can be used to plan the container logistics operation at the real-time and strategic levels to deliver cost savings for operators, faster turn-round times and reduced vehicle emissions. The optimisation solution was designed taking into account the EMSF model conventions, thus enabling visualisation of end-to-end transport chain services, and taking advantage of the increased levels of automation in information exchanges between different stakeholders to provide decision support services for optimisation of existing, new and upgraded services. The EOS system uses a flexible and intuitive graphical user interface that enables the user to visualise the operation. Interactive maps, gantt charts, histograms and reports	eMAR

are used to display information such as planned routes/corridors, resource allocation, container inventory levels, port activity and current/expected schedule of ships in the terminal. The EOS uses this information to optimise the integrated multimodal operation: ▪ Port/dock activity ▪ Rail movements ▪ Truck movements ▪ Container repositioning ▪ Ship schedules	
Port inland interface (inland transport, release/admittance confirmation)	
Ports (both sea ports and hinterland ports) play a pivotal role in the supply chain and as such, for the past few years we have witnessed a strong will to upgrade systems and procedures as well. The most important advance in the sector is the Port Community systems (PCS). In their elementary state, PCSs have been in operation within the main ports of Europe for many years, but their structure and presentation has predominantly been text based. The modern PCS is well advanced including web based and cloud based technologies, advanced applications that improve decision making in all organizational tiers and making the freight movement more efficient. Many carriers, agents and stakeholders still use legacy technologies including telex and fax and these are some of the obstacles that modern systems and EU led interventions have to overcome. To this extent, the 3SNET project advocates in favour of a single product that can be used by all different stakeholders and for different needs. In addition to that, the eMAR project develops the Maritime Single Window, which encompasses an advanced approach, the Maritime Ecosystem. eMAR developed the EMSF – e-maritime Strategic Framework, addressing the needs and the requirements of the maritime community. The different systems develop semi-autonomous modules (sub-systems) that may communicate one another using the ***"Access Point Technology"*** developed in the eFreight Project and coupled with the CRS- Common Reporting Schema. This technology is a set of descriptions and data models that enable a successful communication between interested parties in the supply chain. CONTAIN is also developing front/back end systems for port and port operators to improve risk management and to upgrade security in trade lanes. The Situational Awareness Platform that is developed includes advanced methodologies, instructions and procedures for ports to adopt and check security. Moreover, eMAR systems include interfaces with SafeSeaNet, e-Freight, e-Customs, National Single Windows, Galileo and e-navigation, which will fuse relevant information to the ports (for example, the data repository (/repositories) of SSN goes beyond simple ETA/ETD to include FAL Forms, safety forms etc. which may then be disseminated to other ports minimizing administrative burden for the shipping line). Additionally, the repository of e-maritime Applications and Services will also help the stakeholders improve the business offerings and become more efficient and more effective. Last but not least, eMAR developed a broad range of typical e-maritime services such as security and safety management, legislation and regulation	3SNET eMAR CONTAIN

compliance, shipping, port operations, and transport logistics.	
Both Projects are Government led in a sense, developing A2B and B2A systems. In this respect, the project by: ▪ Mapping the needs of relevant stakeholders, ▪ Designing and developing the MIELE middleware, ▪ Developing specifications for adapting, upgrading and integrating existing ICT systems (national single windows, port single windows, port communities, private operators' ICT systems) in order to be interoperable with the MIELE middleware, Demonstrating systems interoperability through the MIELE middleware ▪ Designing the framework for the exploitation of the MIELE middleware and the full deployment of its services after the completion of the pilot action. Building systems that can increase the visibility in terms of port hinterland. The systems will prepare all the necessary recommendations in terms of legislative improvements as well as the ICT systems themselves in order to enable the inland interfaces, improve the release/admittance processes, etc.	AnNA, MIELE
Monitoring	
Monitoring of cargo and movements has been very important and all projects address this issue one way or another. For example, Integrity developed the SICIS – the Shared Intermodal Container Information System – which provides functionality to allow containers to be tracked on trade lanes using a combination of data from Container Security Devices (CSD's) and the participating Terminals. The objectives of INTEGRITY's intervention are market led and include ▪ To be easily be adopted by any trade lane worldwide. ▪ Seamless interfacing possibilities and minimum no limitations in data exchange with other systems. ▪ Platform agnostic and easy interfacing to other platforms like the EU projects SmartCM dealing with similar aspects of container visibility and CHINOS addressing the issue of RFID in container logistics ▪ Data exchange and cooperation among the interested stakeholders To this extent, INTEGRITY's main value is the ability to integrate data from different sources along container supply chains, offering door-to-door tracking of containers. This unique level of coverage is not available through common visibility systems.	INTEGRITY
Vulnerability is a main issue in monitoring the Supply Chain. SMART-CM identified that the shift towards global supply networks during the past few years has increased the network vulnerability and risk. In order to better monitor the risks and decrease disruptions in the supply chain SMART-CM. The	SMART-CM
To this extent, the CONTAIN Project is also promoting the use of appropriate container security sensors providing monitoring and tracking data to be fused with additional information in order to identify high-risk containers that should be more carefully monitored and investigated. The project developed an EU Containers Surveillance Framework (ECSF) which provides a stakeholder enabled approach to secure containers transport balancing the interests, responsibilities and benefits of the key stakeholders. The Container Monitoring Solutions that are developed provide	CONTAIN

permanent and reliable localisation as well as information on the integrity and content of containers. This is coupled with a Situational Awareness Support Platform that facilitates the development of a distributed information management application. Last but not least, the CONTAIN Decision Support Services fully exploit the extended container monitoring and tracking information to optimise container transport related processes both in terms of security performance and efficiency and quality of container transport services.	
In EURIDICE, the consortium developed an Integrated Intelligent Cargo Framework to simplify the use of Access Based technology, under the name ecNodes. The Intelligent Cargo Network collects local intelligence and through the use of the semantic and security frameworks it fuses relevant information to the relevant stakeholders. The EURIDICE framework provides a design for the virtual and system service layers of the EURIDICE architecture. Additionally, EURIDICE introduces the term “digital shadow” to declare the interaction between systems by specifically instructing, at a functional level, the different systems what information they should exchange and how. EURIDICE uses functional oriented languages like Scala and Lisp, as an add-on for more commonly used programming languages like C++ and Java. Again, we see that the project consortium selected the Integrated Intelligent Cargo Framework to be platform independent.	EURIDICE
Special attention is to be given to the AnNa project, an EU Member States driven project, since it is the only project commissioned to support the implementation of the EC Directive 2010/65/EU (Reporting Formalities for Ships arriving in/departing from EU ports). AnNa fosters a harmonized approach for Administrative Facilitation: ▪ to reduce red tape for users (business) ▪ to parse IT languages and ▪ to exchange data between national (Maritime Single Window) networks. The AnNa project will support the integration of national Maritime Single Window developments and both B2B, B2A and A2A, including SafeSeaNet (SSN) integration. The most important contribution of the project will be a minimum data set based on which the requirements of the EU Directive 2010/65/EU can be (nationally) fulfilled as well as identification of standardisation and harmonisation opportunities. Similarly, MIELE developed processes and systems that increase the visibility of the cargo flows, in order to improve the monitoring of cargo, pre and post release from the ports.	AnNA, MIELE
The frameworks that were developed and piloted with these projects improve the monitoring and the supply chain/transport visibility. The projects by promoting standardisation and by continuing work in this area initiated in the SKEMA project, at an international level (IMO technical cooperation committee, ISO and specifically addressing supply chain integration GS1) have developed a Strategic Framework that is aimed at providing a bottom-up approach, open structures, participatory approaches and has followed these principles: ▪ Commonality: establishment of a common conceptual model of the transport domain of which shipping, ports and logistics, are an integral element, ▪ Simplicity: simple and easy to be interpreted so as to provide a common context for key processes and related solutions,	eMAR, iCARGO, ECOHUBS

▪ Stability: a governance structure that guarantees the framework stability, covering all changes in user needs, user requirements, organisational structures and technology, ▪ Independence: a framework that is independent of organisational issues as well as the physical realisation of the technical solutions, ▪ Usability: with easy to map activities, projects, systems, stakeholders and challenges into the model, and thus to find those parts of the architecture that are of relevance.	
Regulatory, Policy & High Level Interventions	
INTEGRITY set a vision on new ways of working for Customs, which was encompassed by the Dutch and UK Customs. The project advised on practical operations and consequences related to the EU ICS/ECS regulation for advanced notification to Customs and explored the value of visibility in logistics chains and the reasons for the current bottlenecks.	INTEGRITY
CONTAIN on the other hand has made solid recommendations not only for customs but also for all the transport security stakeholders (both business and administrations) in managing container security threats within logistic chains as part of an integrated approach to the efficient management of Door to Door (D2D) transportation networks. The technology options for container- integrated sensors are in line with other projects, however the advanced real time communication and security hardware and software technologies to monitor container movements and security and business related parameters can benefit the risk awareness of the Security officers. These recommendations have been noted by ports and transport networks to establish cost effective upgraded container security processes in addition to recommendation on the appropriate information gathering, validation, fusion and situational awareness services. The establishment of secure trade lanes between the EU and selected trading partners is also pivotal in facilitating seamless transport. Furthermore, CONTAIN has made recommendations on the policy level for an upgraded risk based management of screening based on different information sources to provide sound economic and technological argumentation and to benchmark container security performance in order to formulate improvement policies. Additionally, the project has contributed in the development of standards to address and improve container security specifically and supply chain security.	
Similarly, FREIGHTWISE promotes EU-policies encouraging the development of open and interoperable systems, which meet the requirements of cargo owners, transport operators and intermodal freight integrating services. The project advocates that any future legislation should develop initiatives to provide a platform on which the industry can develop management solutions that increase the competitiveness of intermodal transport. To this extent, the FREIGHTWISE Framework -FWF- developed generic system architecture for intermodal transport management capitalizing previous European and national efforts. The FWF uses management tools that facilitate market transparency and a management framework supporting the organisation of intermodal transport chains, which are very important elements in legislative interventions.	FREIGHTWISE

The AnNa and MIELE projects have made significant contributions to the authorities that participate in the projects as well as to the European Commission. Taking into account the EC Directive 2010/65/EU they have streamlined and harmonized the processes for Administrative Facilitation.	AnNA, MIELE
Last but not least, eMAR, iCARGO and ECOHUBS have identified opportunities for standardization (e.g. MSW – Maritime Single Windows) and through the network of the relevant projects have addressed the data requirements to this extent. Additionally, the eMAR policy support includes measures to address legal and organisational inconsistencies at national and regional levels, including for example FAL form and competence authority's certifications' requirements. To this extent, the projects have made recommendations to the relevant authorities, including IMO, EU (DG MOVE) and CEN/ISO.	eMAR, iCARGO, ECOHUBS

5.4 Port Operation: Overview of research status and technology achievement to date

Over the last 10 years, EU research projects related to ports have focussed on three main areas: port management and operations, infrastructures, and multi-modal traffic in port terminals. The common objective was to help achieve higher levels of efficiency in ports.

More recently, research has focussed on port security and environmental issues, including port noise and use of energy. The concept of "green ports" is also receiving more attention, together with issues of marine environment protection, global climate change and rising sea levels.

EU Research has provided important information for logistics and multimodal transport operations and processes, or how they can be improved, through the application of new support technologies, such ICT and simple data exchanges. Current EU research focuses on integrating web based systems for multimodal transport logistics and port networking within the e-maritime framework.

Particularly regarding port management and operations, the European Commission (EC) communicated, in 2007, the European Ports Policy[13] which has had an influence on the advancement of modernization measures of the European Ports in the future. The measures include, for instance, the adoption of the new Directive 2010/65/EU of 20 October 2010 on reporting formalities for ships arriving in and/or departing from ports of the member States, the e-maritime initiative, and the development of Port Community Systems (PCS) and the Modernised Customs Code.

These applications can reduce waiting times at ports, secure processing of data, simplify formalities, and provide timely information to transport operators. Below is a summary of the main achievements, to date, of EU projects in the field of application of IT solutions to improve port operations efficiency.

Moreover, the use of ICTs in areas such as Customs automation, electronic documentation and advance information in logistics is likely to continue to grow in coming years. These opportunities for implementation are recorded on Chapter 6.1**.**

[13] COM (2007): "Communication on a European Ports Policy", Commission of the European Communities. COM (2007) 616 final.

Overview of research status and technology achievements	*Reference project:*
Improving information distribution between all parties involved ▪ FREIGHT4ALL has designed and developed a distributed platform that acts as a mediator for the effective interactions of the stakeholders, end to end supply chain management and continuous visibility of the operations. ▪ The platform was designed using .NET technology. This provided the GUI and many of the web services necessary for the independent platform components to communicate data. In terms of security SAML was used for the gateway and to maintain user identities over multiple components. ▪ MS SQL was used for the databases as it was most compatible with the .NET framework. EDI and XML messaging were interpreted by the Interoperability component.	FREIGHT4ALL
▪ Integrating into one network all ports enabling the entire NAPA (Northern Adriatic Ports Association, established in Trieste in March 2010 by the port authorities of Ravenna, Venice, Trieste and Luka Koper) community to exchange information and implementing a common application based on electronic exchange of data and a common web portal for sharing of data. Initially, it was necessary to improve the existing port community systems in order to harmonize them as much as needed to allow for the subsequent creation of the e-platform prototype. This EDI platform prototype provides complete information interoperability in a large region at the crossing of Corridors 1 and 5 and extended to the Adriatic-Baltic corridor. It has a high level of flexibility in the management of processes and information (documents and data in general), and its implementation is based on the analysis of user and system requirements, and on carefully selected document interchange standards, meeting the typical operational needs of the individual port communities, but also the requirements of legislation governing the processes involved.	ITS Adriatic
▪ The goal of the MIELE project was to design the architecture of an ICT platform ("MIELE middleware") able to interface existing systems for ship reporting formalities (such as national/port "single windows" or proprietary port community systems), in order to make them fully interoperable, as required by the Directive 2010/65 EU. The platform was tested through pre-deployment pilots in Italy, Cyprus, Germany, Portugal and Spain (the "National Vertical Pilots"), where the local ICT systems for ship reporting are made interoperable by interfacing with the MIELE Middleware. Therefore, the National Vertical Pilots were demonstrators of both the feasibility of a national single interface ("single windows") and of their interoperability, as requested by the Directive.	MIELE
Supporting commercial port-maritime services ▪ An IT system (PORTMOS Portal) was implemented for fostering MoS in Portugal as well as in contributing to the implementation of two pilot actions of MoS (Motorways of the Sea) links: Leixões-Tilbury-Rotterdam-	PORTMOS

Leixões and Sines-La Spezia-Sines. ▪ This portal is a **web service that supports the Booking process** between the Consigners and Freight Integrators and between the Freight Integrators and the Service Providers. ▪ The Web Service is accessible by SOAP 1.2 over HTTP. This Web Service is used to setup track and trace information from several providers to the PORTMOS system. ▪ Two types of security were implemented at the message level: signature – for client authentication and non-repudiation; and encryption – to prevent business sensitive message content disclosure. ▪ PORTMOS PORTAL established, together with two pilot actions in order to evaluate, test and validate under real conditions the information system developed and measure the business advantages.	
▪ The principal objective of the project was to establish a network between maritime ports and dry ports to **improve and facilitate freight movements** in the Mediterranean area using low-cost technologies such as UHF passive RFID. ▪ MED.I.T.A. project aimed to implement a Cargo Community System by a technology transfer borrowed from the experience gained in the TEN-T project MOS4MOS. The system promotes the implementation of Motorways of the Sea to overcome the territorial boundaries: all vehicles' departures and arrivals are tracked down and recorded in a single data system (origin and destination, description of goods, quantities, transit time, etc.). This procedure provides a common platform to be shared by Valencia, Livorno, Ancona and Patras, through the low-cost technology passive R-FID UHF tags. This application will speed up the access control operations and data acquisition process besides security procedures.	MEDITA
▪ A standard high level **process map and actors model** were developed that can be used in house to develop own models at a more detailed level and for specific purposes (risk assessments, process improvements, introduction of new ICT systems etc.). This process model was captured in BPMN language with support of Enterprise Process Centre (EPC), a process modelling tool of Interfacing Technology Corp. The EFFORTS Methodology was implemented in Enterprise Architect (EA) as a Template Model. This Template Model contains Standard Business Cases (the EFFORTS Toolbox), a Specification Model of an actual port ICT system (specified using UMM as Business Domain View, Business Requirements View and Business Transaction View by the developer of the actual system), and also documentation of the Design Model and Deployment Model (Platform Specific Parts). The objective of obtaining enhanced interoperability within a Port Community clearly points to an efficient way of exchanging information.	EFFORTS
Improving the integration of ports with their hinterland ▪ The FUTUREMED project aims to improve the competitiveness of port systems in the MED area by improving accessibility through technology and procedural innovations making freight and passenger flows seamless. Various solutions have been developed and tested with success dealing with:	FUTUREMED

- Interoperable solutions integrating actors at intermodal port-hinterland corridors for efficient electronic information exchange (including inland terminals). Besides savings in burden administrative e and paperwork, this allows operators to manage better quality information and improve the efficiency of operations due to better planning. - The development of secure port-hinterland 'customs corridors' speeding up the flow of goods through the port by using a centralized track-and-trace system for trucks. - The development of new cruise passenger's information system integrated with the city and inland destinations of tourists that enable ports to manage and ease the arrival and the stay of "not organized" tourist in the port's cities, by providing them a wide bunch of services. - The development of a visibility platform including information of maritime and inland nodes, maritime and port-hinterland transport services and an intermodal planner. FUTUREMED has also established the bases for the constitution of European Economic Interest Group (EEIG) in order to continue working together with the same common objectives once the project is officially finished. ▪ The objective of the STIMULO project has been to develop and test intelligent traffic management system by predicting in real-time the status of the various components of the transport system (infrastructure, vehicles, goods, users, etc.). The principal elements of the infrastructure include the simulation model, data mining from heterogeneous sensors in real-time, generating traffic indicators and using these indicators jointly with collective intelligence techniques to provide services linked to the transport system that improve performance and efficiency. A decision-making support system based on real-time simulations and the mining of large quantities of heterogeneous data, with the possibility of applying developed technologies in other fields requiring the compilation of data from diverse and heterogeneous sources. The overall architecture and solution has been tested in a road port-hinterland corridor. The real implementation of the solution would require of further developments.	STIMULO
Fostering maritime-railway integration ▪ Setting standards and making recommendations to further develop and integrate maritime-railway transport at the physical level (accesses and infrastructure), the functional level (services and marketing) and the knowledge management level (information and documents). Analysing the state of intermodal maritime-railway transport in Spain focusing on traffic flows and infrastructure. Developing methodologies that can be applied in practice in maritime-railway intermodal projects to identify the needs, nature and evaluation or valuation of these.	CEDEX INTERMODALITY
Improving ship operations at ports ▪ Efforts project developed a technology to have a reliable position of tugs. The technology used to achieve this goal is Global Navigation Satellite System (GNSS). As the GNSS relies on a clear view to the sky, respectively the satellites. The conditions are very special when operating close to large ships which block parts of the sky. This causes the so called "shadow effect". In	EFFORTS

order to find out how strong the shadow effect is under certain circumstances the two different sets of GPS systems of Marimatech were tested during a test sailing on the tug "Lesum" in Bremerhaven: E-Sea Fix Pilot CAT III and E-Sea Fix Pilot CAT I. ▪ In addition, two port processes were selected to be analysed and modelled in the framework of the EFFORTS project: - the Berth Allocation - the Manifest Distribution Studying and analysing the ICT requirements and standards in their conformity.	
Developing technologies to support intermodal freight transport systems ▪ In the framework of the TIMI project (funded by the Spanish Government) new technologies and methodologies were developed to permit the creation of the future generation of devices, systems and tools contributing to making such transport more intelligent. ▪ A Web simulator was developed that shows the different interactions along the whole freight transport chain (TIMI Web Simulator) ▪ The current data holdings (such as barcodes, RFID and plus smart cards) were studied as the way to interchange data in safe mode in container transport. ▪ Detection of risk situations due to major disruptions of transport modes.	TIMI Project (Intelligent Intermodal Freight Transport)
Fostering the creation of knowledge networks ▪ Port Integration contributed to the development of a knowledge network through a programme of combined activities such as research, workshops and best practice visits. Port Integration's partners worked together to develop solutions for more sustainable maritime and hinterland transport and structures. Based on lessons learned from previous EU-Interreg IVC projects, Port Integration took this useful information to contribute in following fields: - EU policy (better understanding of EU policy and how it is evolving; first-hand information of best use of funding opportunities through EU programmes) - Hinterland Transport, Gateways and Innovative Logistical Concepts (suggestions to improve maritime transport corridors and the development of innovative and sustainable multimodal structures and logistics concepts) - Single Windows, e-maritime and Port Community Systems (best practice guide and roadmaps for best practice transfers)	PORT INTEGRATION
Developing sustainable solutions in ferry operations ▪ iTransfer's aim was to develop, demonstrate or pilot innovative, sustainable solutions in ferry technology, operation and policy to improve regional accessibility by water-based public transport. ▪ This has been achieved through: - resolving technical issues including new designs for ferries and shore-side facilities; - improving ferry operations and integrating ferries with existing public	I-TRANSFER

transport networks; - supporting a policy environment that resolves current tendering problems and which promotes barrier-free access for all passengers.	
Simplifying and harmonising the maritime transport formalities ▪ The main goal of MEDNET was the development of a common framework of understanding of customs procedures and the clearance of vessels. ▪ An exhaustive inventory of port procedures and customs practices active to date has been drawn up. ▪ Initially, a survey was conducted at the MEDNET partner ports. According to the survey results, several pilot actions were launched during the project's lifetime. All actions were related to the key port processes and share a common goal: to improve and to streamline logistics chains. Pilot actions were explicitly defined and fine-tuned according to survey results. ▪ Pilot actions concerning specific port operation procedures were implemented at the ports of Igoumenitsa (Greece), Patras (Greece), Ancona (Italy), Taranto (Italy), Valencia (Spain), Rijeka (Croatia) and Zadar (Croatia) while certain pilot actions focusing on the application of a wider system will be implemented on a country level. Each partner developed their own prototypes in preparation to test and pilot the actions. Then, each prototype developed was tested. Finally, the potential impact that pilot actions may have on the improvement of maritime accessibility and transit capacities by multimodality and inter modality in the Mediterranean were evaluated. ▪ Some of the pilot actions proposed include: 1. Analysis, enhancements and recommendations of procedures for lodging the Summary Declaration for Temporary Storage 2. Introduction, promotion, extension of electronic and automatic processing of T2L declarations of goods transported by sea 3. Introduction of electronic monitoring mechanisms for improving customs, sanitary, phytosanitary and veterinary controls 4. Management of car, coaches and truck movements/parking in and outside port area 5. Berth allocation for RO-RO,RO-PAX, cruise ships 6. EXS/ENS collaborative solutions amongst ports 7. Master plan to be used as a guide for the set-up of a national single window (NSW) in Malta.	MEDNET
▪ The SESTANTE work was directed to create tools based on information and communication technologies (ICTs) that facilitate the interoperability of the necessary paperwork in commodity transport in the various ports of the Mediterranean, placing special emphasis on the notification of dangerous goods.	SESTANTE

5.5 Regulations Management: Overview of research status and technology achievement to date

This review covers both EC-funded research projects and other European Union initiatives that have addressed e-maritime and Regulations Management.

The principal objectives have been:-

1. to streamline administrative processes to improve the competitiveness of maritime transport
2. to enhance safety and minimise environmental impact while optimising the use of maritime and inland waterway infrastructures
3. Information sharing and integration to enhance maritime surveillance through better maritime data exchange
4. to provide support for regulatory compliance
5. e-maritime policy and strategic guidance

The starting point for much of the e-maritime activity in the area of regulations management has been various EU directives and international regulations that determine information exchange requirements between businesses and administrations in the maritime sector, including:

- Directive 2009/17/EC, in the framework of the Third Maritime Safety package, modifying Directive 2002/59/EC for establishing a Community vessel traffic monitoring and information system (the "VTM Directive"). One of the main objectives of the amended Directive is to guarantee that all Member States will be interconnected via the Community maritime information exchange system SafeSeaNet (SSN) in order to obtain a complete overview of the movements of ships and dangerous or polluting cargoes in European waters. The integrated maritime transport strategy opens new horizons for SSN as a core platform to support "upgraded EU maritime transport information management".
- Simplifying and harmonising administrative procedures concerning reporting formalities with a view to establishing a European maritime transport space without barriers (COM (2009) 10 final). Maritime transport must comply with complex administrative procedures concerning reporting formalities2, even when it relates to navigation between EU ports (intra-EU transport) and when the cargo consists of goods in free circulation in the EU. These administrative procedures used to be regulated by Directive 2002/6/EC on reporting formalities for ships arriving in and/or departing from ports of the MSs of the Community, resulted (and still result) in costs and delays and could make maritime transport less attractive.
- In January 2009, the EC published a proposal to amend Directive 2002/6/EC. After discussions at the EU level, Directive 2010/65/EU of the European Parliament (EP) and of the Council of 20 October 2010 on reporting formalities for ships arriving in and/or departing from ports of the Member States and repealing Directive 2002/6/EC (also referred to as the Reporting Formalities Directive) was adopted in October 2010. This new directive repealed Directive 2002/6/EC from 19 May 2012.
- The development of the European Border Surveillance System (EUROSUR), which foresees the gradual creation of a common information sharing environment for the EU maritime domain. EUROSUR, focussing initially on the southern and eastern external borders of the EU, suggests to Member States a roadmap for gradually developing a common technical framework to support Member States' authorities in reaching full situational awareness over the coming years. EUROSUR is closely related to the 'integration of maritime surveillance activities' as described in the Commission documents COM 2009-538 'Towards the integration of maritime surveillance: a common information sharing environment for the EU maritime domain" and SEC 2009-134.
- The e-Customs programme will also impact significantly the development of e-maritime. Indeed, customs authorities should be users of the e-maritime systems, and this system should

be fully compatible with the e-Customs systems introduced by Decision No 70/2008/CE. The e-Customs vision for 'electronic declarations as a rule', interoperable national computer systems and single window solutions will facilitate information exchange on cargo movements and at the same time will create specific requirements for e-maritime.

More recently, particular impetus has come from the need to meet the deadlines for compliance with the EU Directive on reporting formalities (2010/65/EU), specifically Article 5 - Electronic transmission of data, which requires that:

- The EU Member States shall accept electronic reports and their transmission via a Single Window (SW) as soon as possible and, at the latest, by 1 June 2015
- The single window will be the place where all information is reported once and made available to various competent authorities and the EU countries. EU countries must ensure that information received in accordance with reporting formalities is made available in their national SafeSeaNet systems and make available parts of such information to other EU countries via the SafeSeaNet system.

Another objective has been to assist in the implementation of the New Inspection Regime (NIR) for Port State Control, which took effect on 1 January 2011 in the European Union (and by extension the Paris MoU region) and which was aimed at harmonising the inspections of all ships visiting the ports and anchorage areas in the Paris MoU region. A new information system was required to facilitate planning of inspections by linking to the Community's SafeSeaNet system, which provides information on ships in, or expected at, all ports of the Member States.

In addition to EU directives and regulations, the GMES (Global Monitoring for Environment & Security) services that are currently being developed, to support public policy makers' needs in the domain of environment and security, have also brought demands to expand the range of GMES services and to enhance their performances where unmet needs can be identified, for example by improved and faster data collection, fast data dissemination, provision of GMES data products down to the end-users on-the-field, early warning systems, ad-hoc networking etc.

An aspiration of the EU Integrated Maritime Policy (COM 2007 575) is to change the way in which policy is made and decisions taken to create the necessary interaction between the various sectors and to ensure that common tools are developed. The Commission proposes 'an Integrated Maritime Policy for the European Union, based on the clear recognition that all matters relating to Europe's oceans and seas are interlinked, and that sea-related policies must develop in a joined-up way if we are to reap the desired results'. To this end, integrated maritime policy guidelines have been issued to Member States, to encourage them (and other players) to take steps towards adopting an integrated approach to sea-related affairs within their governance frameworks.

Greater coherence between different policy areas and approaches is particularly needed:

- to avoid duplication of regulatory powers of different national or regional authorities in the Member States and to create a one-stop-shop approach in each Member State
- for reliable and comparable statistics to inform maritime policy making on all levels
- to facilitate closer coordination on maritime surveillance between, and within, Member States.

The main areas covered by the various research projects and other initiatives reviewed have been information sharing and integration, interoperability of disparate "legacy" systems, re-use of information.

Overview of research status and technology achievements	*Reference projects:*
1. Reducing the administrative burden - through technical means to achieve the "interoperability" of existing (legacy) systems, improved efficiency of the ship reporting processes, and better use of information by authorities.	
MIELE demonstrated the Proof of Concept of a pre-deployment pilot for an interoperable ICT platform (the "MIELE Middleware") able to interface ICT systems (i.e. single windows, port community systems). The demonstrations included:- ▪ Deployment of a maritime Directive 2010/65-compliant Single Window concept through a Port Community System (MAINSYS) in Israel. ▪ Development of MIELE Middleware (MMW), which can provide data exchange Data Exchange Mechanism (DEM) with other software environments, particularly also interfacing with the other national SPOC (Single Points of Contact) or NMSW.	MIELE
MarNIS addressed the maritime transport 'reporting' issue both from the point of view of improved efficiency of the ship reporting processes and from the way the information is used by authorities in enhanced safety and environmental risk management. The two main MarNIS outputs were: 1. MOS: Maritime Operational Services addressing the integration of emergency related processes. MOS promotes proactive services to avoid incidents occurring and to minimise their impact once detected. Functions such as SAR, VTS, enforcement, oil pollution response, risk determination, use of places of refuge through the use of temporary Maritime Assistance Services (MAS) and sending Emergency Towing Vessels (ETV) are combined in a MOS centre, enabling information sharing and integration. 2. MIM: Maritime Information Management addressing the adoption of National Single Windows by all member states improving the manner in which data is reported to the authorities but also the way in which this data is distributed and made available to the various authorities, these being not only the "traditional" maritime authorities but also authorities such as customs, immigration and health. MarNIS has established specifications for Port Entry Profiles and Port Exit Profiles (PEPs) generated by the NSW to support decision making before the vessel arrives at port thus increasing clearance efficiencies.	MarNIS
More recently, the issue of which legacy systems, processes and information flows can be kept, in order to keep costs down, has been addressed in the guidelines on establishing a National Single Window (NSW) for maritime transport as required by Directive 2010/65/EU, which have been developed by the Expert Group on Maritime Administrative Simplification and Electronic Information Services.	eMS Group
The goal of the **AnNa** action is to facilitate and foster an effective and sustainable Maritime Single Window development that:	

▪ Allows smooth interaction of data between the user and national administrations involved; ▪ Optimally meet the needs of the maritime industry; ▪ Adheres to the Rule of Law; ▪ Recognizes existing (partial) systems; ▪ Safeguards the varying ambition levels of individual Member States; ▪ Is future proof, i.e. substantially enhancing interconnection in the logistic chain on the long term.	AnNa
The **Blue Belt** pilot project aims to see if providing ship information could simplify customs formalities for ships trading within the EU, based on the concept according to which ships can operate freely within the EU internal market with a minimum of administrative burden and in which safety, security and environmental protection as well as customs and tax revenues are ensured by an optimal use of existing capabilities to monitor maritime transport and the cargo concerned. The Blue Belt pilot project has successfully demonstrated that it is possible to provide information about a ship which is useful and relevant to customs authorities: the information provided relates to the ship's particulars, whether the vessel is authorised for a Regular Shipping Service and voyage information.	Blue Belt
The **eFreight** project has delivered IT Capabilities supporting EU freight transport stakeholders to have a common, standard framework for freight transport in the European Community and, as far as possible internationally, adhering to EU policy on co-modality. The e-Freight project has developed a prototype Next Generation Single Window dealing specifically with the new Ship Formalities directive.	eFreight
2 Information sharing and integration: to improve safety and reduce accidents. The **ARIADNA** project aims to optimise the use of maritime and river infrastructures in order to manage increased traffic density and, at the same time, improve safety at congested maritime and inland areas with the support of the latest ICT navigation aids. The first trial has shown that potential collisions such as collisions with bridges, port infrastructure, and other vessels can be avoided due to the additional information, which the boat master receives.	ARIADNA
The **Integrated Maritime Data Environment** (IMDatE) is a technical framework currently under development. In future, it will combine and process data from EMSA's maritime applications and other external sources to provide more comprehensive and configurable services to users, as well as supporting the relay of data between the applications themselves. **3. Information sharing and integration -** to enhance maritime surveillance through better maritime data exchange. For several years the European Union and its Member States have been developing a "Common Information Sharing Environment [CISE] for the EU maritime domain", which aims to ensure "seamless practical cooperation" through increased information exchange amongst defence, customs, border control, law enforcement, fisheries control,	

environmental protection and maritime security and safety authorities. The projects Contraffic, VESPO, VESCOSUR, SeaBILLA and FLAGSHIP (summarised in the first version of this report) contributed to this objective. In July 2014, the European Commission announced its proposed "next steps" for "enhancing information exchange between maritime surveillance authorities," in order to "increase the efficiency, quality, responsiveness and coordination of surveillance operations in the European maritime domain and to promote innovation, for the prosperity and security of the EU and its citizens." The objective is to ensure that maritime surveillance information collected by one maritime authority and considered necessary for the operational activities of others can be shared and be subject to multiuse, rather than collected and produced several times, or collected and kept for one purpose. Some more recent pilot projects contributing to this include: ▪ BlueMassMed, which "developed the concept of national 'IT nodes' that may in future act as national information hubs"; ▪ MARSUNO, which "made progress in reviewing the legal situation and made suggestions for a possible governance structure"; and ▪ The Cooperation Project, which "calculated the potential economic added value of a Maritime CISE" and developed a "common data model" to "ensure the interoperability of surveillance information systems."	ARIADNA
The BlueMassMed project was promoted and funded by the EU DG MARE with the objective of favouring the integration of Maritime Surveillance on the Mediterranean Area and its Atlantic Approaches, a major milestone along the implementation of the C.I.S.E. roadmap. The project aimed to catalyse and foster cooperation in maritime information sharing between 37 State partners from 6 Member States (MS) bordering the Mediterranean Sea and Atlantic approaches (Ellas, España, France, Italy, Malta, and Portugal). The BlueMassMed pilot project is one first step toward achieving a better cooperation between the numerous actors of maritime surveillance (Member States' administrations and European agencies principally) and obtaining a better efficiency of resources through the sharing of maritime information, in a cross-sectoral and cross border understanding and implementation. BMM supports the process of creating a Common Information Sharing Environment (CISE) which will serve as decentralised information exchange network interlinking existing and future maritime surveillance and tracking systems throughout EU and connecting to third parties as well. The BMM project developed a solution to allow the exchange of added-value information about maritime domain, not only ship positions and reports, respecting the European treaties and the principles of subsidiary and proportionality. MARSUNO Maritime Surveillance in the Northern Sea Basins – ('MARSUNO') - was a 24-month pilot	BlueMassMed

project initiated by the EU Commission involving 9 Member States: Sweden as lead partner, Belgium, Estonia, Finland, France, Germany, Latvia, Lithuania and Poland, in partnership with Norway, inviting Russia as an observer. In total 24 public authorities were involved. The project's objective was to support the creation of the 'CISE' by identifying practical solutions to overcome legal, technical and administrative hurdles to cross-sectorial and cross-border information sharing between maritime authorities. Indeed, 'CISE' is to become a legal, technical and cultural environment allowing for such information exchange between all relevant sectorial maritime authorities throughout the EU/EEA. MARSUNO concludes that establishing a functional and efficient CISE for all authorities acting in the European maritime domain is crucial for enhancing the efficiency and cost effectiveness of maritime surveillance. CISE will be a concrete and tangible outcome of Europe's Integrated Maritime Policy.	MARSUNO
Cooperation Project 2013 (CoopP) aims at bringing together EU's operational actors from various sea basins to jointly contribute to the development of the CISE. Integrating maritime surveillance is a necessity to ensure safer, more secure, and cleaner seas. In addition, there is potential added value in terms of accessible and relevant data created by authorities with public funding for further cultivation and processing by private sector. The project foresees possibilities to create Public/Private partnerships when highly qualified data is accessible to private business and industry:- ▪ applications, blogs, portals, solutions (logistics, environment, free time activities, hobbies etc.) ▪ Boosting the effectiveness and cost-efficiency of maritime surveillance activities thus making best use of tax payers' money. Another project addressing some of these issues was the IMP-MED project (Project on Integrated Maritime Policy in the Mediterranean). The project's overall objective is to improve governance of maritime affairs in the Mediterranean sea- basin by promoting and achieving a more integrated and co- ordinated approach to policies impacting on the sea in each of the beneficiary countries and encouraging further co-operation on marine and maritime affairs at regional level and implementation of agreed provisions. One of the areas addressed was Maritime surveillance, which aims to collect information on maritime activities, in order to direct operational decisions (e.g. control...), control compliance with existing laws and regulations (e.g. safety rules, fishing areas, dumping...) and more generally support maritime policies. Integration of maritime policies requires the definition of common objectives for all stakeholders, but also sharing knowledge and information, which is the condition for common and shared decision making. The project organised technical regional workshops to discuss the issues associated with maritime surveillance in the Mediterranean, presenting the actions in the neighbouring countries and the European experiences, and highlighting the problems in developing integration of surveillance in order to identify potential development axes within the framework of integrated national maritime policies in the region countries and in the framework of multilateral cooperation. Most recently, the EUCISE2020 (EUropean test bed for the maritime Common Information	CoopP

Sharing Environment in the 2020) project began work. EUCISE2020 is a Security Research project of the European Seventh Framework Program; it aims at achieving the pre-operational Information Sharing between the maritime authorities of the European States. EU CISE 2020 aims to be a significant step forward along the accomplishment of the European roadmap for CISE (Common Information Sharing Environment). EU CISE 2020 takes as reference a broad spectrum of factors in the field of European Integrated Maritime Surveillance, arising from the European legal framework, as well as from studies, pilot and R&D projects accomplished in the last three years; in particular, the project is based on: ▪ the CISE Roadmap developed by DG MARE ▪ the results of European pilot projects BluemassMed and MARSUNO, ▪ the work performed by CISE TAG-Technical Advisory Group, ▪ the European studies on maritime surveillance already carried out, ▪ the results of Security research projects in progress, with particular reference to PERSEUS and SEABILLA ▪ the needs of innovation expressed by the maritime stakeholders arising from their operational experience in managing maritime surveillance processes and systems at European, international and national levels. ▪ The COOPERATION project should be explicitly mentioned. The Commission recently adopted a Communication on the next steps for the Common Information Sharing Environment for the EU maritime domain (COM (2014) 451 final). See http://ec.europa.eu/maritimeaffairs/policy/integrated_maritime_surveillance/index_en.htm **4 Support for regulatory compliance** The FLAGSHIP project demonstrated a considerable simplification in the management of maritime regulations on board a ship which was based on an advanced semantic search mechanism applied to selected sets of rules and regulations. The technology developed in FLAGSHIP B5 was a proof of concept for the use of an on-board Decision Support System to facilitate compliance with maritime regulations. Building on the success of other EU projects such as FLAGSHIP, e-Compliance will create a model for managing maritime regulations digitally and thus help to harmonise these regulations. The e-Compliance project will build on the work done in FLAGSHIP by formalising the translation of maritime regulations into rules. In addition, rather than just catering for the needs of a ship's crew, e-Compliance will create and integrate systems for compliance, enforcement and creation of maritime rules. By creating a model for managing regulations digitally and creating services for all the different stakeholders, e-Compliance can harmonize these regulations and allow for co-operation between the different stakeholder groups. Not only will this improve the quality of regulations, but it will also reduce the burden for those having to enforce the regulations as well as those who must comply, resulting in a regulatory regime that is more effectively implemented. e-Compliance will also develop capabilities to ensure that all stakeholders are aware of the current active regulations and allow preparation for regulations that will take	EUCISE2020

effect in the future.

In addition to the work towards regulatory compliance in the e-Compliance project, a considerable amount of the detail involved in meeting the deadline of 1st July 2015 for the implementation of the Reporting Formalities directive (2010/65/EU) has been undertaken by the Expert Group on Maritime Administrative Simplification and Electronic Information Services (eMS Group).

The group has worked to develop specifications and services for the electronic data exchange and single windows for the EU Maritime transport; to liaise with national stakeholders, paying also attention to multimodal and multidisciplinary aspects. It has also sought to encourage electronic data sharing and services within administrations and businesses.

The group has developed guidelines for setting up a National Single Window, and has discussed details such as data mapping and functionalities. It has agreed the definition of the minimum required functionalities that the NSW should support and the functionalities associated with the exchange of data between Member States.

Although for the Directive has entered into force, the work of the group will be continued by the new Digital Transport and Logistics Forum. In preparation for this, the group has summarised the outstanding issues, proposed topics to be addressed by this new Forum, and has identified some maritime topics which require attention, and which represent outstanding issues that can be addressed by research projects such as e-Compliance.

5. e-maritime policy and strategic guidance

The **eMAR** project aimed to deliver an e-maritime Strategic Framework (EMSF) bringing together into a coherent whole concepts, processes, standards and technologies to create a common language enabling networking and computer supported co-operation between the principal maritime transport stakeholder groups.

The e-maritime Strategic Framework is targeted at supporting various stakeholders in establishing, managing and optimising their electronic interactions between business partners, regulatory authorities, vessels and ports.

The EMSF holds a number of models/frameworks/architectures for different stakeholders that can be used as a basis for activities such as system design and development, communicating among parties involved in the development, use and promotion of systems, planning for transition from a legacy architecture etc. The EMSF also defined a number of electronic documents (messages) that should be used when stakeholders in the maritime sector interact.

In addition, the eMAR project has made a number of recommendations on policy, standardisation and further research. These were intended as input to a Communication and a Framework Directive (FD) that would give a coherent view of how maritime transport will operate in the future, and reflect the principal e-maritime policy aims, as set out in the e-maritime Stakeholders Conference in 2010.

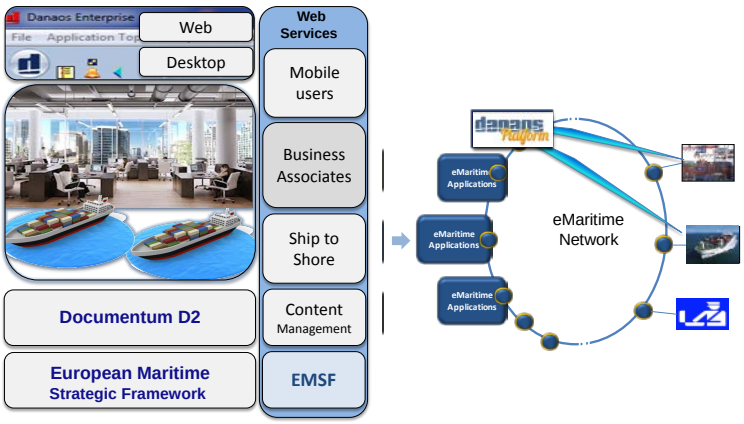
Following feedback received through a consultation process, the following conclusions were drawn:-

- The e-maritime initiative should concentrate on information exchange between

businesses and authorities and between authorities (National Single Window) ▪ Standardisation of information exchange and interoperability ▪ Establishment of an ICT infrastructure that enables low-cost connectivity between all stakeholders involved in maritime transport With the aim of making maritime transport streamlined and well integrated in the complete transport chain in mind, it was stressed that the purpose of the policy should be to give each maritime transport stakeholder the freedom to develop and use applications that are suitable for the relevant operation. However, the policy should specify the relevant interfaces between the applications used by the commercial stakeholders and the authorities. Hence, the e-maritime should concentrate on the three issues listed in the bullets above.	

6 Recommendations for Implementation

6.1 Ship Operation: Opportunities for implementation

Opportunities for implementation	*Reference project:*
The eMar project aimed to empower the European maritime sector in offering efficient quality shipping services fully integrated in the overall European transport system over an upgraded information management infrastructure. From the view point of ship operations, after discussions with the relevant stakeholders, the following areas were selected for implementation. The criterion for the selection was coverage of information exchange between the ship operators and key stakeholders: ▪ Ship Voyage Monitoring (Cooperation between Shipping Company and Charter) ▪ e-Purchasing (Cooperation between Shipping Company and Supplier) ▪ e-Drawing (Cooperation between Shipping Company and Technical/Repair Yard/Purchasing) ▪ e-Crewing (implemented by EBOS) (Interaction between shipping companies and crew candidates) The approach: The EMSF platform, which was produced and used to implement the above applications, provides a place to publish software services related to shipping and also acts as a kind of proxy to use those services.  	eMar

6.2 e-navigation: Opportunities for implementation

This section will point to some exploitation possibilities that can be realized from the previous list of projects. All projects will have taken care of "low hanging fruit" so this has not been taken into the below lists. Here, we focus on implementation possibilities that remain open.

Opportunities for implementation	*Reference project:*
1. Architecture	
Much work is needed in this area, but it is expected that eMar will contribute significant results here, at least on the software integration side. Accseas also have a WP dedicated to architectural work.	eMAR Accseas
There is also need for more work on special purpose service oriented architectures to handle low bandwidth and intermittent connections that are often the case for shipping. MUNIN considered this problem for remote control of ships.	MUNIN
e-Compliance will contribute ontologies to the legal domain which can also be integrated into the architectural system. eMar will also contribute components here.	e-Compliance
2. Human element	
Significant contributions are expected from CyClades and CASADe on methodological approaches to the human factors issues. It is expected that these will focus on human factor issues related to new equipment and work processes on board.	CyClaDes CASCADe
MUNIN and Accseas will contribute insights into more automated services for ship crews. MUNIN will in particular look at the concept of a shore control centre that can also assist crews during nights and in open water where not much human intervention will be required as a rule.	MUNIN Accseas
FAROS will contribute insight into how ship design affects crew performance.	FAROS
3. Conventions and standards	
Standards for information management are expected from eMAR and MUNIN. This will be based on ISO 28005, IEC 61162 and S-100. There will be output from Accseas, particularly on S-100 based messages for navigation and topology based routing.	eMar MUNIN Accseas
Standards for ship data networks on ships will be provided by MUNIN as IEC 61162-460, safe and secure integration with bridge networks.	MUNIN
MUNIN and eMar will also look at ship-shore communication, but probably not in term of standards.	MUNIN eMar
e-Compliance will provide ontological standards for legislation. eMar may also contribute higher level functional models for e-maritime in general.	e-Compliance
MUNIN will investigate legislation related to unmanned operation of ships and other projects also have some activities in the specific areas they cover. Accseas	MUNIN

will also investigate some issues related to more systematic exchange of navigational information. eMar will look into some aspects of the legislation related to single windows in Europe.	Accseas eMar
4. Position fixing	
Accseas has activities dedicated to more accurate positioning services as well as fine manoeuvring. MUNIN will investigate remote control, particularly for fine manoeuvres over low capacity radio links. ARIADNA will provide results in volumetric navigation and MOS4MOS will provide additional input on port navigation.	Accseas MUNIN ARIANDA MOS4MOS
TRITON will provide insight into resilient positioning systems with a view to increase security (i.e. verifiable position fixes). MUNIN will look into spoofing and jamming of position signals for unmanned ships. Accseas will provide results on position signal integration.	TRITON MUNIN Accseas
5. Communication technology and information systems	
Results for onboard ship networks have been provided by Flagship in the form of IEC 61162-450. MUNIN will continue this work with the IEC 61162-460 security and safety standard.	Flagship MUNIN
Satellite communication standards will not be forthcoming as far as we can see now.	
Accseas are looking into ship to ship communication via AIS, but there is a need to look into use of the emerging VDES also. This will be investigated by MUNIN, but it is too early to expect standards from this work.	Accseas MUNIN
Data standards have been produced by Efforts and Flagship in the form of ISO 28005. MUNIN will also look at S-100 based data standards as will Accseas. eMar will also work with data standards, but it is not clear in what format – possibly based on UBL or other trade related standards.	Efforts Flagship MUNIN Accsea eMar
6. Electronic Navigation Charts (ENC)	
Contributions to port ECDIS were developed in Efforts.	Efforts
Accseas is working with overlay of safety information on ECDIS and will provide specifications.	Accseas
Accseas also look at new ways to utilize the ECDIS planning station.	Accseas
7. Equipment standardization	
This is a wide area where in particular Flagship has made major contributions on alarm management, handheld bridge devices, emergency management, hull condition monitoring and energy efficiency. NAVTRONIC focused on developing a shore control centre application for voyage efficiency.	Flagship NAVTRONICS
Accseas will contribute new equipment for route exchanges and for improved ship safety.	Accseas
MUNIN will provide new sensor applications for the bridge as well as improved maintenance monitoring.	MUNIN

e-Compliance and eMar will provide new ship applications for more administrative purposes, e.g. ship clearance and regulation compliance. **8. Scalability** No immediately appearing results have been found in any of the following areas: ▪ Navigation in Arctic ▪ Heavy weather operations (HANDLING WAVES) provided a prototype. ▪ Applications for smaller craft	e-Compliance eMar

6.3 Logistics Chain: Opportunities for implementation

The reviewed projects give many opportunities for implementation of results. The most important are described in the following table.

Opportunities for implementation	*Reference project:*
Freight Management Systems Regarding the Freight Management systems, iCARGO, ECOHUBS and FREIGHTWISE provide front end and backend systems to support logistical planning. Additionally, eMAR also provides subsystems to improve efficiency in parallel information flow (e.g. BoL and supporting documentation arriving to all stakeholders, cargo lists, etc.). Additionally, ECOHUBS and iCargo are developing systems for more efficient logistical planning throughout the supply chain.	iCARGO ECOHUBS FREIGHTWISE eMAR
Improvement of the interface between transport modes – Development of intermodality Improving the interfaces between transport modes has two main elements: (a) a common architecture (including data models, data structures, etc.) for fusing information to all stakeholders and (b) front end systems to manage this information. The following projects pose an interesting opportunity for reusing their results: ▪ INTEGRITY ▪ CONTAIN ▪ eMAR ▪ FREIGHTWISE ▪ 3SNET ▪ SHORTSEAXML Furthermore, important components to be reused include messages, sample messages and subsets.	INTEGRITY CONTAIN eMAR FREIGHTWISE 3SNET SHORTSEAXML
Fostering eMARITIME Operations, Motorways of the Sea (MOS) concept and Logistics Activities Regarding the e-maritime operations, eMAR project and the family of MIELE / AnNA projects have developed front and backend systems to support the logistics and transportation aspects of the maritime operations. For example the Connectivity Services to interconnect the different actors in the supply chain as well as the optimization services (routing, cargo list, etc.) are also systems that	ANNA eMAR 3SNET SHORTSEAXML, MIELE

can be reused by the market players. Additionally, the 3SNET and the SHORTSEAXML projects have also developed components for standardizing messages among the maritime market players.	

6.4 Port Operation: Opportunities for implementation

The opportunities for implementation of project results that have either already taken place or could take place in the future are listed below.

Opportunities for implementation	*Reference project:*
Freight Management Systems ▪ Freight4all project demonstrated that a distributed platform that acts as a mediator for the effective interactions of the stakeholders is feasible and it laid the foundation for implementing it in the near future. Four Components were successfully developed, each capable of running on a separate server providing a distributed architecture. These components provide specialised functionality that can be adapted to work independently. The system was successfully demonstrated in 5 different use cases. These use cases tested the new systems ability to make a booking for a shipment and then monitor it as it moved across national lines.	FREIGHT4ALL
Improvement of the interface between transport modes – Development of intermodality. ▪ It is necessary to work on the integration of maritime-railway transport at the physical level (accesses and infrastructure), the functional level (services and marketing) and the knowledge management level (information and documents).	CEDEX INTERMODALITY
Improving the integration of ports with their hinterland ▪ FUTUREMED tested a number of solutions to improve port-hinterland integration that could be further developed and/or implemented in a larger scale in Europe. Therefore, there are opportunities for further extending the interoperable solutions and standard messages for information exchange between stakeholders involved in maritime-rail operations and port-hinterland intermodal corridors, improving the efficiency and competitive position of rail transport for port-hinterland connections. Also the 'customs corridors' tested in Italy and based on centralized technology to track and trace trucks from port to inland logistics areas could be an option to explore in other European regions. The development of Information Systems devoted to cruise passengers and integrating ports and cities are also a great opportunity for further development and implementation in the framework of smart cities and smart ports policies and trends. Finally, the concept of the 'Futuremed visibility platform' supports the integration of information from maritime and port-hinterland services and it is a tool with a great potential that could be further developed and that requires for new approaches from the governance and business models. ▪ Regarding port-hinterland integration, also the development of intelligent transport systems to better plan and manage road traffic from and to the	FUTUREMED STIMULO

ports, reducing congestions, waiting times and other impacts, should be further explored and solutions following similar approaches to STIMULO could be developed in the framework of the development of more smart ports.	
Supporting commercial port-maritime services ▪ Ro-pax companies operating in daily round-trip: o Ro-pax companies operate two different traffics. On one hand, they transport passengers, having relevant peaks during the tourist high season. On the other hand, they transport goods during the whole year. In both cases, business is based on a stringent compliance of the schedules. Delays have a negative effect on passenger satisfaction and it is essential that goods should arrive in the market in time. Ferry transport usually offers a highly flexible schedule permitting last time trucks shipment. This is possible because carriers book several slots, sending a prevision every day of how many trucks are going to embark. In addition, the trucks that embark last are the first ones to disembark in the next port. For this reason, drivers try to embark in the last minute. This particular way of doing things requires the intensification of the controls in order to avoid delays or outstanding payments, because the shipping company is responsible for proving the trucks have embarked. o Passive RFID technologies and mobile antennas can significantly contribute to minimise this problem. Fixing the antennas at the port and terminal main gate would permit the immediate identification of truck through the Meditatracknet web. Mobile antennas would provide evidence of the truck embarking and disembarking, recording truck number plate, type of vehicle, date and time. In particular, these antennas would avoid embarking delays that forces the ship to sail at higher speed in order to comply with the schedule. This speed increase results in greater amount of fuel consumption, increasing not only operational costs but also ship pollutant emissions. Additionally the system paves the way for implementing booking systems based on truck position in the hold. Similar to the airline booking system, fares could be issued according to the position in the hold or the booking prevision. The system could lead to an innovative loading/unloading process based on introducing significant improvement in the booking system. ▪ Optimization of the operation in Ro-Ro Terminals: o Ro-Ro terminals could benefit from using passive RFID technologies by introducing them into terminal operations. Current state of the art technologies being used allow us to know what vehicles are in the yard and their exact position. However, logistical operations inside the terminal could be significantly improved by the use of RFID technologies in conjunction with GPS. In the particular case of Ro-Ro terminals, goods are load/unload in semi-trailers driven by Ro-Ro tractor. o The installation of passive RFID in cargo in conjunction with a GPS in the terminal tractor could, with the development of an adequate	MEDITA

software permit a thorough analysis of terminal operations. Firstly, the system links goods and vehicles giving up stevedore's anonymity about the performance of the load/unload operation. This fact will permit at the same time measuring the stevedore´s productivity and avoiding damages in cargo due to careless handling. Secondly, the traceability of load/unload operation is crucial in its optimisation, contributing to avoid bottlenecks and unused equipment, etc.	
Fostering the creation of knowledge networks ▪ The development of networks and clusters to cooperate between ports in areas such as the one addressed in Port Integration (EU policy, new logistics concepts and trends, ICT and e-services) is something that could be expanded and consolidated through different stable structures and/or mechanisms.	PORT INTEGRATION
Fostering Motorways of the Sea (MOS) concept ▪ PORTMOS project demonstrated that is necessary to set conditions for successfully developing the new motorways of the sea services in Portugal, but the same situation occurs in other European countries. The project identified constraints that had not been eliminated or attenuated and should be solved.	PORTMOS
Information distribution among all parties involved ▪ The "MIELE middleware platform" established the basis for ship reporting formalities. It aimed to make them fully interoperable, as required by the Directive 2010/65 EU. Although, it was tested through pre-deployment pilots, there are no evidences of its use after those test beds. Moreover, there is still a considerable scope for improvement in information sharing and distribution among the port-maritime cluster's stakeholders.	MIELE
Information/data exchange among ports ▪ In the framework of the ITS ADRIATIC project, they developed an e-platform capable of integrating the information systems of the port communities of all NAPA partners. The platform provides communication between the computer systems of the individual ports (port community systems) where these already exist, and guarantee adequate connectivity, flexibility in data transformation and formatting, and a high level of integration with third party systems, services and data interchange technologies. Although it was a pilot and only few services were integrated, the experience gained could be a useful reference for future data exchange among ports.	ITS ADRIATIC
Developing sustainable solutions in ferry operations ▪ Although passenger ferry transport is already cleaner and more sustainable than moving people by road, there are numerous technology-related opportunities that have potential to make commuting by water even greener. iTransfer partners worked together to innovate and share best practice ensuring that ferry operations in the North Sea Region are as sustainable as possible.	I-TRANSFER
Simplifying and harmonising the maritime transport formalities ▪ Mednet project established and operated a network of port authorities and transport experts alongside the Mediterranean focusing on the exchange of	MEDNET

experiences concerning ports and customs procedures and the simplification of clearance for vessels and freight. As a part of the project, several electronic prototypes for Customs documents have been integrated into each Port Community System (PCS). Some of these prototypes are currently working in each port solving these detected problems. Electronic solutions are examples of information systems that facilitate and simplify port operations, customs procedures, and mark another step towards establishing a barrier-free European maritime space pursuant to Directive 2010/65/EU on reporting formalities for ships arriving in and/or departing from ports of the Member States.	

6.5 Regulations Management: Opportunities for implementation

Opportunities for implementation	*Reference project:*
1 Streamlined administrative processes In addition to the continuing development of the National Single Window (see below), clarity is needed on the modalities for lodging cargo information in the NSW. Currently, an electronic goods manifest (E-Manifest) is being developed in the context of the Blue Belt initiative with the aim of using it to also meet the Directive's reporting requirements on cargo. The electronic cargo E-Manifest, with information on the status of goods, is considered as a practical solution to the problems in complying with reporting requirements encountered by ships involved in intra-EU trade but calling also at a foreign port. With the development of the E-Manifest, operators will be able to prove the Union status of the goods on board, even if the vessel has left the EU customs territory to move from one EU port to another or if the vessel has called at a third country port in between. The implementation of the electronic cargo E-Manifest, with information on the status of goods, is a crucial step towards the simplification of formalities. This electronic and harmonised cargo manifest will facilitate voyages of vessels calling in third countries. Shippers and shipping companies, as well as for customs authorities will enjoy this facilitation. On 8 July 2013, the Commission adopted a Communication on "Blue Belt, a Single Transport Area for shipping", referring to two legal measures to be developed: a simplification of the Regular Shipping Service scheme and the development of an electronic harmonised cargo document, the so-called E-Manifest. Both measures necessitate a modification of the customs legislation. For the first measure, an implementing act has been adopted by the Commission on 5 November 2013. The new scheme applied as from March 2014. The development of the E-Manifest has shown to be more challenging. The initial aim of the Commission was to get the proposal adopted by July 2014. After	

consultation of trade and Member States, an agreement has been found on the scope of the E-Manifest, which as a first stage will be limited to the identification of the EU or non-EU status of goods.

To this purpose, the Commission will propose to the Customs Code Committee a harmonised electronic Customs good manifest, which will be sufficient to identify EU goods as from 1st May 2016 for "authorised issuers". For non-authorised issuers an endorsement by Customs of the port of departure will be needed. The corresponding legal provisions will be integrated in the implementing provisions of the Union Customs Code after having been formally accepted by the Customs Code Committee.

A further opportunity to facilitate this enhancement could be a central database – connected to Blue Belt – that would inform shippers in advance whether their goods will be transported by a ship that falls within the scope of Blue Belt or not. This central database would be available to all stakeholders.

2 (Maritime) National Single Window

The concept of a single information system that links various government data exchange functions relating to incoming and outgoing ship movements appears to be an inherently obvious way to manage the different business processes of the connected administrations, such as Customs, Health etc.

The NSW can simplify and facilitate to a considerable extent the process of providing and sharing the necessary information to fulfil regulatory requirements for both authorities and the shipping industry. The use of such a system can result in improved efficiency and effectiveness of official controls and can reduce costs for both authorities and industry due to better use and re-use of resources.

Notwithstanding these apparent benefits, NSW implementation is proving to be more difficult and expensive than had perhaps been thought. One answer lies in the fact that when administration implement a NSW, they must adhere to a more rigorous set of business processes than they have been used to using.

The AnNa project has identified a number of elements that make it so difficult and expensive to implement a maritime National Single Window, as well as a methodology for addressing these, both at the level of individual administrations and, more ambitiously, towards the development of an overarching European IT system architecture.

The Maritime Single Window has the potential to contribute to the development of a European digital maritime transport platform. In the light of the 10 policy priorities of the Juncker Commission, the Maritime Single Window could substantially contribute to the development of a (common) EU Digital Single Market, providing an opportunity for European companies to sell new services connected to the EU maritime transport industry.

These represent significant opportunities for implementation, if the challenges

noted can be overcome.

A further area of possible development comes from the idea that there should be a "single window environment" in which the data between single windows through the interoperability principle of Rec. 36 of the UNECE (United Nations Economic Commission for Europe) are connected to each other. This concept arises from the recognition that, within various domains, separate Single Window programs, each with their own merits and conventions, have emerged. There is often a separation between legal obligations and B2A and B2B logistics interactions. There are within the public domain separate Single Window perspectives, i.e. Customs, port, health. Therefore, it can be said that multiple single windows exist, and it is felt by some that merging of existing single windows is very unlikely.

In the light of this, the concept of fostering the interoperability between the different Single windows is currently under discussion, in the framework of UNECE Recommendation. 36.

There is therefore possibly scope for systems and technologies to assist the development of the Single Window as a collaborative network of information systems.

3 Enhanced maritime surveillance

The conference "Maritime Surveillance: Cooperation in Practice", held in EMSA on 7 May 2015, provided an opportunity for interested member state and EU authorities to find out about the latest developments in maritime surveillance across Europe. A growing number of authorities are engaging an ever-increasing range of sea-based activities, and there is subsequently an increasing need for reliable maritime data.

Clear themes emerging from the conference were: the critical role of cooperation between all actors; the importance of building on synergies; the potential of new technologies for further improving the maritime picture; and the importance of developing operational capacity in a 'bottom-up' manner. EMSA will continue to provide support through its Integrated Maritime Services, taking into account developments at sea and the evolving priorities of member states and the Commission.

At present, there is no analysed information available at European level, or at the sea region level where ship movement data and cargo data are linked. There is the potential for an overview of ship traffic/movements to be obtained by linking and analysing cargo data and ship movement data. In part, this could be addressed by an adaptation of the current Directive 2009/42/EC of Eurostat, to permit the use of the cargo data on a port to port basis and if possible also to derive the movement data from the existing data bases.

Another possibility is to undertake specific analyses of AIS data, possibly linked with cargo data, to gain insights into the shipping movements and cargo traffic

within the EU and/or calling at third country ports or in free zones. The progress made to date towards a Common Information Sharing Environment (CISE) for the EU maritime domain provides a basis for further work and in particular to focus on the remaining challenges, showing that the vision of Maritime CISE is being pursued both at national and EU level. One of the most important needs is to improve information exchange between military and civilian authorities. Including the defence community and identifying information that could be exchanged between civilian and military authorities in a Maritime CISE will be important since military authorities are one of the main holders of maritime surveillance data. **4. Support for regulatory compliance** The e-Compliance project is building on the work done in FLAGSHIP by formalising the translation of maritime regulations into rules. In addition, rather than just catering for the needs of a ship's crew, e-Compliance will create and integrate systems for compliance, enforcement and creation of maritime rules.	

7 Recommendations for Cooperation

Proposals for cooperation and information exchange between the recent projects related to e-maritime are given below for the four main focus areas, namely: Ships Operation and e-navigation; Port Operations; Logistic Chain and Regulations Management; and also by specific sub-topics,

7.1 Ship Operation

The e-maritime Strategic Framework (EMSF) being developed by the eMar project provides a platform to publish software services related to shipping; it also acts as a kind of proxy for these services and it could also be used for implementing applications for ship operations. There are a number of outcomes of current projects that could be adjusted and transformed into services within the EMSF platform, and these include the following projects:

Integrated ship design and operational environments: The SHOPERA project addresses the outlined challenges by looking holistically at integrated ship design and operational environments, and implementing multi-objective optimization procedures to optimize a ship's powering while ensuring safe ship operation; but at the same time seeking the right balance between the ship's efficiency and economy, safety and greenness. The project is focused in order to achieve a successful transfer and implementation of the proven resilience engineering concepts and tools from the aeronautical industry to marine transport. The aim of the SEAHORSE project is to transfer the effective and successful safety concepts utilised in the aeronautical industry, adapting and tailoring them to the unique needs of marine transport.

Regulatory Compliance: The e-Compliance project will build upon strengths created across numerous EU projects in order to facilitate tighter integration and co-operation in the fragmented field of regulatory compliance in the maritime domain. Regulations are created by numerous different bodies, with little co-operation between them. As such, there is a significant lack of cohesion between the vast array of regulations and the possibility of conflicting regulations is very

real. By creating a model for managing regulations digitally and creating services for all the different stakeholders, can harmonize these regulations and allow for co-operation between the different stakeholder groups. Not only will this improve the quality of regulations, but it will also reduce the burden for those having to enforce the regulations as well as those who must comply, resulting in a regulatory regime that is more effectively implemented.

Safety Enhancements by Achieving Human Orientated Resilient Shipping Environment: The SEAHORSE project brings together an experienced, diverse and committed consortium from air and maritime transport sectors and world leading expertise, with the overall goal of tackling the issue of 'Human Factors and Shipping Safety'. Through the SEAHORSE concept and the utilization of some of Europe's leading companies and institutions, both in the consortium and advisory board, in various fields including human factors research, operation, engineering and training in air and maritime transport; SEAHORSE has the potential to create a significant impact, at not only a European level but also an International one, in making the ship operation a safe, resilient, attractive and efficient environment.

Ship Inspection: The INCASS (Inspection Capabilities for Enhanced Ship Safety) project is a multifaceted project bringing together a range of experienced and dedicated partners in order to tackle the issue of ship inspection, identification of high-risk and sub-standard ships, providing access to information related to ship surveys independent of the ship flag state and inspection regime and moreover incorporate enhanced and harmonized cooperation of maritime stakeholders in order to avoid ship accidents, promote maritime safety and protect the environment (EC 2012). The INCASS consortium aims to bring an innovative solution to the integration of monitoring, inspection, data gathering (including real-time information), risk analysis and management and Decision Support for ship structures, machinery and equipment in an efficient and collaborative manner.

Ship operational status and efficiency monitoring: The MARIBRAIN project is focused in research and implementation of an integrated data acquisition system over a wireless sensors network and knowledge administration analysing remotely the vessel's operational status and monitoring the efficiency. The full project title is: "Ship's Health Condition, Operational Status and Performance Remote Monitoring based on wireless sensor network and technical experience management system". The project will lead to a product/platform aimed to be used by maritime companies that own, manage and operate any types of ship.

7.2 e-navigation

As is the way with most of projects running under national or EU funding, there is a contribution from the partners themselves into the work that they normally plan to take out in the form of new products, processes or other results that can improve their competitiveness. The selection process for the proposals will also normally consider the need for what technology to address and the usefulness of having more than one project work in a specific area. Thus, these issues are not normally a useful arena for cooperation, unless the projects themselves find it useful to do so. This also applies to information exchanges beyond what is already in the dissemination plan.

However, developments in the area of e-navigation and e-maritime can be severely hindered by a number of factors that it is difficult for the individual companies or projects to pursue individually. These main factors are:

- **Standards for communication**. e-navigation requires improved integration between parties and systems and a key element in this is standards. For communication one needs to consider on-board networks, integration between networks onboard and integration between ship and shore. Currently standards in the IEC 61162 series and ISO 16425 address parts of this, but certainly not sufficiently well. Particularly exchanges between ships and between ship and shore need more attention. This is under way in IEC 62940, but this work should also if possible be supported by EU projects. One new standard that is proposed is VDES (VHF Data Exchange - worked at within IALA and ITU), but also here more work is needed. For satellite communication one also needs to look into variable quality of service and consequences for bandwidth and availability.
- **Standards for information exchanges**: Communication links carry information and information must also be standardised. Currently UN/EDUFACT, ISO 28005 and IEC 61162 define some information models and message formats. New developments within e-navigation is supposed to be done within the IHO S-100 framework, but it is not clear if this is the best approach for all data types as S-100 is mainly for geographic information and rendering. A complementary approach may be to define mappings between existing and new standards and the S-100 system. Accseas has done work on implementing operational data in the S-100 product definitions, but this is not general enough to be used for, e.g. general reporting purposes. There is also a need to extend the single window standards to also cover other reporting formalities, e.g. for electronic certificates. E-Compliance will look into this issue, but the standardization is currently not in the work plan.
- **Legislation**: Legislation and regulations represent another area that is a typical show-stopper for deployment of new technology. A stronger cooperation between projects in this area would be greatly appreciated although it is clear that the projects as such cannot directly influence regulations and legislation.
- **Commercial and organisational relationships**: Old contract forms and sub-optimal organisational structures can also be a hindrance to developments in this area. A typical example is that it is the charterer that gains benefits from lower fuel consumption while the owner has to pay for systems or equipment. The management company is stuck in between and have responsibility for part of the operational issues.
- **Cost-Benefit analysis**: Ship owners are reluctant to accept new technology, particularly that which claims to increase safety or security, without a solid cost-benefit analysis behind it. Unfortunately, these tend to be based on different numbers and assumptions in each project and there is little agreement on how to perform these correctly.
- **Test-beds and simulation facilities**: Testing of results could also benefit from harmonization, either through simulations or tests in the real world. This is also important for efficient cost-benefit analysis. Part of this issue is also access to real data sets, e.g., for ship traffic, that can be used to test or analyse performance of systems. Accseas has contributed to the general development of the concept of e-navigation testbeds. This has now been taken up by IMO and other EU projects working in this domain is strongly encouraged to investigate this issue and see if it is possible to cooperate in this.

In summary, these issues can be defined as part of the e-navigation or e-maritime architecture.

7.3 Logistics

It is evident from the review that most of the projects, if not all, address similar issues and in most of the cases, they come up to similar standards. Nevertheless, the working practices in most of them limit the cooperation and thus constrain significantly the applicability of the results. The main issues that have been reviewed include:

- PILLAR I: Communication systems and protocols
- PILLAR II: New applications both front and backend
- PILLAR III: Improved or new business processes
- PILLAR IV: Legislative improvements

More precisely, the following table addresses collaborations opportunities per these four pillars:

1. Communication systems, protocols, standards and ICT

Most of the projects address the issue of standardization of messages and communications. More precisely, the following projects have developed standard messages and standard data models to be used by the interested parties:

- 3SNET
- FREIGHTWISE
- EURIDICE
- eMAR
- CONTAIN
- SHORTSEAXML
- iCARGO
- INTEGRITY

Integrating and streamlining the data models and requirements will lead to better adoption of these messages by more logistics stakeholders and as such, cooperation among these projects will lead to improved data models and structures.

2. New applications both front and backend

All of the reviewed projects build frontend and backend applications and as such the need for better collaboration is high. More precisely, INTEGRITY, CONTAIN and eMAR all have security elements for the container based cargo flows. L4L, ECOHUBS and iCARGO on the other hand have efficiency improvement elements (both energy and environmental). SMART-CM, eMAR, iCARGO, EURIDICE and NSFRITS has modules for the transport planning process, each addressing different aspect of the process.

3. Improved or new business processes

An additional issue that is being tackled by some of the projects is developing new services and new processes. The MIELE project has developed middleware that can help visibility in the supply chain. To this extent, this supports the company in building new services and or improving existing ones. Similarly, the projects iCARGO and CONTAIN also build similar new procedures for the optimization of services and for improving existing services. Additionally, FREIGHTWISE and EURIDICE also offer similar services and components, whereas SMART-CM, NSFRITS and ECOHUBS are improving the energy efficiency of traditional services and make them “more” marketable.

4. Legislative improvements

Regarding the legislative improvements, CONTAIN and eMAR are working towards streamlining processes in the maritime domain and as such there is potential for cooperation since they make legislative and standardization recommendations. To this extent, eMAR and AnNA are both working towards delivering Single Windows for the maritime sector.

7.4 Port Operation

As is apparent from the previous 5.4.1 section, there are a numerous links among projects carried out in recent years. For instance, projects such as Freight4all, ITS Adriatic and MIELE all had the common objective of improvement the information distribution between all parties involved. PORTMOS MEDITA and EFFORTS were also focused on supporting commercial port services and the list goes on.

In addition, it has also been considered appropriate to study the relationship among these Port Operation projects taking into consideration the kind of issues developed in each case. This methodology is made in order to provide a broader range of proposals for cooperation and information exchange between them and that could be really useful for future research studies.

The MESA investigation into e-maritime has been limited to issues that support more efficient cooperation involving ships, but recognising that some information relating to multimodal transport logistics is required. Furthermore, these issues have also been limited to those that are related to improved information management.

These categories of analysis comprise issues related to:

- Communication systems and protocols, on the ship and between ship and shore
- Storage systems, messages and technology that facilitate more efficient information use and reuse in matters that relate to the ship
- New applications on shore or on ship that make use of improved information availability
- New systems or services that improve working conditions for the crew on the ship
- Improved or new business processes that improve ship-shore cooperation
- Legislative improvements that can enable new or improved business processes
- The use of information arising from and provided to other elements in the multimodal transport chain.

According to this categorisation, proposals for cooperation and information exchange between them are outlined hereafter.

- Projects related to new applications on shore or on ship that make use of improved information availability

  MEDNET, PORTMOS and EFFORTS were or are working on the development of IT solutions to support port operations procedures.

  MEDNET intends to develop a common framework of understanding of customs procedures and the clearance of vessels, including berth allocation for RO-RO, RO-PAX and cruise ships, EXS/ENS collaborative solutions among ports among others. Likewise, it was carried out a web service that supports the Booking process between the Consigners and Freight Integrators and between the Freight Integrators and the Service Providers in the framework of PORTMOS

project. And the Berth Allocation and Manifest Distribution were analysed and modelled in the framework of EFFORTS project.

- Projects related to issues developed with the aim of improving or carrying out new business processes to foster cooperation and coordination among maritime agents/actors.

  In the framework of MIELE, it is being designed an ICT platform able to interface existing systems for ship reporting formalities, in order to make them fully interoperable. Similarly, ITS Adriatic project have boosted the development of an EDI platform able to provide information interoperability and integrating in one network the four ports of NAPA community (Venice, Trieste, Koper and Rijeka).

  As well, more generally, PORT INTEGRATION aims to create the base for a guide of best practices on Single Windows, e-maritime and Port Community System implementation for its application in European ports in general.

  Furthermore, EFFORTS project studied in detail the relationships between actors involved in the maritime transport chain and developed a standard high level process map that can be used to find cooperation opportunities and to introduce new ICT systems.

- Projects related to the use of information arising from and provided to other elements in the multimodal transport chain.

  An important number of projects related to port operations are focused on fostering multimodal transport. On the one hand, some of them have already been completed such as Freight4all, TIMI, SESTANTE and CEDEX Intermodality. On the other hand, some are under development, such as FUTUREMED, STIMULO and MEDITA.

  Regarding the milestones achieved, Freight4all developed a distributed platform using .NET technology that acts as a mediator for the effective interactions of the stakeholders. As well, in the framework of the TIMI project, new technologies and methodologies were developed to permit the creation of the future generation of devices, systems and tools contributing to making such transport more intelligent. Finally, CEDEX Intermodality set standards to further develop and integrate maritime-railway transport at the physical, functional and knowledge management level.

  Additionally, FUTUREMED intends to make freight and passenger flows seamless by means of experimental activities and pilot projects concerning interoperable information systems which integrate port systems with inland logistics infrastructures and with transport and service operators. Similarly, STIMULO aims to develop intelligent traffic management systems by predicting in real-time the status of the various components of the transport system. MEDITA goal is the implementation of a Cargo Community System.

  All these projects are also related to other projects studied in the Logistics Chain section, such as Contain, eMar, FREIGHTWISE, Logistics for Life as well as all others included in this category.

7.5 Regulation Management

As has already been noted in the review of projects on e-maritime in connection with regulations management in section 5.5 above, many of the more recently-started projects are taking forward results from projects that have already been completed. This is an illustration of actual cooperation and information exchange between projects.

Some more general possibilities for cooperation and information exchange between projects are set out below.

Technologies that have been demonstrated ("proof-of-concept") and are now made available for further development

The **MIELE** project has developed an interoperable ICT platform (the "MIELE Middleware"), as a process layer receiving messages from existing ("legacy") systems, and forwarding them to the appropriate counterpart in such a way that the message can be received and correctly interpreted by both competent authorities (single windows or B2A) and dedicated business systems (B2B). In this way, by adding a single component to their existing systems (the plug-in to the MIELE middleware) interested operators can tap into a common resource (the MIELE platform) that takes care of dispatching the message to the appropriate counterpart.

ARIADNA has developed a system that combines data on navigation, position and vessel characteristics with time information about relative positions in regard to vessels and infrastructures that are located in its surroundings.

MarNIS has developed two outputs which are available for further development; these are: MOS: Maritime Operational Services addressing the integration of emergency related processes and MIM: Maritime Information Management addressing the adoption of National Single Windows by all member states improving the manner in which data is reported to the authorities but also the way in which this data is distributed and made available to the various authorities, these being not only the "traditional" maritime authorities but also authorities such as customs, immigration and health. MarNIS has established specifications for Port Entry Profiles and Port Exit Profiles (PEPs) generated by the NSW to support decision making before the vessel arrives at port thus increasing clearance efficiencies. PEPS are designed for approximately 10 roles with emphasis on inspection reports and coordination of inspections. PEPS can be combined to suit the different ways maritime authorities are organised in different Member States.

Contraffic has developed a technology to screen data on global maritime container movements to detect potentially suspicious consignments. DG JRC is currently extending the ConTraffic system to address maritime security and specific security related concerns including illicit trafficking of security-sensitive goods.

TANGO has proved that efficient operational technologies are available to meet GMES requirements, and has proposed a way forward after TANGO, which could include TANGO platform as a major tool in the development of the emergent Telecom Risk Charter concept, which would allow communalising and sharing the potential of satellite telecommunications solutions from operators and institutions to serve the GMES community needs in case of disaster and crisis. Telecommunications should have a key role in the future GMES model. The future and development of GMES itself relies in its pioneering infrastructure and highly-efficient telecommunication services.

As a result of the **Blue Belt** initiative, the idea of a harmonized and electronic manifest (eManifest) has been generally supported. Beside the facilitation resulting from the harmonisation and the possibility to use it as proof for the status of goods, additional functionalities of that eManifest and

the impact of such an extended use needs to be examined in order to be able to achieve the most profit from its establishment.

The **Integrated Maritime Data Environment** (IMDatE) is a technical framework currently under development. In future, it will combine and process data from EMSA's maritime applications and other external sources to provide more comprehensive and configurable services to users, as well as supporting the relay of data between the applications themselves. The IMDatE platform will offer a dedicated Data Processing Centre for satellite AIS, and will also facilitate the processing and distribution of other new data sources.

At the programme level, EU Maritime Policy also offers possibilities for greater cooperation, for example between European Territorial Co-operation (ETC) maritime cross-border programmes ((INTERACT), 2013). These are programmes characterised by the presence of the sea in the geography of their programme areas, although the sea is only considered as "one of several features of the programme geography and only requires some co-operation activities to be related to it."

However, where there is competition between different uses (shipping, fishery, renewable energy generation, mineral extraction, etc.) for access to limited space and resources, some way of reconciling these competing demands is clearly of benefit.

Prior to 2007, EU marine policy had been limited primarily to a communication on Integrated Coastal Zone Management, one framework Directive to improve water quality and maritime safety directives following the losses of the Erika and Prestige. However, the publication of the Maritime Policy Green Paper in 2006 meant that the 2007-2013 programme period corresponded with a "step change" in the development of EU marine and maritime policy, although maritime policy was still not fully elaborated at the time 2007-2013 Operational Programmes were developed.

Now that a marine and maritime policy framework has come into being at European level, there is an opportunity for programmes to investigate, as part of their situation analysis, how they can link to this framework, and so cooperate more closely.

The principle policy areas which may be potential sources of projects are:

- Integrated Maritime Policy;
- Marine Strategy Framework Directive;
- Common Fisheries Policy;
- Integrated Coastal Zone Management;
- Maritime Transport;
- Ports;
- e-Maritime;
- Maritime Safety;
- Water Framework Directive

Technologies that have been contributing to related projects and initiatives

VESPO has been involved in a number of FP6 / FP7 projects that have contributed to the EUROSUR concept design (OPERAMAR, WIMAAS, SEABILLA, and I2C) and provided support in the technical assessment of studies that the Commission and Frontex have contracted out to explore the EUROSUR components.

VESCOSUR made substantial contributions to EUROSUR CONOPS (Concept of operations for the common application of surveillance tools at EU level in the context of EUROSUR), a key output issued in 2011. This document provides a definition and detailed description of the necessary services to make available surveillance information, mainly derived from satellite observation, on borders and on the pre-frontier area on a frequent, reliable and cost-efficient basis.

In 2013, VESCOSUR will study the feasibility of exploiting advanced cargo information for safety and security purposes. VESCOSUR also contributes on occasion to crisis response with its technologies, as was the case of the Costa Concordia emergency management operations in 2012, where VESCOSUR offered its Melissa radar to monitor displacements of the wreck with unique accuracy.

VESCOSUR provides policy support to a number of Directorate Generals and Services of the Commission. For its maritime surveillance activities these are DG MARE, DG DEVCO, DG ENTR, DG HOME and DG MOVE, while for its container monitoring and risk analysis activities, these are OLAF and DG TAXUD.

THETIS has been developed by EMSA as an information system to support the New Inspection Regime for Port State Control. It is available 24/7, with a high grade of reliability, at https://portal.emsa.europa.eu/web/thetis/home

Common Framework/ Common Reporting Schema

The **eFreight** project has developed the *e-Freight Framework* consisting of:-

- A Reference Model de-composing the transport and logistics domain into manageable subdomains
- Functions performed by roles pertinent to each sub-domain
- Processes of the key activities in the transport and logistics domain
- Information models structuring the information being exchanged into standardised messages. The e-Freight project has developed a prototype Next Generation Single Window dealing specifically with the new Ship Formalities directive

The *Common Reporting Schema* (CRS) is being further developed under the **eMAR** project. The *e-Freight Applications* include the *Next Generation Single Window* which is being further developed under eMAR. The **e-Compliance** project will also seek to integrate other private initiatives into the framework developed by e-Freight and other projects

It became apparent in the **FLAGSHIP** project that many regulations are highly complex and require a unified description and more advanced semantic techniques. The **e-Compliance** project is building on the work done in FLAGSHIP by formalising the translation of maritime regulations into rules. In addition, rather than just catering for the needs of a ship's crew, e-Compliance will create and integrate systems for compliance, enforcement and creation of maritime rules.

Policy guidance on e-maritime for regulations management

The *e-maritime Strategic Framework* (EMSF) that is being developed by the **eMAR** project will bring together into a coherent whole concepts, processes, standards and technologies to create a common language enabling networking and computer supported co-operation between the principal maritime transport stakeholder groups. In so doing, it will foster cooperation and

information exchange between projects, while also helping to shape the policy context in which these and future projects will develop.

The goal of the **AnNa** action is to facilitate and foster an effective and sustainable Maritime Single Window development that: (1) Allows smooth interaction of data between the user and national administrations involved; (2)Optimally meets the needs of the maritime industry; (3) Adheres to the Rule of Law; (4) Recognizes existing (partial) systems; (5) Safeguards the varying ambition levels of individual Member States; (6) Is future proof, i.e. substantially enhancing interconnection in the logistic chain on the long term.

Both eMAR and AnNa, together with DG Taxud and others, are cooperating on various issues related to Maritime reporting documentation, such as the introduction of the electronic customs goods manifest (e-Manifest) into EU Custom's law.

The **e-Compliance** Project aims to reduce the administrative burden on maritime stakeholders by using semantic technology and digital models to manage regulations. It will include the development of a system which provides an annotated digital library of maritime regulations allowing users to more easily establish definitions and their meaning. The project will create software systems to aid those who need to create, enforce and comply with maritime regulations

The project has developed a Maritime Thesaurus and Ontology, designed to help with the drafting, structure and understanding of maritime regulations. The thesaurus and ontology will be used as the basis to develop semantic technologies for searching, drafting and annotating maritime regulations.

8 Overview of e-maritime Clustered Research Projects

8.1 State of Play

The aim of e-maritime is to enable maritime transport actors to seamlessly and effortlessly exchange information and improve the efficiency and quality of their services. e-maritime also supports the EU's e-maritime initiative in making maritime transport *safer, more secure, more environmentally friendly, more effective and more competitive,* for all parts of a sustainable EU transport system. This will be achieved through the development of a framework based on the latest information, communication, and surveillance technologies.

e-maritime promises to provide interoperability between all maritime administrative functions, and will have important applications for commercial operations. e-maritime solutions must therefore offer a holistic approach that extends beyond pure transport services addressing logistics, customs, border-control, and the environmental etc. The key application domains are where competitiveness and performance can be strengthened and enhanced

e-maritime, as envisaged by the European Commission, encompasses commercial, logistical and more general efficiency measures, whereas IMO's e-navigation led concept is understood to relate to activities that directly address safety, security and environmental protection. On the other hand e-maritime and e-navigation can be viewed holistically as embracing and overlapping reference frameworks for maritime information services and products.

There are still a number of obstacles that prevent the full exploitation of a digital waterborne transport and logistics system that includes both e-maritime and e-navigation. Existing systems that

handle data are fragmented and rarely interoperable, which complicates sharing of data and e-transport documents are not recognised by all stakeholders. There is also a need for standards for representation and transmission of large volumes of data in order to develop new integrated applications.

A comprehensive overview of the current state-of-the-art has been obtained for the completed and ongoing e-maritime research projects and initiatives. A detailed overview of the research status is given in Chapter 5 for five main focus areas: Ships Operation, e-navigation, Logistic Chain, Port Operations and Regulations Management.

The research projects that have been analysed have addressed different aspects of e-maritime and e-navigation. For example a number of projects have worked on the National Single Window and on reporting formalities to simplify and harmonise administrative procedures by making the electronic transmission of information standard; other projects have dealt with standards for ship data networks on ships and ship-shore communication, shore control centre application for voyage efficiency, and unmanned ships.

The eMar project has developed an e-maritime Strategic Framework (EMSF), which will help ensure interoperability and support policies and ongoing developments. This will be facilitated by an e-maritime Support Platform for the enabling technologies (communication, navigation and surveillance networks), European networks (SafeSeaNet (SSN), databases, e-Customs, e-Freight etc.), and to promote the development of standards, ICT and software tools for interoperability and integration of data and services, facilitating the development and deployment of e-maritime applications for the waterborne transport sector.

Considerable progress has been made in recent years for the realisation of both European Commission's e-maritime initiative and the IMO's e-navigation led concept, but more work is needed before both can be fully implemented. A summary of the key conclusions reflecting the current state-of-the-art is given below:

8.2 Summary of key conclusions

Ship Operations:

i. Commercial services are now available for all areas of a ship operation, including: Strategic Fleet Management, Personnel management and training systems, Chartering, Ship condition monitoring, maintenance and emergency support systems, Loading planning and optimization, and Voyage management systems, energy efficiency, operation risk management.

ii. Electronic documentation, e-compliance, e-recruitment, e-drawing, e-purchasing, and e-voyage planning are covered within the innovative single window architecture.

e-navigation:

iii. The availability of standards is a critical element in all ICT related research. The amount of information being made available and the volumes being transmitted makes it next to impossible to develop new integrated applications without also considering standards for representation and transmission.

iv. There is a need for more work on special purpose service oriented architectures to handle low bandwidth and intermittent connections for shipping.

v. The scalability of current research does not appear to address: Navigation in the Arctic, applications for smaller craft, and heavy weather operations, although HANDLING WAVES provided a prototype for the latter.

Logistic chain:

vi. There is still a need to further develop concepts, processes, standards and technologies that will enable networking and ICT supported co-operation among the main transport stakeholders in order to:

vii. Improvement of the safety and security of the transport sector

viii. Increase the competitiveness of the EU transport industry and strengthen the EU presence on the international scene

ix. Integrate sustainable transport services into efficient and secure door-to-door transport services in Europe and beyond.

x. Reinforce the human factor particularly supporting competence development and welfare for seafarers.

Port Operations:

xi. EU Research has provided important information for logistics and multimodal transport operations and processes, or how they can be improved; this has been achieved through the application of new support technologies, such ICT and simple data exchanges. Current EU research has focused on integrating web-based systems for multimodal transport logistics and port networking within the e-maritime framework.

xii. There is still a considerable scope for improvement in information sharing and distribution among the port-maritime cluster's stakeholders.

xiii. Electronic solutions are examples of information systems that facilitate and simplify port operations, customs procedures. These solutions mark another step towards establishing a barrier-free European maritime space in accordance with Directive 2010/65/EU on reporting formalities for ships arriving in and/or departing from ports of the Member States.

Regulations Management:

xiv. The main areas covered by the various research projects and other initiatives reviewed have been information sharing and integration, interoperability of disparate "legacy" systems, re-use of information.

xv. Much of the e-maritime activity in the area of regulations management has been promoted by various EU policies, directives and international regulations that determine information exchange requirements between businesses and administrations in the maritime sector. e-navigation activity on the other hand is an IMO concept.

xvi. A recently impetus has come from the need to meet the deadlines for compliance with the EU Directive on reporting formalities (2010/65/EU). The single window will be the place where all information is reported once and made available to various competent authorities and the EU countries. Another objective has been to assist in the implementation of the New Inspection Regime (NIR) for Port State Control.

xvii. The Expert Group on Maritime Administrative Simplification and Electronic Information Services (eMS Group) has produced guidance for establishing and implementing a National

Single Window (NSW) for maritime transport, as required by Directive 2010/65/EU. The guidelines stress that careful consideration should be given to which legacy systems, processes and information flows can be kept without unduly harming the overall objective of simplification, and provide guidance on how this might be achieved, whilst still retaining the emphasis on the harmonization of processes and data models.

Following the entry into force of Directive 2010/65/EU, the eMS Group has handed over to the newly created Digital Transport and Logistics Forum. The DTLF's field of application will be focused on freight transport and logistics, across all transport modes. In preparation for this, the eMS Group has some possible maritime topics for consideration by the DTLF, including: Optimised sea routeing, Optimised port services (including port clearance and national reporting obligations), Maritime clouds, Electronic ship certificates and Cybersecurity.

xviii. GMES (Global Monitoring for Environment & Security) services are currently being developed, to support public policy makers' needs in the domain of environment and security. This has also brought demands to expand the range of GMES services and to enhance their performances, for example by improved and faster data collection, fast data dissemination, provision of GMES data products down to the end-users on-the-field, early warning systems, ad-hoc networking etc.

8.3 Network of Projects

MESA's focus in e-maritime related projects has been limited to issues that support more efficient cooperation involving ships, but recognising that some information relating to multimodal transport logistics is required. Furthermore, these issues have also been limited to categories related to improving information management, including: communication systems and protocols, on the ship and between ship and shore, new applications on shore or on ship that make use of improved information availability, and improved or new business processes that improve ship-shore cooperation.

A comprehensive list of EU and nationally funded research projects relevant to e-maritime has been established and are given in Table 1 and Annex 1. A list of the main actors is given in Tables 2 to 6 in Annex 2.

An overview and analysis of the research status of the relevant research projects, including the state-of-art, their achievements and opportunities for implementation is detailed in Chapter 5. This overview and analysis concentrated on five main focus areas: Ships Operation, e-navigation, Logistic Chain, Port Operations and Regulations Management.

Many of the projects considered dealt with particular aspects of information exchange technology between the ship and the stakeholders onshore, including ship and port operations, authority functions, transport logistics and others, for the facilitation of efficient maritime transport. The development of an e-maritime Strategic Framework (EMSF) within the eMar project and the improvements sought in the e-Compliance project for regulatory compliance in the maritime domain are both supporting the European Commission's e-maritime initiative. A number of recent projects, including eMar and AnNa are supporting the development of the important Maritime Single Window. The Blue Belt pilot project has successfully demonstrated that it is possible to simplify customs formalities for ships trading within the EU.

8.4 Opportunities for implementation

The e-maritime applications envisaged by the EU's e-maritime initiative, many of which have been and are being addressed by the research projects considered, are potential opportunities for implementation, and these come under the following categories of operations:

i. Administration Domain Applications: (National Single Windows; ship and cargo reporting; e-Manifest, SSN; e-customs, e-certificates and generally e-compliance).
ii. Improved Shipping Operations: (Ship voyage monitoring, e-navigation and VTS, e-Purchasing, e-Drawing, monitoring CO2 operational index, compliance monitoring, remote technical support and crew training etc.).
iii. Improved Port Operations: (Integration of Port Single Windows with national and international web portals; resource management, optimized movements of cargo, containers, passengers, equipment; integrated port security management).
iv. Integration of Logistic chains: (Improved interfaces for inter-modal transport networks, common architecture for fusing information and front end systems to manage this information).
v. Integrated Freight Management Systems: (Distributed platforms for effective stakeholder interactions).
vi. Promoting the Motorways of the Sea (MOS) concept: (Set conditions for developing new services).
vii. Promoting the seafaring profession and sea-shipping (e-Learning and training courses, and e-Crewing for recruitment of seafarers).
viii. Regulations management. (Ontologies standards for legislation; integrated systems for compliance, enforcement and creation of maritime rules).

8.5 Cooperation Potential

Many of the more recent research projects related to e-maritime make use of the results from completed projects. This is a good illustration of actual cooperation and information exchange between projects. Some more general possibilities for cooperation and information exchange between current and future projects related to e-maritime are given below.

Ship operations:

i. The e-maritime Strategic Framework (EMSF) developed by the eMar project provides an architectural framework for integration of systems and services in the e-maritime domain.
ii. The e-maritime Ecosystem and its cloud services provide a platform to publish software services related to shipping; it also acts as a kind of proxy for these services and it could be used for implementing different applications for ship operations.
iii. SHOPERA and INCASS: for the development of holistic and integrated ship design, operational and ship inspection environments for optimized ship's powering and enhanced ship safety.
iv. SEAHORSE brings together an experienced, diverse and committed consortium from air and maritime transport sectors and world leading expertise, with the overall goal of tackling the issue of 'Human Factors and Shipping Safety'.

e-navigation:

i. As legislation and regulations can delay the deployment of new technology a stronger cooperation and information exchange between projects in this area would be beneficial e.g. with e-Compliance etc.
ii. e-navigation requires improved integration between the parties and systems and a key element is standards for communication e.g. on-board networks, integration between networks on-board and the integration between ship and shore; cooperation between projects in this area would be beneficial.

iii. Communication links for information exchange needs to be standardised. Information exchange on these standards or on any complementary approach to define mappings between existing and new standards would be beneficial.

iv. Accseas has contributed to the general development of the concept of e-navigation testbeds, which has been taken up by IMO. Other EU projects working in this domain are strongly encouraged to adopt the use of test-beds and simulation facilities to analyse the performance of systems.

Port operations:

i. MEDNET and PORTMOS: for the development of IT solutions to support port operations procedures.
ii. MIELE is designing an ICT platform to interface existing systems for ship reporting formalities, in order to make them fully interoperable. Similarly, ITS Adriatic project have boosted the development of an EDI platform able to provide information interoperability and integrating in one network the four ports of NAPA community (Venice, Trieste, Koper and Rijeka).

iii. MEDNET: for developing a common framework of understanding of customs procedures and the clearance of vessels. PORT INTEGRATION aims to create a guide of best practices on Single Windows, e-maritime and Port Community System implementation for its application in European ports in general.

iv. FUTUREMED, STIMULO and MEDITA are related to the use of information arising from and provided to other elements in the multimodal transport related to port operations.

v. The above projects are also related to other Logistics Chain projects, such as Contain, eMar, FREIGHTWISE, and Logistics for Life.

Logistics:

i. 3SNET, FREIGHTWISE, EURIDICE, eMAR, CONTAIN, SHORTSEAXML, iCARGO and INTEGRITY: for the development of communication systems, protocols, standards and ICT. Integrating and streamlining the data models and requirements will lead to better adoption of these messages by more logistics stakeholders. Cooperation between these projects will lead to improved data models and structures.
ii. All the logistics projects reviewed are developing frontend and backend applications. INTEGRITY, CONTAIN and eMAR all have security elements for the container based cargo flows. L4L, ECOHUBS and iCARGO have efficiency improvement elements (both energy and environmental). SMART-CM, eMAR, iCARGO, EURIDICE and NSFRITS has modules for the transport planning process, each addressing different aspect of the process.

iii. MIELE, iCARGO, CONTAIN, FREIGHTWISE and EURIDICE are related to the development of new services or new business processes. SMART-CM, NSFRITS and ECOHUBS are improving the energy efficiency of traditional services and make them "more" marketable.

iv. MIELE has developed an interoperable ICT platform as a process layer for receiving messages from existing ("legacy") systems, and forwarding them to the appropriate counterpart in such a way that the message can be received and correctly interpreted. There is a potential for cooperation between MIELE 2 and eMar who are both working on information exchange platforms.

Regulation management:

i. eMAR developed the *e-maritime Strategic Framework* (EMSF) to bring together into a coherent whole concepts, processes, standards and technologies to create a common language enabling networking and computer supported co-operation between the principal maritime transport stakeholder groups. In so doing, it will foster cooperation and information exchange between projects, while also helping to shape the policy context in which these and future projects will develop.

ii. eMAR and AnNa, together with DG Taxud and others, are currently cooperating on various issues related to Maritime reporting documentation, such as the introduction of the electronic customs goods manifest (e-Manifest) into EU Custom's law.

iii. The e-Compliance project is building on the work done in FLAGSHIP by formalising the translation of maritime regulations into rules. In addition, rather than just catering for the needs of a ship's crew, e-Compliance will create and integrate systems for compliance, enforcement and creation of maritime rules

iv. eMar is further developing the Common Reporting Schema (CRS). The former e-Freight project developed the Next Generation Single Window, which is being further developed by eMar. AnNa is facilitating and fostering an effective and sustainable Maritime Single Window development.

v. The Blue Belt pilot project has successfully demonstrated that it is possible to simplify customs formalities for ships trading within the EU, by providing information to customs authorities relating to ship and cargo movements. The idea of a harmonized and electronic manifest (eManifest) has also been generally supported, and is being further developed by the Electronic Customs Group (ECG). All of these aspects are relevant to transport logistics and modal shift as well as shipping.

vi. After developing guidelines for setting up a National Single Window, the Expert Group on Maritime Administrative Simplification and Electronic Information Services has summarised the status of electronic data exchange and single windows development for maritime transport, and has identified some issues for consideration by the newly-established Digital Transport and Logistics Forum, as there are possibilities for cooperation and information exchange across all transport modes. These issues include:-
    - Electronic transport documents
    - Track & trace (supply chain visibility)
    - Logistic information pipelines
    - Data value chain (data liability and quality)
    - Data availability (who can access)
    - Common vocabulary

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Annex 1: State of Play for e-Maritime and e-navigation issues

1. What is e-maritime

e-maritime is not a new term and was initially defined in 2006 by the e-navigation Task Force meeting of the EU MarNIS research project. More recently the European Commission have defined e-maritime in a more general way to cover many aspects of information exchange between many of the stakeholders involved. Replacing paper-based information exchange by electronic communication is part of the European Commission's broader digital agenda, and has the potential of significantly improving maritime transport performance and improving transparency and trust between all parties involved, whilst reducing the administrative burden.[14] It will also make "maritime transport safer, more secure, more environmentally friendly and more competitive by improving knowledge and facilitating business networking".

The Thematic Technology Group 4: e-maritime, decided to define e-maritime in a way that was more focussed to help form a comprehensive overview of all projects and initiatives related to e-maritime. It would also support the definition of the EU's e-maritime Framework, and help ensure that e-maritime research needs and priorities are incorporated in the WATER*BORNE*^{TP} research planning process.

e-maritime is defined as the use of information exchange technologies to establish more efficient, more secure and safer cooperation between ships as well as between a ship and onshore stakeholders, in order to facilitate sustainable maritime transport

e-maritime will increase the competitiveness of maritime transport, improve safety, security, environmental performance and increase the attractiveness of the seafaring profession. e-maritime is implemented through development of information exchange technology as well as through improvements in organisational and legal constraints.

This definition of e-maritime establishes that the "ship" is the principal focus of the interactions between stakeholders, including certain functions that may be performed by organisations onshore, as illustrated in Figure 5. This definition also limits the scope of Task 4.1 to issues that support more efficient cooperation and that improve the information management involving the ship, which is the central part of the maritime transport system. However, as well as information exchanges between ships and the shore parties and the ship, the shore-based organisations will also interact between themselves to support ship operations, and these interactions can also be enhanced by e-maritime.

This definition of e-maritime will also help promote an integrated approach to the development of Information and Communications Systems for maritime transport and ensure their relevance and benefit for all relevant stakeholders and to facilitate their take-up in the marketplace.

[14] Roadmap: Actions for the establishment of EU e-maritime systems and services, DG MOVE

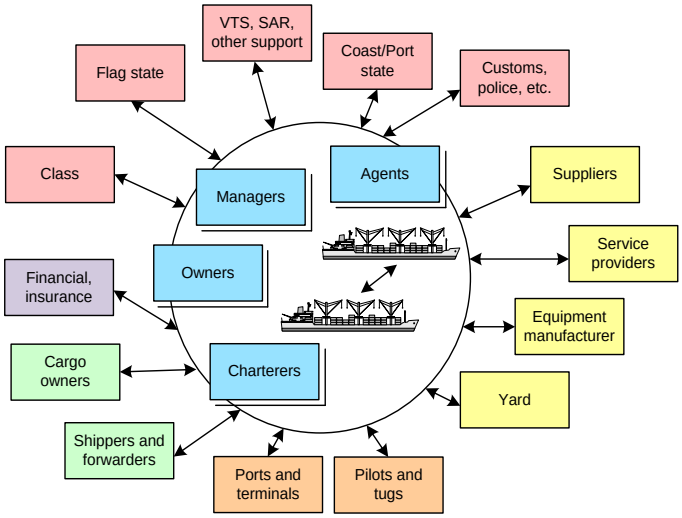

Figure 5: Illustration of some of the European e-maritime stakeholders

e-maritime will have to be integrated with similar frameworks within freight (e-Freight), customs (e-Customs) and will also have to be compatible with the e-navigation framework being developed by IMO. e-navigation can be seen as a sub-set of e-maritime. Where: "e-navigation is the harmonised collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and protection of the marine environment."

2. Historical background

In 2006 the European Commission started considering e-navigation in parallel with IMO, but from the European TEN-T programme[15] (3) point of view and in the context of the priority 21 initiative: *Motorways of the Sea* and its future needs. The MarNIS (Maritime Navigation Information Services) project of FP6 was tasked with producing an appropriate e-navigation perspective. At the MarNIS e-navigation task Force meeting held in 2006, a proposal was made to revise the MSC 81/23/10 concept of e-navigation to embrace the following criteria:

- to minimise navigational errors
- to protect people, the marine environment and resources
- to improve security
- to reduce cost of shipping and coastal states; and
- to deliver benefits for the commercial shipping industry

The last two points above were deemed essential to extend e-navigation into a systems approach that could include non-navigational services such as surveillance, search and rescue and ship performance. The term e-maritime was then introduced for these services and provided a basis for making a clearer distinction between e-navigation and e-maritime.

Although IMO's e-navigation was conceived to improve safety and security of navigation, it can also be interpreted with a broader remit to increase efficiency and performance of ship operation as

[15] European Commission, Tran-European Network: TEN-T Priority axes and projects 2005, Luxembourg: Office for Official Publications of the European Communities.

highlighted under the new objectives needs 7: *Analysis* agreed by NAV 54 in 2008[16]. This remit also includes some services that are the main considerations for ship-owners, port operators, and regulatory authorities, but still limited to ship safety.

NAV 54 agreed that e-navigation systems should support good decision making, improve performance and prevent single person error. To do so, shipboard systems should include analysis functions that support the user in complying with regulations, voyage planning, risk assessment, and avoiding collisions and groundings, including the calculation of Under Keel Clearance (UKC) and air draughts. Shore-based systems should support environmental impact analysis, forward planning of vessel movements, hazard/risk assessment, reporting indicators and incident prevention. Consideration should also be given to the use of analysis for incident response and recovery, risk assessment and response planning, environment protection measures, incident detection and prevention, risk mitigation, preparedness, resource (e.g., asset) management and communication.

In 2009 Pipitsoulis[17] gave a high level definition of e-maritime, namely: Whereas "e-maritime" stands for internet based interactions between all the different stakeholders in the maritime sector, the EU e-maritime initiative includes a set of European capabilities, strategies and policies facilitating the development of "e-maritime" systems and services in support of an efficient and sustainable waterborne transport system fully integrated in the European transport system. Pipitsoulis also indicated that the e-maritime capabilities would encompass legal, organisational and technical frameworks to enable maritime transport operators, shippers/ freight forwarders, and maritime administrations to seamlessly and effortlessly exchange information in order to improve the efficiency and quality of their services.

The European e-maritime initiative is therefore aimed at supporting the development of sustainable maritime transport in Europe through the development of a framework based on the latest information, communication, and surveillance technologies, fully integrated into the overall European transport system. This will enable networking and computer supported co-operation between the principal maritime transport stakeholder's groups.

The scope of the EU's e-maritime initiative is illustrated in Figure 6 and the components for the deployment of EU e-maritime systems, as envisaged by Theologitis in 2009[18], are illustrated in Figure 7.

[16] Sub-Committee on Safety of Navigation 54th Session Agenda Item 25, Report to the Maritime Safety Committee, NAV 54/25, 14 August 2008

[17] Pipitsoulis P, e-maritime: Concept and Objectives, European Commission, DG Energy and Transport, 26 March 2009.

[18] Theologitis D, Deployment of e-maritime systems, DG Energy and Transport; Maritime Security, joint meeting of Short Sea Shipping and Motorways of the Sea Focal Points and Shortsea Promotion Centres, Brussels, 8 July 2009.

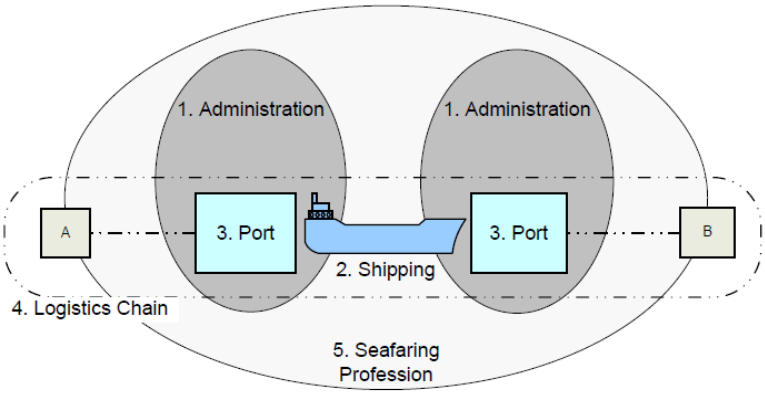

Figure 6: Integrated view of e-maritime domains

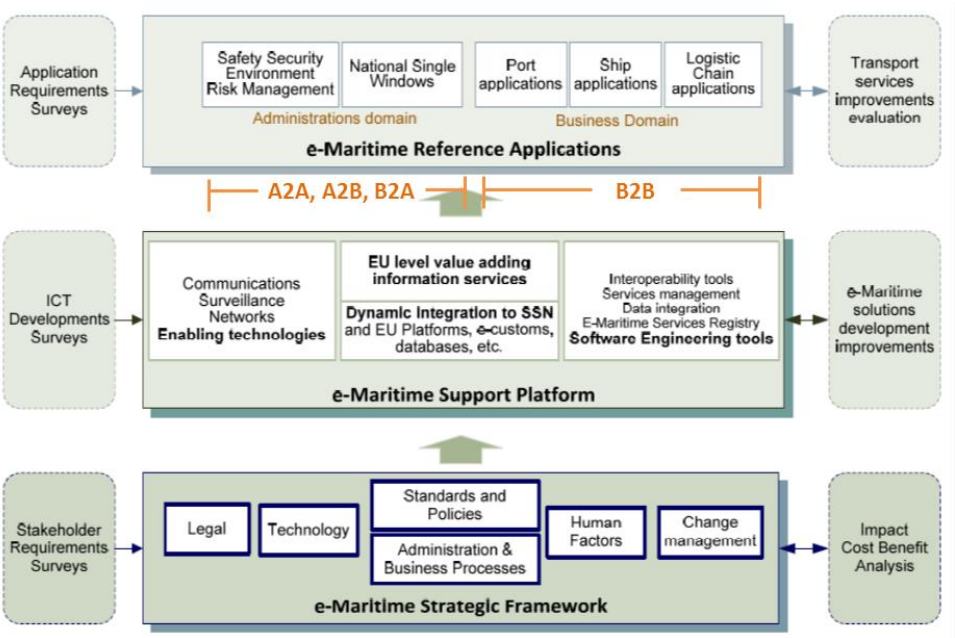

Figure 7: EU e-maritime Components[3]

An overview of e-maritime including the challenges to be addressed was made by Lynch[19] in 2010 and by McLaughlin[20], who also made a state-of-the-art, for the SKEMA project.

Maritime transport is a major economic contributor in the EU as well as a necessary component for the facilitation of international and interregional trade on which the European economy is strongly dependent. The EU Maritime Transport Strategy[21] actively supports the efforts of the European maritime sector in offering quality shipping services which in turn shapes the requirements for upgraded maritime transport information management.

In the short to medium term, the most promising development for maritime transport is e-maritime, which is becoming the focus for the simplification and cohesion of administrative requirements and procedures, with a spill-over into commercial applications.

[19] Lynch G, e-maritime Overview, SKEMA Periodic Study: e-maritime Task 1 Report, 2010.

[20] McLaughlin H, SKEMA e-maritime Periodic Study Summary, 2010.

[21] EU Maritime Transport Strategy 2018, COM(2009) 8; and the establishment of the European Maritime Space without barriers, COM(2009) 11. In addition COM(2005) 589 amending Directive 2002/59/EC establishing a Community vessel traffic monitoring and information system of the 3rd maritime safety package adopted by the European Parliament - 11 March 2009. http://ec.europa.eu/transport/maritime/index_en.htm.

From the perspective of transport chains, e-maritime will provide standardisation, interoperability and security of information exchanges that will set the foundations for cooperative networking strategies in intermodal operations. The implications of this are far-reaching[5]:

1. Efficient functioning of intermodal networks, even for interregional services, without incurring massive IT infrastructural costs;
2. A balanced distribution of risk amongst operating participants;
3. The possibility of inter-network linkages becoming feasible;
4. Increased reliability and security of deliveries with reduced unit costs becoming a reality.

e-maritime has the potential to dramatically change maritime transport and its integration into logistic chains. Those who will take advantage of this opportunity are likely to realise strategic advantages while those that miss out are likely to find themselves lagging behind. Thus, being part of the development of e-maritime is important for the operators in this domain, commercial and public alike.

3. EU e-maritime Initiative Objectives

The implementation of e-maritime should eventually lead to the emergence and consolidation of commercial and public e-services resulting in:

1. Improvements in the European Transport system, resulting in trade facilitation through efficiency gains, greater flexibility and quality maritime transport services;
2. Cost-effective solutions for addressing safety, security and environmental concerns;
3. The long term competitiveness of the European maritime industries.
4. Upgraded maritime transport information management should promote "coherent, transparent, efficient and simplified solutions in support of cooperation, interoperability and consistency between member States, sectors, business and systems involved in the European Transport System"[22].

Therefore what is needed is a strategic European framework to bring together into a coherent whole concepts, processes, standards and technologies that will enable networking and computer supported co-operation between the principal maritime transport stakeholder groups involved in:

1. Improving the safety and security of maritime transport services and assets and environmental protection.
2. Increasing the competitiveness of the EU maritime transport industry and strengthening the EU presence on the international scene.
3. Integrating sustainable waterborne transport services into efficient and secure door-to-door transport services in Europe and beyond.
4. Reinforcing the human factor particularly supporting competence development and welfare for seafarers.

The above represent core objectives of the EU e-maritime initiative[23], seen as a cornerstone for the achievement of the strategic goals of the EU Maritime Transport Strategy 2018.

[22] European Commission (EC) Green Paper "Towards a future Maritime Policy for the Union".
[23] Pipitsoulis C, e-maritime: Concept and Objectives, European Commission, DG Energy and Transport, 26 March 2009.

The ultimate goal for the EU e-maritime initiative is to make maritime transport safer, more secure, more environmentally friendly and more competitive by improving knowledge, facilitating business networking, and dealing with externalities.

The EU e-maritime initiative is aimed at supporting the development of European capabilities, strategies and policies facilitating the adoption of upgraded "e-maritime" solutions in support of an efficient and sustainable waterborne transport system fully integrated in the overall European transport system.

The objective of the European e-maritime initiative is to promote "coherent, transparent, efficient and simplified solutions in support of co-operation, interoperability and consistency between member States, sectors, business and systems involved in the European Transport System". The European Commission has already introduced a number of policy measures and initiatives which facilitate a move towards an e-maritime Policy. Some of these initiatives are concerned with creating an environment which is conducive to e-maritime systems, namely a common approach to policy and decision making and the reduction of barriers for the growth of maritime transport services. Other direct policy is already exploring electronic systems, specifically in establishing a Community vessel traffic monitoring and information system, navigation and vessel tracking, the collection of maritime data, and customs documentation.

The development of e-maritime policy is closely associated with standardisation and the different forms that this may take, often seen as a prerequisite for the development of regional or business policy, and in particular when discussing e-services. However, e-maritime is to a large degree about process improvements and standards alone would not be sufficient to make the necessary changes. Although legislation may help achieve the goals, active user buy-in should be a principal aim.

The EU e-maritime initiative is also closely aligned with the objectives of TEN-T programme aimed at developing an efficient trans-European transport network (TEN-T) to support the re-launched Lisbon strategy for competitiveness and employment in Europe. The TEN-T programme is the main instrument for EU financing of transport infrastructure developments including Motorways of the Sea which invariably rely on advanced ICT integration technologies. A map of the Motorways of the Sea is illustrated in Figure 8. The TEN-T can therefore be seen as an important route to the actual application of e-maritime solutions in the development of the trans-European transport network.

Figure 8: Map of Motorways of the Seas showing the four interconnecting sea States in Europe[9]

5. Progress to date towards realising the benefits of e-maritime

Organisational restructuring across public and business organisations to facilitate rationalisation of processes in the context of e-maritime have been investigated in the MarNIS and SKEMA projects, building on the architectures developed by FREIGHTWISE and MarNIS. The information exchange used for freight transport has been synchronised with outputs from INTEGRITY and Smart-CM, along with other existing initiatives such as AEO and the Green Lane, and the Euridice, EFFORTS and FLAGSHIP projects.

Despite progress over the years from EDIFACT to XML based solutions, including RosettaNet and ebXML (Electronic Business using eXtensible Mark-up Language), there are still considerable problems with both Business-to-Business (B2B) and Business-to-Administrations (B2A) interoperability, limiting the possibilities to interact with other systems.

Standards are the traditional route to interoperability. International standards such as ISO or the equivalent European CEN standards can however take time to be developed. Another important area is communications standards for e-maritime. Satellite communications are as constrained and shaped by policy, regulatory and standards issues as by the technology. A study on e-maritime standardisation requirements and strategies made by Rødseth[24] for the SKEMA project has revealed that 19 standards may be needed, mostly in information management and interfacing between maritime transports stakeholders. The Common Framework having been developed in FREIGHTWISE and currently being extended by a number of FP7 projects creates the basis for interoperability in information exchange and offers the capability of linking freight transport-related EU standardisation efforts to broader international standardisation activities. e-navigation standards will also become available in the future.

[24] Rødseth Ø. J, SKEMA e-maritime standardisation requirements and strategies, 2010.

A crucial issue for e-maritime is improved ship-shore communications for specific applications such as e-navigation, remote condition monitoring, remote damage assessment, remote ship management, crew communications and infotainment, etc. The need for larger frequency bandwidths has been exemplified by INMARSAT. The state of the art within broadband communication in relation to user needs was investigated by the MarNIS project. Ship communications have also been investigated in a number of projects, particularly Flagship and SUPPORT.

6. Progress to date towards the EU's e-maritime initiative

Despite the progress achieved in recent years both in maritime administrative and business information exchange systems there are number of key challenges for the realisation of the objectives set out for the EU e-maritime initiative largely associated with the complexities of the prevailing shipping business and governance environment.

The key challenges for the EU e-maritime initiative are:

1. The maritime transport services sector is heterogeneous and fragmented. Often different stakeholder groups appear to act in isolation from each other according to their own restricted agendas prolonging a culture of intermediaries to carry out tasks which can be easily automated with modern information and communication technologies (ICT).
2. Maritime shipping companies as well as ports have not traditionally invested in information systems primarily because ICT is not viewed as a bottom line item as in other industries such as air transport, road transport, the financial and even the retail sector.
3. The maritime transport sector is heavily regulated with respect to safety, security, environmental protection, competition, customs and labour laws. Complexities arise from the fact that international and national regulations co-exist with inconsistencies and overlapping requirements. The compliance enforcement agencies are also organised in different ways from country to country which hampers efforts to harmonise and simplify applicable laws and regulations and compliance procedures
4. Young people are no longer attracted by a maritime career and Europe is in danger of losing its valuable seafaring skill base. This has implications for both sea and shore based employment. A key issue for recruitment and retention is the lack of continuing professional education and training offered to mariners in a flexible manner at the ship and ashore. The future IMO training requirements now looming large will further impact the time and expense involved with seafarer training. Adapting an e-learning approach to support the professional development of seafarers could provide an effective solution since broadband access is becoming more and more common onboard ship. Other ship-borne applications to improve working and living conditions on board through remote access to shore facilities are also feasible and play an important part in the whole seafarer experience.

7. Outstanding challenges/issues to be addressed

The European Commission's e-maritime conference, held 22-23 November 2012 in Brussels, reviewed the state-of-play for realising e-maritime. The conference highlighted some of the issues and challenges to be addressed in order to achieve this goal, in relation to three of the four areas of the maritime industry noted above.

1. Ship operations

A ship's turnaround time is an important factor for efficient shipping. How could we reduce any unnecessary delays? Are all services available when they are needed or could this be improved? Optimised arrival times – optimised services? Administrative Single Windows are key components for reducing any administrative burden. Which information should be collected and shared? Single Window or Single Windows, are there too many windows? For the submission of information to be easier, is the available technology enough?

2. Port Operations

Space, time and resources need to be used in the best way possible to ensure the efficient and speedy transfer of cargo and passengers through port areas. Port Community Systems (PCS) play an important role in planning, managing and controlling this movement within the port and often beyond. Do all ports offer sufficient PCS services? Is the relevant information available to those who need it and when they need it? Is data confidentiality, both commercial and administrative, ensured? Do we need more standardised processes, information and even technology in order to reduce the development, initial and running costs and to maximise the benefits? ICT Security Challenges in the Maritime Sector: How important are they? What could they be and how could they be addressed?

3. Logistics chain/multimodality

Efficient management of the transport of goods to their final destination require good connections at ports with other modes of transport. How can information flows be adapted to make this connection seamless? How can the data coming from maritime information systems feed into the planning and execution of freight transport along the rest of the supply chain? What are the needs of shippers, of administrations and of logistics service providers in order to achieve efficient multimodal transport? Which kinds of solution or system should be considered and further developed?

4. Regulation and policy organisations related to above

As for the outstanding issues/challenges in the area of regulatory management, these are being addressed by the e-Compliance project, which aims to create a model for managing regulations in digital format and for creating services for different stakeholders (Shipping companies, Ports, Classifications societies) in order to harmonize these regulations and facilitate the cooperation between entities involved. The context for this is the recognition of the importance of the systematic use of ICTs and associated methodological developments in the creation of a barrier-free transport market.

The above issue was noted in the European Commission's Maritime Transport Strategy 2018[25], which set out the main strategic goals for the European maritime transport system up to 2018 and

[25] Strategic goals and recommendations for the EU's maritime transport policy until 2018, COM (2009) 8

identified key areas for action where action by the EU will strengthen the competitiveness of the sector while enhancing its environmental performance. Among these with relevance for e-maritime are the following:-

a. Implement **Simplification measures** to reduce the administrative burden on Masters and senior officers on board ships.
b. **Strengthen EU legislation** regarding port reception facilities and administrative procedures for ship-generated waste
c. **Maritime Surveillance** an integrated EU information management system to enable the identification, monitoring, tracking and reporting of all vessels in European waters. Such system would provide e-services at the different levels of the transport chain, being able to interface with the e-Freight, e-Customs and Intelligent Transport Systems.
d. Establish a true '**European maritime transport space without barriers'**, removing unnecessary administrative barriers, duplicated cross-border controls, and the lack of harmonised documents.
e. **Deployment of 'e-maritime' services** at European and global levels. Such e-services should also encompass public administrations, port communities and shipping companies.
f. Reinforce the **EU strategy for ensuring the full deployment of Motorways of the Sea** projects, further facilitating the start-up of innovative integrated inter-modal transport solutions, simplifying administrative requirements.

8. e-Maritime Strategic Framework (EMSF)

The eMAR project developed an *e-maritime Strategic Framework (EMSF) to* provide a coherent view of the way Maritime Transport could operate at a future date (say 2020), exploiting internet based solutions to support the development of an efficient and sustainable waterborne transport system fully integrated throughout Europe. It also addressed a *pilot implementation of the e-maritime Strategic Framework* interfacing and upgrading existing applications, determining specific policy, standardisation, and future research requirements.

eMAR identified a number of issues for the end-to-end transfer of messages within the supply chain including:-

- Supply chain stakeholders do not have the same level or maturity of ITC infrastructures. It is unlikely that any one method for the transfer of messages will suffice as a practical solution in the near term.
- Some institutions don't have common guidelines for all the employees to enable them to handle changes in their working procedures.
- Human factors can also make some incompatibilities within the system. Very often there needs to be human intervention to gain approval to move through the loading and discharging processes. These steps can be difficult to change / improve.
- There may be additional process steps at individual ports that are non-standard and require consideration.
- Other problems in message exchange:
    - Some documents contain duplicated records/data

- Different authorities may have to be provided with the duplicates of the same documents
- Delays in the processing of electronic information can have a direct effect on delays in cargo handling

The domain model for *EMSF,* including reference process models used to derive standard messages for seamless information flow between maritime stakeholders is illustrated in Figure 9 and the e-maritime Strategic Framework version 1 is illustrated in Figure 10.

Figure 9: Domain model for the *e-maritime Strategic Framework (EMSF)*

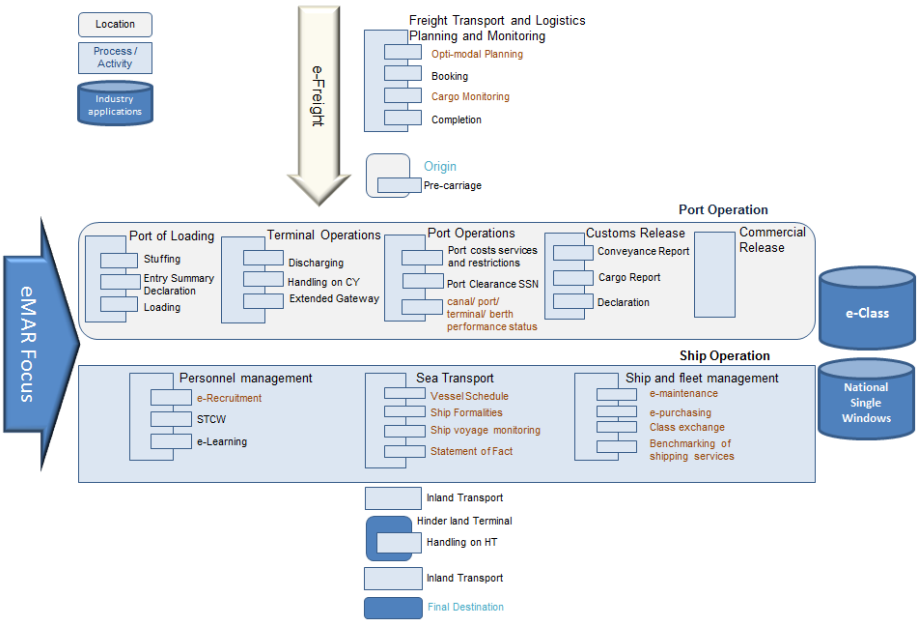

Figure 10: The e-maritime Strategic Framework (EMSF); December 2013

eMAR examined issues arising from interfacing e-maritime with SafeSeaNet (SSN) and related developments. SafeSeaNet is a European network encompassing all the EU Member States as well as Iceland and Norway acting as the European Platform for Maritime Data Exchange between maritime Administrations. Its role is to ensure the implementation of Community legislation. It is composed of a network of national SSN systems in Member States and a SSN central system acting as a nodal point. SafeSeaNet improves the exchange through better standardisation and efficient implementation of EU maritime safety legislation.

In the present release of the Interface and Functionalities Control Document which has been developed for SafeSeaNet, the functionalities are split into two distinct sections:

- Mandatory system functionalities.
- Additional system functionalities.

The mandatory SSN system functionalities are the sending, receipt, storage, retrieval and exchange of information by electronic means required by the SSN legal framework. SSN currently supports the exchange of the following information:

1. **Port call information:** Pre-arrival information sent to ports 24 hours in advance and information on ship arrivals and departures (as per Article 4 of Directive 2002/59/EC as amended and Articles 9 and 24 of Directive 2009/16/EC). In addition, 72 hours pre-arrival information if no other national arrangement is in place.
2. **Hazmat information:** Information on the carriage of dangerous and marine polluting goods (as per Articles 4, 13 and 14 of Directive 2002/59/EC as amended).
3. **Incident information:** Information on accidents and incidents which have occurred at sea (as per Articles 16, 17 and 25 of Directive 2002/59/EC as amended) and information on ships which have not delivered their ship-generated waste and cargo residues (as per Articles 11.2.d and 12.3 of Directive 2000/59/EC).
4. **Position information:** AIS, MRS and LRIT[26] information (as per Articles 5, 6.b, 9 and 23 of Directive 2002/59/EC as amended).

In 2012 the SSN group decided to improve the current data exchange framework of incident reports exchange by including a new data exchange mechanism enabling the "pushing" of incident information provided to central SSN system to MS. The new mechanism is documented in the XML Reference guide v2.07 and could be implemented by MS on voluntary basis from the last quarter of 2013 onwards.

9. Further objectives and outcomes

Despite progress towards the objectives/desirable, more needs to be done to achieve the stated outcomes of improved competitiveness, reduced administrative burden and improved safety for the European maritime transport industry.

Some of the necessary actions were outlined by Violeta Bulc EU Commissioner for Transport, in a speech on 4 March 2015 at the European Shipping Week Conference in Brussels. The Commissioner foresaw a wave of innovation for transport, involving digital solutions, alternative fuels, shared mobility etc., with the potential to bring huge opportunities and benefits, and stressed that shipping must remain at the forefront of innovation to stay competitive.

[26] The currently available version of the SSN enables "flag" state users to visualise in the system's graphical user interface the, so-called, "mandatory" LRIT reports that are provided by ships four times per day every 6 hours. The full distribution of LRIT data to MSs through SSN is under development and shall be implemented in future releases of the system.

With this in mind, she affirmed that an important objective of her term would be to integrate shipping better into the overall transport system. More efficient ports and their connection to the hinterland are needed for that, as well as administrative simplification and digital logistic services.

To improve the competitive environment for shipping, she will push hard for simplified reporting formalities and interoperable IT solutions, and also wants to advance on the Blue Belt through the e-Manifest and complete by 2020 an EU maritime transport space without barriers.

Digital solutions play a key role for simplifying procedures. The Union Maritime Information and Exchange System, hosted by the European Maritime Safety Agency, is seen as an excellent basis and, with a small investment here, some giant steps forward could be taken. However, Member States, were also urged to play their part, including implementing their national single windows by June this year.

The Commissioner stated that the digitalisation of maritime transport and of transport and mobility in general would be one of the priorities of her term. It is a key to better integrate maritime transport into the logistic chain. As a first step, a Forum on Digital Mobility and Logistics has been established and will soon start its work.

As an example of how some of these KPIs might be measured in practice, INTTRA, the world's largest multi-carrier network for the ocean shipping industry, has conducted various studies that show (for example) how standardisation and better data quality improve planning efficiencies and increase productivity.

10. Continuing administrative burdens

Despite the initiatives noted above, many of the problems identified earlier persist. A study[27] by the Danish Maritime Authority, supported by InterManager, the international trade association for ship and crew managers, has reported that seafarers feel they spend too much time on tasks they consider to be an administrative burden. These burdens stem from what the seafarers consider to be unnecessary repetition of tasks and demands for too much paperwork and documentation. The study also concludes that there is a "significant potential to relocate time to more fruitful tasks" to increase efficiency and quality.

The survey concentrated on seven main areas: preparation of and participation in Port State Control, Flag State Control or class inspections; vetting inspections; handling of International Vessel and Port Facility Security requirements (including paperwork and mandatory deck watch duties); planning and executing exercises and drills; using and maintaining internal management systems (QSM, ISM etc.); completion of journals (garbage, oil, deviation etc.); and the completion of port and pre-arrival documents (such as crew and passenger lists, vessel stores, port calls, health declarations etc.).

11. SafeSeaNet SSN

Following the accident of the ERIKA off the French coast in 1999, the European Union adopted several legal instruments for improving the prevention of accidents at sea and combating marine

[27] Survey on administrative burdens among international seafarers: Final Report. Danish Maritime Authority, July 2013.

pollution. Directive 2009/17/EC of the European Parliament and Council of 23/4/2009 (amending the Directive 2002/59/EC of 27 June 2002) aims at establishing in the Community, a vessel traffic monitoring and information system "with a view to enhancing the safety and efficiency of maritime traffic, improving the response of authorities to incidents, accidents or potentially dangerous situations at sea, including search and rescue operations and contributing to a better prevention and detection of pollution by ships". Member States and the European Commission shall co-operate in development of a computerised data exchange system and its necessary infrastructure.

To achieve these objectives, in 2001 the European Commission launched development of a European network - the so-called SafeSeaNet. The main objective of SafeSeaNet is to provide a European Platform for Maritime Data Exchange between maritime administrations of the Member States, by:

- Setting-up a telematics network between all the maritime EU Member States for their co-operation in preventing maritime pollution and accidents at sea.
- Creating this network taking into account new technologies such as XML and the Internet/TESTA network, making it flexible to cope with future technological developments.

Implementation of Directives 2009/17/EC and 2002/59/EC, as well as other provisions from different instruments of European legislation (like the recently approved 2009/16/EC directive on Port State Control), requires the collection and distribution of various kinds of data. These concern vessel traffic monitoring, dangerous cargo details, vessels' pre-arrival/ arrival and departure notifications, information related to incidents etc. SafeSeaNet improves the exchange through better standardisation and efficient implementation of EU maritime safety legislation.

The EU Systems currently interfaced to SafeSeaNet is illustrated in Figure 11, are based on internet technologies (such as XML) and involves a number of entities at national and regional local level: National Competent Authority (NCA), Local Competent Authority (LCA), and Coastal Station,

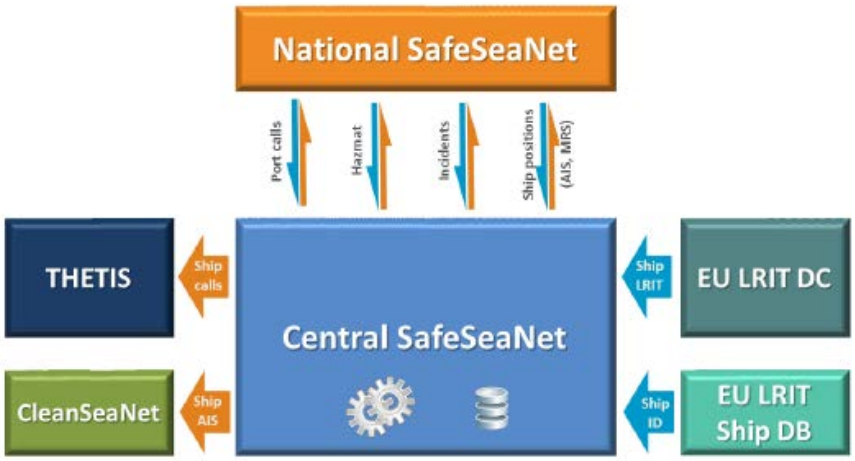

Figure 11: EU Systems currently interfaced to SafeSeaNet (Source: SSN IFCD)

12. Single Window Concept

The Single Window (SW) Concept is the main requirement for the implementation of the European Commission Directive 2010/65/EU. It aims to meet the generic goals of simplification and

harmonisation of the administrative procedures applied to maritime transport by making the electronic transmission of information standard and by rationalising reporting formalities.

According to the "Single Window and data flow definition" document agreed at the 6th eMS Group Meeting, (Expert group on Maritime administrative simplification and electronic information services), "the SW consists of the user web interface and interfaces requirements, harmonised on the EU level in regard to a common set of services and specific layout, semantics, for submitting the information". In addition, "the business activity flows used by the Shipping industry for submitting notifications, updating data in the notifications and receiving feedback by the Authorities concerned via the National Single Windows (NSWs) should be harmonised at EU level."

By the definition in Article 2(a) of Directive 2010/65/EU, "reporting formalities" are the information required by three different categories:

a) Reporting formalities resulting from the legal acts of the Union;

b) FAL forms and formalities resulting from international agreements (such as International Maritime Organization - IMO or International Health Regulation - IHR); and

c) Any relevant national legislation.

Each Member State hosts its implementation of the NSW. The NSW collects the reporting formalities information received from the data providers. Each relevant authority receives from the NSW the information it requires. Relevant parts of the information are made available to other Member States via SafeSeaNet (SSN), which involves the central and national SSN systems. Other EU systems should interact with the NSW. Direct links between NSW should also be established.

The system context for the Reporting Formalities Directive is shown in Figure 12 below.

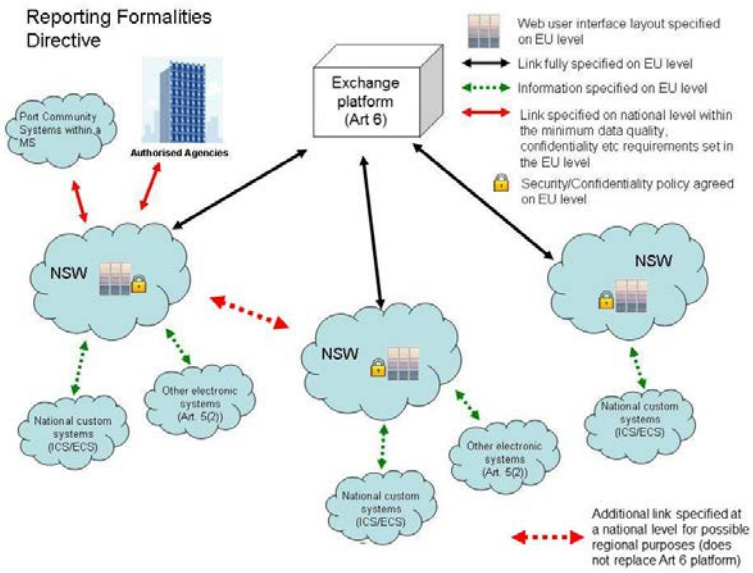

Figure 12: Illustration of the Reporting Formalities Directive system

National Single Windows are seen as the way to ensure that operators have a single point of contact for all reporting requirements both relating to vehicle movements and cargo and that information is transmitted automatically to various national authorities, SSN, e-Customs, etc.

The concept of NSW is closely linked to Single Transport Document (also known as the Common Reporting Schema (CRS)), which is to provide unified content for all reporting requirements, potentially including the e-Manifest, and will resolve related legal issues regarding liability and customs procedures. Action towards establishing NSWs and a Single Transport Document are called for both by the EU Freight Logistic Action Plan and the European maritime transport space without barriers short term actions including:

- 'simplification of customs formalities for vessels only sailing between EU ports' and 'clarification of the use of IMO/FAL harmonised forms.
- measures for "National Single Windows" building on Decision No 70/2008/CE introducing a single window for goods-related formalities ensuring that all information necessary for port authorities is lodged once whereby information will be exchanged between vessels and authorities in an electronic format as far as possible.

It is recognised that the eventual solution in this area will emerge through the evolution of different national approaches, SSN and e-Customs developments, possibly influenced by research project outputs. A number of European projects have worked on the Single Window concept for the maritime transport sector, including: **eMAR, Anna** and **e-Compliance**.

EMSA was delegated to implement action 3.1 regarding the "Evolution of the SafeSeaNet" under the Integrated Maritime Policy (IMP) work programme (C(2012) 1447 final). One of the objectives on this action is to evaluate and demonstrate how SafeSeaNet could support the Member States obligation to set up at national level a single window for reporting and exchanging formalities in accordance with Directive 2010/65/EU. This was done through a demonstration project: the National Single Window Prototype.

The general NSW configuration in the National Single Window Guidelines[28] is shown in Figure 13. This figure illustrates the information flows which take place within the NSW, covering:
a) Submission of information by the shipping industry (e.g. ship master, operator or agent) and the receipt of decisions from authorities;
b) Distribution of the received information to the authorities and the submission of their; decisions to the shipping industry; and

c) Exchange of relevant information between Member States via the SafeSeaNet system.

[28] National Single Window Guidelines, DG MOVE, 17 April 2015.

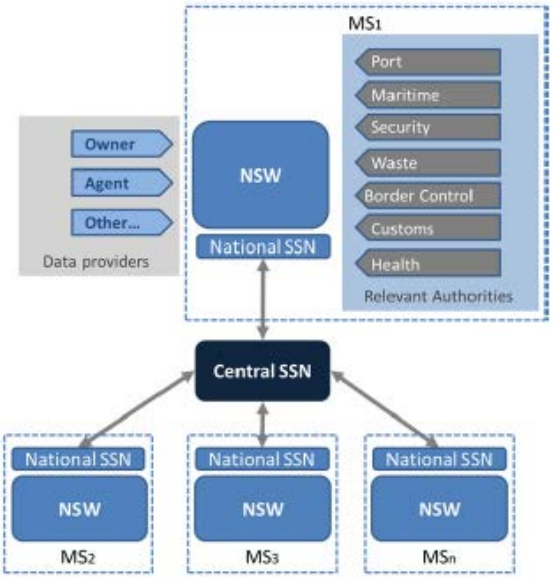

Figure 13: Illustration of information flows, which take place within the NSW[14]

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

- Whether the NSW has to be linked to other authorities systems or authorities will only access information through a NSW user interface;
- 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;
- Which legacy systems will be included within the NSW environment?

13. Port Community Systems (PCS)

A Port Community System (PCS) is an electronic platform which connects the multiple organisations that make up a seaport, airport or inland port community by integrating existing systems and providing services based on the information collected[29], as illustrated in Figure 14. It is shared in the sense that it is set up, organised and used by firms in the same sector – in this case, a port community. This neutral and open electronic platform enables intelligent and secure exchange of information between public and private stakeholders in order to improve the efficiency and competitive position of the ports and maritime transport. It also optimises, manages and automates smooth port and logistics processes through a single submission of data and by connecting transport and logistics chains.

A Port Community System provides for the electronic exchange of information between all port and logistics sectors and is acknowledged as the most advanced method for the exchange of information within a single or national port community infrastructure. Port Community Systems provide at least EDI message interchange and interconnection with National Single Windows. The system has the ability to act as a National Single Window or to integrate into a National Single Window. A Port Community System is therefore pivotal in the Single Window concept and will reduce duplication of data input through efficient electronic exchange of information.

[29] How to develop a Port Community System, IPCSA www.ipcsa.international

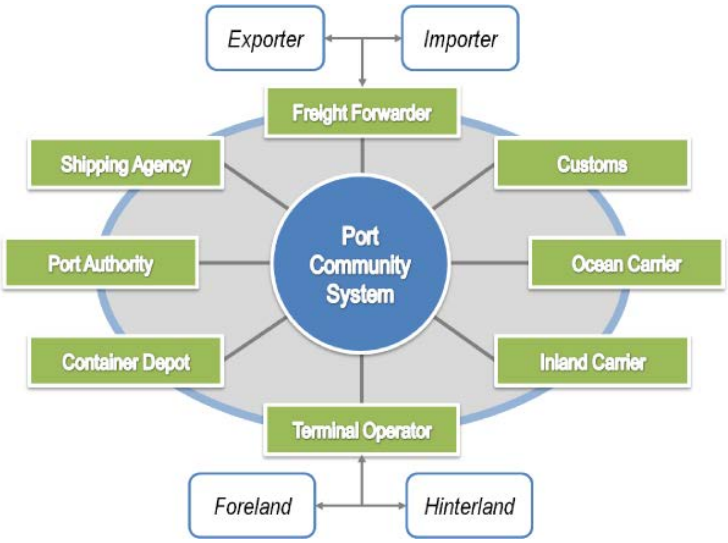

Figure 14: Illustration of a Port Community System (PCS)

Port Community Systems provide an extensive range of services and key features which can be summarised as follows:

- Easy, fast and efficient EDI information exchange, re-use and centralisation
- Customs declarations
- Electronic handling of all information regarding import and export of containerised, general and bulk cargo
- Status information and control, tracking and tracing through the whole logistics chain
- Processing of dangerous goods
- Processing of maritime and other statistics

The core benefits for all parties involved are higher efficiency and speed regarding port processes, particularly through automation and the reduction of paperwork. In this way, PCSs contribute to sustainable transport logistics and support the ambitions to meet global carbon reduction requirements.

14. e-navigation

e-navigation is an International Maritime Organisation (IMO) led concept based on the harmonisation of marine navigation systems and supporting shore services driven by user needs. e-navigation encompasses human factors, standards, and procedures etc. and is more than a system composed of integrated subsystems and equipment.

In 2006 at the NAV 52 Conference, The IMO included e-navigation in the work programme, held initial discussions and established a Correspondence Group (CG) to consider the development of an e-navigation strategy. The CG was given terms of reference and instructed to report back at the NAV 53 Conference in 2007. NAV 53 considered the report of the CG together with other input papers and concluded in accordance with COMSAR 11 that e-navigation must be user driven rather than technology driven; the CG continues to work on the development of e-navigation and strategy and works with other IMO committees such as the NAV subcommittee and COMSAR. The IMO also invited the involvement of other maritime organisations such as IALA, IHO, the Nautical Institute

and other international organisations in the development of an e-navigation strategy and provide their contributions to the CG within its terms of reference.

The Group decided to treat e-navigation not as the physical installations, nor as the service provided, but as a strategic framework for developing existing and future technological infrastructure onboard and ashore. As such the term e-navigation currently incorporates systems and services, but as an e-navigation user requirement is developed, it is envisaged that the term will also include an increased focus on more tangible elements. It should be noted that without e-navigation the multiplicity of systems and equipment will continue to evolve at varying degrees of effectiveness. The development of e-navigation is an opportunity to optimise these developments, and ensure the focus of future developments is on a holistic approach to safe navigation from berth to berth.

The group also adopted the initial definition of e-navigation from IALA as follows:

'e-navigation is the harmonised collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and to protect the marine environment.'

The core objectives of an integrated e-navigation have been identified as "Using electronic data capture, communication, processing and presentation, to:

1. facilitate safe and secure navigation of vessels having regard to hydrographic and navigational information and risks (e.g. coastline, seabed topography, fixed and floating structures, meteorological conditions and vessel movements)
2. facilitate vessel traffic observation and management from shore/coastal facilities where appropriate, for example in harbours and approaches
3. facilitate ship-to-ship, ship-to-shore, shore-to-ship and shore-to-shore communications, including data exchange, as needed, to achieve the above points
4. provide opportunities for improving the efficiency of transport and logistics
5. facilitate the effective operation of distress assistance, search and rescue services and the storage and later use of data for the purposes of traffic and risk analysis and accident investigation
6. integrate and present information onboard and ashore in a format, which, when supported by appropriate training for users, maximizes navigational safety benefits and minimizes risks of confusion or misinterpretation; and
7. facilitate global coverage, consistent standards and mutual compatibility and interoperability of equipment, fitment, systems, operational procedures and symbology, so as to avoid potential conflicts between vessels or between vessels and navigation/traffic management agencies
8. facilitate (subject to a local risk assessment) a phased migration to e-navigation while maintaining physical aids to navigation and systems where required to ensure continued navigational safety, and having regard to legacy systems, the varying state of development of aids to navigation and systems in different parts of the world and the likely timescales for adoption;

9. demonstrate levels of accuracy, integrity and continuity appropriate to a safety-critical system (under all operating conditions and having regard to risks of malicious or inadvertent interference);
10. be viable as a safety-critical system on a stand-alone basis having regard to both the onboard and ashore applications of e-navigation;
11. integrate data and communications systems mandated for other purposes (e.g., security), as far as practicable, so as to minimize the number of 'stand-alone' systems on board and ashore;
12. be scalable, to facilitate fitment and use, by smaller vessels (e.g. fishing, leisure vessels);
13. be capable of development/adaptation to integrate other, value-added functionality, while avoiding any interference with or degradation of core safety-related functions;
14. be capable of development/adaptation to facilitate low cost generational change as new capabilities and functionality are developed;
15. facilitate effective waterway use for different classes of vessels.

The Correspondence Group endorsed three key outcomes, put forward by IALA, focusing in turn on the onboard, shore and communications elements of e-navigation:

On board

Navigation systems that benefit from the integration of own ship sensors, supporting information, a standard user interface, and a comprehensive system for managing guard zones and alerts. Core elements of such a system will include high integrity electronic positioning, electronic navigational charts (ENCs) and system functionality with analysis reducing human error, actively engaging the mariner in the process of navigation while preventing distraction and overburdening.

Ashore

The management of vessel traffic and related services from ashore enhanced through better provision, coordination, and exchange of comprehensive data in formats that will be more easily understood and utilised by shore-based operators in support of vessel safety and efficiency.

Communications

An infrastructure providing authorised seamless information transfer onboard ship, between ships, between ship and shore and between shore authorities and other parties with many related benefits, including a reduction of single person error.

Many of the electronic building blocks of navigational technologies are already available, are being developed, or are capable of development, which can be integrated to provide an accurate, secure and highly cost-effective e-navigation system, with potentially global coverage. The same technologies should be scalable for use by larger and smaller vessels. In addition to reducing navigational errors, these technologies can deliver benefits in areas such as search and rescue, pollution incident response, national and international security and the protection of critical marine resources such as fishing grounds.

The future of e-navigation will rely heavily on the integration of latest state-of-the-art navigation systems and the incorporation of global navigational satellite systems for communication, positioning information and surveillance – specifically, GALILEO. However, the introduction of new technologies and associated operational procedures will result in the need for adequate training; this will be an important aspect in developing the e-navigation concept illustrated in Figure 15.

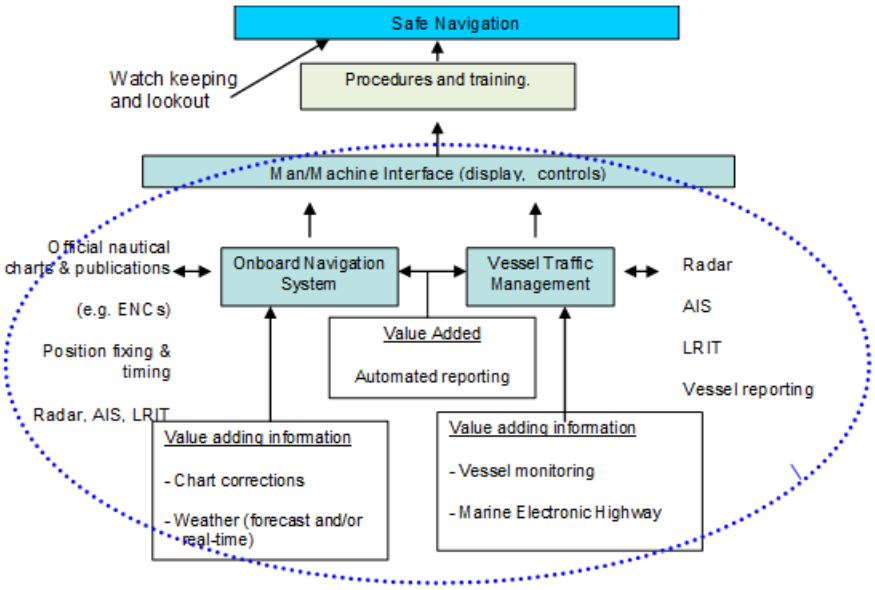

Figure 15: The e-navigation concept - Source: IALA Vision of e-navigation, 2007

e-navigation development and strategy since NAV 53

In 2007 NAV 53 re-established the Correspondence Group with new terms of reference to report back to NAV 54 in 2008. NAV 54 presented results from a questionnaire survey based on a "user needs methodology template" designed by IALA to capture on information on e-navigation user needs used to summarise the feedback. The user survey findings are summarised under the following headings:

1. Common marine information/data structure
2. Automated and standardised reporting functions
3. Effective and robust communications Hunan Machine interface
4. Human centred presentation needs
5. Human Machine interface
6. Data and system integrity
7. Analysis

The above points introduce a significantly broader perspective to e-navigation that originally presented in MSC 81/23/10, in particular the introduction to point 7 "Analysis", which states:

> *e-navigation systems should support good decision making, improve performance and prevent single person error. To do so, Shipboard systems should include analysis functions that support the user in complying with regulations, identifying risks, and avoiding collisions and groundings including the calculation of Under Keel Clearance (UKC) and air draughts. Shore based systems should support environmental impact analysis, forward planning of vessel movements, hazard/risk assessment, reporting indicators and incident prevention. Consideration should also be given to the use of analysis for incident reporting and recovery, risk assessment and response planning, incident detection and prevention, risk mitigation, preparedness, resources (e.g. asset) management and communication.*

The above *user needs* focus was accepted by NAV 54 to provide a baseline for a new draft strategy for the development and implementation of e-navigation and the importance of the *implementation process* is now separately recognised and highlighted. This IMO vision illustrated in

Figure 16 is very different to the earlier prescriptive vision. The increasingly diverse scope of marine information services and actions that appear to be arising out of the *user needs approach* has broaden the scope of e-navigation.

Figure 16: Potential components of an e-navigation implementation process (NAV 54)

In December 2008 the IMO Maritime Safety Committee adopted an e-navigation Strategy and drew up an Implementation Plan covering the main aspects of user needs, architecture including the use of Gap, Cost-Benefit and Risk Analysis, to be developed by 2012. The strategy includes the continuous assessment of how best to meet user needs with evolving technology and the use of cost benefit analysis.

The concept of e-maritime was introduced at NAV 55 in 2009 as a possible integrating framework for the many different maritime sector services of which e-navigation is one. This would enable a more detailed specification of e-navigation and would facilitate interaction and integration with other parallel marine information services that will emerge under the European Commission's e-maritime initiative.

Further significant progress on IMO's e-navigation strategy implementation plan was made at NAV 56. The user needs identified included shipboard user needs and priorities; shore-based user needs; search and rescue authority user needs; and a list of existing systems and new communication technologies supporting user needs.

The vision behind the e-navigation strategy is to integrate existing and new navigational tools, in particular electronic tools, in an all-embracing transparent, user-friendly, cost-effective and compatible system that will contribute to enhanced navigational safety (with all the positive repercussions this will have on maritime safety overall and environmental protection) while

simultaneously reducing the burden on the navigator. NAV 56 also endorsed a functional architecture concept, which was developed to provide a framework for on-going work on e-navigation, on the basis that it will be continually updated.

The development of the e-navigation strategy implementation plan presented at NAV 56 was progressed at NAV 57. The development of the current overarching e-navigation architecture illustrated in Figure 17 enables the shipboard and the shore-based parts to be connected through different links. It also identifies the concept of Maritime Service Portfolio (MSP) which defines and describes the set of operational and technical services and their level of service provided by a stakeholder in a given sea area, waterway, or port, as appropriate.

The architecture also includes the Common Maritime Data Structure (CMDS) that spans the whole of the horizontal axis (indicated by the shaded oval in the background), which serves an important function as it is a key to harmonization between the technical systems of stakeholders both shipboard and shore-based.

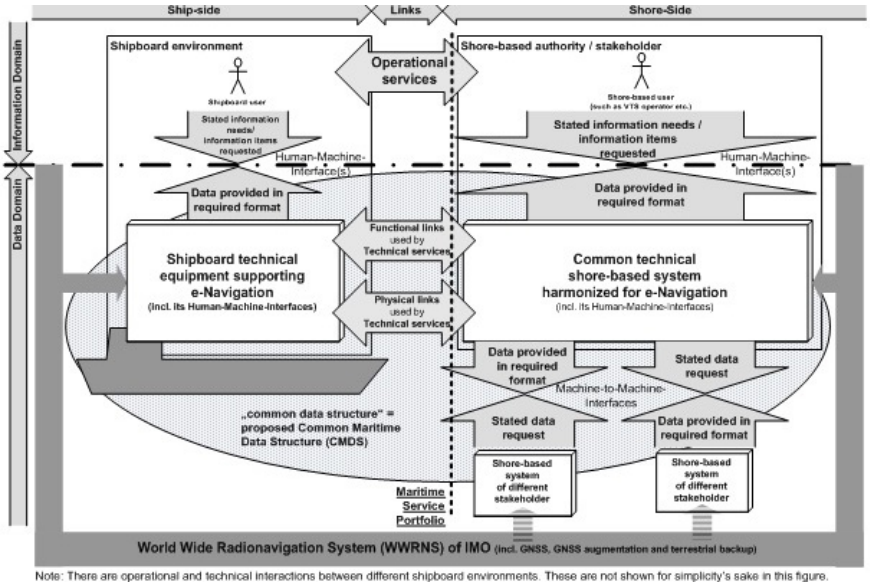

Figure 17: Current overarching e-navigation architecture (NAV 57)

NAV 58 noted the progress on the development of the detailed onboard e-navigation architecture, the approval of the gaps on e-navigation for shipboard users and shore-based users, the preliminary list of potential e-navigation solutions, the methodology of the Human Element Analysing Process, the procedure for the Formal Safety Assessment methodology and the further development of Maritime Service Portfolios (which define and describe the set of operational and technical services and their level of service provided by a stakeholder in a given sea area, waterway, or port, as appropriate).

The potential solutions to address the identified gaps include the following:

a. improved, harmonized and user-friendly bridge design;
b. means for standardized and automated reporting;
c. improved reliability, resilience and integrity of bridge equipment and navigation information; integration and presentation of available information in graphical displays received via communication equipment;
d. information management improved access to relevant information for search and rescue;

e. improved reliability, resilience and integrity of bridge equipment and navigation information for shore-based users;
f. improved and harmonized shore-based systems and services;
g. improved communication of vessel traffic services (VTS) service portfolio.

NAV 59 endorsed the preliminary draft of the Strategy Implementation Plan for e-navigation. The e-navigation strategy implementation plan aims to integrate existing and new navigational tools, in particular electronic tools, in an all-embracing transparent, user-friendly, cost-effective and compatible system that will contribute to enhanced navigational safety while simultaneously reducing the burden on the navigator.

The e-navigation Strategy Implementation Plan (SIP), was approved by MSC 94 in November 2014, contains a list of tasks required to be conducted in order to address 5 prioritised e-navigation solutions endorsed by NAV 59, namely:

1. improved, harmonized and user-friendly bridge design;
2. means for standardized and automated reporting;
3. improved reliability, resilience and integrity of bridge equipment and navigation information;
4. integration and presentation of available information in graphical displays received via communication equipment; and
5. improved Communication of VTS Service Portfolio (not limited to VTS stations).

At MSC 95 in June 2015 six outputs were identified and prioritised for the five agreed e-navigation solutions. The outputs proposed were:

1. *guidelines on Standardized modes of operation (S-mode);*
2. an update, by adding new modules, to the *revised performance standards for Integrated Navigation Systems (INS)* (resolution MSC.252(83)) relating to the harmonization of bridge design and display of information;
3. a revision of the *Guidelines and criteria for ship reporting systems* (resolution MSC.43(64), as amended) relating to standardized and harmonized electronic ship reporting and automated collection of onboard data for reporting;
4. amendments to the *General requirements for shipborne radio equipment forming part of the global maritime distress and safety system (GMDSS) and for electronic navigational aids* (resolution A.694(17)) relating to *Built In Integrity Testing* (BIIT) for navigation equipment;
5. guidelines on Harmonized display of navigation information received via communications equipment; and
6. consideration of reports on development and implementation of Maritime Service Portfolios (MSPs) (and other e-navigation reports) by Member States and other international organizations

Annex 2: Comprehensive list of EU and National Research Projects

e-maritime related research projects (April 2014)

Project Acronym	Project Title	Project Funding	Start date	End date	website
EU Framework Projects					
3SNET	Short sea shipping network	FP4	01/1998	09/1999	http://www.transport-research.info/web/projects/project_details.cfm?ID=107
ADOPT	Advanced decision support system for ship design, operation and training	FP6	04/2005	09/2008	http://adopt.rtdproject.net
ARIADNA	Maritime assisted volumetric navigation system	FP7	11/2009	10/2012	http://www.transport-research.info/web/projects/project_details.cfm?ID=38151 http://www.ariadna-fp7.eu/
CASCADe	Model-based Cooperative and Adaptive Ship-based Context Aware Design	FP7	01/2013	12/2015	http://cordis.europa.eu/projects/index.cfm?fuseaction=app.details&REF=106310
CONTAIN	Container Security Advanced Information Networking	FP7	10/2011	03/2015	http://containproject.com/ http://cordis.europa.eu/projects/index.cfm?fuseaction=app.details&TXT=contain&FRM=1&STP=10&SIC=&PGA=&CCY=&PCY=&SRC=&LNG=en&REF=100574
DSS-DC	Decision support systems for ships in degraded condition	FP5	01/2004	12/2007	http://cordis.europa.eu/projects/index.cfm?fuseaction=app.details&REF=74292
EcoHubs	**E**nvironmentally **co**herent measures and interventions to debottleneck **HUBS** of the multimodal network favoured by seamless flow of goods	FP7	11/2012	04/2015	http://www.hubways.eu http://www.transport-research.info/web/projects/project_details.cfm?ID=45365
e-Compliant	Integration and co-operation of	FP7	06/2013	05/2016	http://www.e-compliance-project.eu

	regulatory compliance in the maritime domain				
EfficientSea 2	Efficient, Safe and Sustainable Traffic at Sea	H2020	01/2015	01/2018	http://efficiensea2.org/#/
e-Freight	European e-Freight Capabilities for Co-modal Transport	FP7	01/2010	12/2013	http://www.efreightproject.eu/ http://www.transport-research.info/web/projects/project_details.cfm?ID=41599
EFFORTS	Effective Operations in Ports	FP6	05/2006	10/2009	http://www.efforts-project.org/ http://www.transport-research.info/web/projects/project_details.cfm?ID=28076 http://cordis.europa.eu/projects/index.cfm?fuseaction=app.details&REF=81520
eMAR	e-maritime Strategic Framework and Simulation based Validation	FP7	01/2012	12/2014	http://www.emarproject.eu/ http://www.transport-research.info/web/projects/project_details.cfm?id=44613
EMDM	European maritime data management	FP6	03/2007	02/2009	http://www.euroqualityfiles.net/emdm/index.php
EU CISE 2020	EUropean test bed for the maritime Common Information Sharing Environment in the 2020 perspective	FP7	12/2014	06/2017	http://cordis.europa.eu/project/rcn/192603_en.html
EURIDICE	**EUR**opean **I**nter-**Di**sciplinary research on **I**ntelligent **C**argo for **E**fficient, safe and environment-friendly logistics	FP7	02/2008	10/2011	http://www.euridice-project.eu/ http://www.transport-research.info/web/projects/project_details.cfm?ID=44425
FAROS	Human Factors in Risk-Based Design Methodology	FP7	10/2012	09/2015	http://www.faros-project.eu
FLAGSHIP	European Framework for Safe, Efficient and Environmentally-friendly Ship Operations	FP6	06/2007	04/2010	http://flagship.be/ http://www.transport-research.info/web/projects/project_details.c

					fm?ID=36155
FREIGHTWISE	Management Framework for Intelligent Intermodal Transport	FP6	06/2007	04/2010	http://freightwise.tec-hh.net http://www.transport-research.info/web/projects/project_details.cfm?ID=11016
Handling Waves	Decision Support System for ship operation in rough weather	FP6	01/2007	07/2010	http://www.transport-research.info/web/projects/project_details.cfm?id=36157 http://www.mar.ist.utl.pt/handlingwaves/members.aspx?id=3
HORIZON	Research into effects on cognitive performance of maritime watch-keepers under different watch patterns, workloads & conditions, with reality usage of ships bridge, engine & cargo control simulators	FP7	06/2009	11/2011	www.project-horizon.eu
i-Cargo	Intelligent Cargo in Efficient and Sustainable Global Logistics Operations	FP7	11/2011	04/2015	http://i-cargo.eu http://www.transport-research.info/web/projects/project_details.cfm?ID=44463
INCASS	Inspection Capabilities for Enhanced Ship Safety	FP7	11/2013	10/2016	http://www.incass.eu
INTEGRITY	Intermodal Global Door-to-door Container Supply Chain Visibility	FP7	06/2008	10/2011	http://www.integrity-supplychain.eu/ http://www.transport-research.info/web/projects/project_details.cfm?ID=37462
ITEA-DS	Intelligent tools for emergency applications & decision support	FP5	11/2000	10/2002	http://cordis.europa.eu/projects/rcn/56860_en.html
Logistics for Life	Logistics Industry coalition of Long-term ICT based Freight Transport Efficiency	FP 7 (CA)	01/2010	06/2012	http://www.logistics4life.eu/ http://www.transport-research.info/web/projects/project_details.cfm?ID=44500
MarNIS	Maritime Navigation and	FP 6	11/2004	11/2008	http://www.transport-

	Information Services				research.info/web/projects/project_details.cfm?id=11127
MUNIN	Maritime Unmanned Navigation Through Intelligence in Networks	FP7	09/2012	08/2015	http://www.unmanned-ship.org/munin/
NAVTRONIC	Navigational System for Efficient Transport System	FP7	10/209	09/2012	http://www.navtronic-project.eu/ http://www.transport-research.info/web/projects/project_details.cfm?ID=39065
SEABILLA	Sea Border Surveillance	FP7	06/2010	02/2014	http://www.seabilla.eu http://cordis.europa.eu/projects/rcn/94732_en.html
SEAHORSE	Safety Enhancements in transport by Achieving Human Orientated Resilient Shipping Environment	FP7	11/2013	10/2016	http://www.seahorseproject.eu
SAFETOW	Strategic Aid for Escort Tugs at Work	FP6	04/2004	09/2007	http://safetow.bmtproject.net/ http://www.transport-research.info/web/projects/project_details.cfm?ID=35409
SAFEWIN	Safety of winter navigation in dynamic ice	FP6	09/2009	08/2013	http://www.safewin.org
SAFEICE	Increasing the safety of icebound shipping	FP6	09/2004	09/2007	http://ec.europa.eu/research/transport/projects/items/safeice___cutting_a_path_through_icy_waters_en.htm http://www.maritimetransportresearch.com/site/project/FP6_13
SKEMA	Sustainable Knowledge Platform for the European Maritime and Logistics Industry	FP7	06/2008	06/2011	http://www.skematransport.eu/ http://www.eskema.eu/defaultinfo.aspx?topicid=85&index=6 http://www.transport-research.info/web/projects/project_details.cfm?ID=37470
SMART-CM	SMART Container Chain Management	FP7	08/2008	10/2011	http://www.smart-cm.eu/ http://www.transport-

					research.info/web/projects/project_details.cfm?ID=37567
SUPPORT	Security UPgrade for PORTs	FP7	07/2010	06/2014	http://www.support-project.eu/ http://cordis.europa.eu/projects/rcn/94831_en.html
TANGO	Telecommunications Advanced Networks for GMES Operations	FP6	11/2006	10/2009	http://cordis.europa.eu/search/index.cfm?fuseaction=lib.document&DOC_LANG_ID=EN&DOC_ID=114980161&pid=1&q=C2A356C916931281B7344D8DD82FACE1&type=sim http://cordis.europa.eu/projects/rcn/84918_en.html http://cordis.europa.eu/documents/documentlibrary/114980161EN6.pdf
TRITON	Trusted Vessel Information from Trusted On-board Instrumentation	FP7	12/2013	11/2013	http://tritonproject.eu/project.php
SAFETOW	Strategic Aid for Escort Tugs at Work	FP6	03/2004	09/2007	http://safetow.bmtproject.net/ http://www.transport-research.info/web/projects/project_details.cfm?ID=35409
SHOPERA	Energy Efficient Safe SHip OPERAtion	FP7	10.2013	09/2016	http://shopera.org/
DG Mare					
BlueMassMed	Project for Maritime Surveillance of the Mediterranean Area and the Atlantic Approaches	Integrated Maritime Policy	12/2009	10/2012	http://bluemassmed.net/
IMP-MED	Integrated Maritime Policy for the Mediterranean	Integrated Maritime Policy	2010	11/2014	www.imp-med.eu/
MARSUNO	Maritime Surveillance in the			03/2012	http://www.marsuno.eu/

	Northern Sea Basins				
CoopP	Cooperation Project	Integrated Maritime Policy	12/2012	03/2014	http://www.coopp.eu/
Marco Polo Projects					
SHORTSEA-XML	Message Standard for Short Sea Shipping	Marco Polo	09/2006	09/2008	http://www.shortseaxml.org http://www.efta.int/~/media/Files/Publications/Fact%20sheets/EFTA%20participation%20in%20EU%20programmes/MARCO-POLO-Programme.pdf
TEN-T Projects					
AnNa (MIELE 2)	Advanced National Networks for Administration	TEN-T	01/2013	12/2015	http://www.annamsw.eu/about/43-factsheet.html
B2MOS	Business to Motorways of the Sea	TEN-T	07/2012	12/2015	http://www.luka-kp.si/eng/about-us/eu-projects#B2MOS
ITS Adriatic	ITS Multi-Port Adriatic Gateway	TEN-T	09/2010	12/2013	http://www.its-napa.eu/
MoS4MoS	Monitoring and Operating Services for Motorways of the Sea	TEN-T	2011	05/2012	http://www.mos4mos.eu/
MIELE	Multimodal Interoperability E-services for Logistics and Environment sustainability	TEN-T	09/2010	12/2013	http://www.miele-action.org/
MIELE Extended	Multimodal Interoperability E-services for Logistics and Environment sustainability	TEN-T	04/2010	06/2013	http://tentea.ec.europa.eu/en/ten-t_projects/ten-t_projects_by_country/multi_country/2010-eu-21106-s.htm
MONALISA	Motorways & Electronic Navigation by Intelligence at Sea	TEN-T	09/2010	12/2013	http://www.sjofartsverket.se/en/MonaLisa/
MONALISA 2.0	Motorways & Electronic Navigation by Intelligence at Sea	TEN-T	01/2012	12/2015	http://www.sjofartsverket.se/en/MonaLisa/MONALISA-20/

					http://monalisaproject.eu/
PORTMOS	Integration of the Portuguese Ports and Maritime System in the Motorways of the Sea	TEN-T	04/2004	12/2007	http://tentea.ec.europa.eu/en/ten-t_projects/ten-t_projects_by_country/portugal/2004-pt-91204-s.htm
INTERREG projects					
ACCSEAS	Accessibility for Shipping, Efficiency Advantages and Sustainability	INTERREG	03/2012	02/2015	http://www.northsearegion.eu/ivb/projects/ http://www.containproject.eu/containknowledge/defaultinfo.aspx?topicid=633&index=6
iTRACT	Improving Transport and Accessibility through new Communication Technologies	INTERREG	01/2012	03/2015	www.itract-project.eu http://www.northsearegion.eu/ivb/projects/details/&tid=132
i Transfer	Innovative Transport Solutions for Fjords, Estuaries and Rivers	INTERREG	10/2010	10/2013	http://www.itransferproject.eu/ http://www.northsearegion.eu/ivb/projects/details/&tid=126&back=yes
Port Integration	Multi-modal Innovation for Sustainable Maritime & Hinterland Transport	INTERREG	2010	03/2013	http://www.portintegration.eu
NS FRITS	North Sea Freight and Intelligent Transport	INTERREG	01/2009	12/2010	http://www.northsearegion.eu/ivb/projects/details/&tid=94&back=yes
SESTANTE	ICT instruments for interoperable processes at Mediterranean ports	INTERREG	01/2003	10/2004	http://www.fundacion.valenciaport.com/Projects/Projects/sestante.aspx
European Regional Development Fund projects					
Efficensea	Efficient, Safe and Sustainable Traffic at Sea	ERDF	10/2008	01/2012	http://www.efficiensea.org
FREIGHT4ALL (MED project)	A distributed and open FREIGHT transport ICT solution 4 ALL stakeholders in the Mediterranean area	ERDF	05/2011	05/2013	www.med-freight4all.eu
FUTUREMED	Freight and passenger supporting	ERDF	05/2012	05/2015	www.futuremedproject.eu

(on-going MED project)	info-mobility systems for a sustainable improvement of the competitiveness of port-hinterland systems of the MED area				
MEDITA (on-going MED project)	MEDiterranean Information Traffic Application; RFID solutions at ports and port terminals	ERDF	06/2012	05/2015	http://www.fundacion.valenciaport.com/Projects/Projects/MED-I-T-A----MEDITERRANEAN-INFORMATION-TRAFFIC-APP.aspx
MEDNET (on-going MED project)	Mediterranean Network for Customs procedures and Simplification of Clearance in Ports	ERDF	06/2012	05/2015	http://www.mednetproject.eu/
EMSA Project					
Blue Belt Project	Blue Belt pilot project	EMSA	05/2011		http://emsa.europa.eu/operations/safeseanet/items/id/1463.html?cid=113
IMDatE	Integrated Maritime Data Environment -	EMSA			http://emsa.europa.eu/operations/lrit/117-lrit/489-integrated-maritime-data-environment-imdate.html/
THETIS	Information system that supports the new Port State Control inspection regime	EMSA			http://emsa.europa.eu/implementation-tasks/port-state-control/thetis.html
JRC Projects					
MASURE 2007 MASURE 2008	Maritime Surveillance	JRC	2007 2008		masure 2007 http://projects.jrc.ec.europa.eu/jpb_public/actionsbypolicy.html?year=2007&actionId=870&from=list&policyCombo=2.1&yearSearch=&instituteCombo=-1 masure 2008 http://projects.jrc.ec.europa.eu/jpb_public/actionsbypolicy.html?year=2008&actionId=1395&from=list&policyCombo=2.1&yearSearch=&instituteCombo=-1

CONTRAFFIC 2009 CONTRAFFIC 2010 CONTRAFFIC 2011	Container Traffic Monitoring	JRC	2009 2010 2011		contraffic 2009 http://projects.jrc.ec.europa.eu/jpb_public/actionsbypolicy.html?year=2009&actionId=1569&from=list&policyCombo=4.1&yearSearch=&instituteCombo=-1 contraffic 2010 http://projects.jrc.ec.europa.eu/jpb_public/act/publicexportworkprogramme.html?actId=3152&wpId=100&d-2325611-p=2&instituteCombo=-9 contraffic 2011 http://projects.jrc.ec.europa.eu/jpb_public/act/publicexportworkprogramme.html?actId=234&wpId=1&d-2325611-p=2&instituteCombo=-9
VESCOSUR	Vessel and Container Surveillance	JRC	2012		http://ipsc.jrc.ec.europa.eu/?id=310
VESPO 2009 VESPO 2010 VESPO 2011	Vessel Surveillance and Port Security	JRC	2009 2010 2011		vespo 2009 http://projects.jrc.ec.europa.eu/jpb_public/actionsbypolicy.html?year=2009&actionId=1535&from=list&policyCombo=2.1&yearSearch=&instituteCombo=-1 vespo 2010 http://projects.jrc.ec.europa.eu/jpb_public/act/publicexportworkprogramme.html?actId=3151&wpId=100&d-2325611-p=1&instituteCombo=-9 vespo 2011 http://projects.jrc.ec.europa.eu/jpb_public/act/publicexportworkprogramme.html?actId=252&wpId=1&instituteCombo=-9
National Projects					
CEDEX INTERMODALITY	Maritime-rail integration	Spain	2007	2010	http://www.fundacion.valenciaport.com/Projects/Projects/FOSTERING-MARITIME-

					RAILWAY-INTEGRATION.aspx?lang=en-US
MariBrain	Research and Development of an automated data collection system through wireless sensor networks and knowledge management with remote monitoring and analysis of the status and performance of ships	Greece	2007	2013	http://www.laros.gr/index.php/knowledgecenter
Marsafe	Maritime Safety in High North	Norway	2008	2011	www.sintef.no/Projectweb/MARSAFE
Shipping KPI	Shipping KPI	Norway	2006	2011	http://www.sintef.no/home/MARINTEK/Projects/Maritime/Shipping-KPI-reaches-maturity/
STIMULO	Simulation and real time prediction of trucks arrival to ports	Spain	2013	2015	http://www.prodevelop.es/en/noticia/13/02/01/empezamos-nuevo-proyecto-idi-junto-fundaci%C3%B3n-valenciaport-stimulo
TIMI	Intelligent Intermodal Freight Transport	Spain	2007	2010	http://www.fundacion.valenciaport.com/Projects/Projects/TRANSPORTE-INTELIGENTE-DE-MERCANCIAS-INTERMODAL-(T.aspx?lang=en-US

Annex 3: Consolidated lists of main actors

Table 4: Main Actors for EU Framework projects

Organisation	website	Country
TeleConsult Austria GmbH	www.teleconsult-austria.at	Austria
Via Donau – Österreichische Wasserstraßen-Gesellschaft mbH	www.via-donau.org	Austria
Econsult Betriebsberatungsgesellschaft Mbh	www.econsult.at/	Austria
European Community Shipowners Associations	www.ecsa.be/	Belgium
European Marine Equipment Council/Conseil Europeen de l'equipment naval	www.emec.eu/	Belgium
Clecat - European Association for Forwarding, Transport, Logistics and Customs Service	www.clecat.org/	Belgium
AWZ - Ministry of the Flemish Community Administration Waterways and Maritime Affairs	www.lin.vlaanderen.be/awz	Belgium
Sequoyah NV	www.sequoyah.be/	Belgium
ANAST-ULG - University of Liege	www.anast.ulg.ac.be/	Belgium
Persiskal - RESCO Navigation Systems	www.periskal.com/	Belgium
Danaos Shipping Company Ltd	www.danaos.gr/	Cyprus
eBOS Technologies Ltd	www.emarproject.eu/default.aspx?articleID=1087	Cyprus
Decision Dynamics Limited	www.decisiondyn.com/	Cyprus
eBOS Technologies Ltd	www.ebos.com.cy	Cyprus
Syddansk Universitet	www.sdu.dk/	Denmark
LMA - Lyngsoe Marine A/S	www.lyngsoe.com/	Denmark
Øresund University (Øresund Logistics	www.orelog.org/	Denmark
Marimatech A/S	www.marimatech.com/	Denmark
Force Technology	www.forcetechnology.com/en/Menu/Services/Maritime/	Denmark
EHMC - European Harbour Masters' Committee	www.harbourmaster.org/ehmc.php	Europe
EMPA - European Maritime Pilots' Association	www.empa-pilots.org/	Europe
VTT	www.vtt.fi/	Finland
Port of Turku	www.port.turku.fi/portal/en	Finland
Ilmatieteen Laitos - Finnish Meteorological Institute	en.ilmatieteenlaitos.fi/	Finland
Suomen Ymparistokeskus	www.syke.fi/en-US	Finland
VTT Technical Research Centre of Finland	www2.vtt.fi/	Finland
TEMIS	community.temis.com/home	France
Societe de Gestion de Terminaux Informatiques	www.societe.com/	France
Bureau Veritas	www.bureauveritas.fr/wps/wcm/connect/bv_fr/local	France
IFN - Institut Francais de Navigation	www.ifnavigation.org/	France
INRETS - Institut National de Recherche sur les Transports & leur Sécurité	www.inrets.fr/	France
France Développement Conseil	www.fdc.fr/en/index.php	France

GMSD - Groupement Maritime Saunier-Dreyer	www.societe.com/societe/gpt-maritime-saunier-dreyer-sarl-493150510.html	France
Areva TA (Societe Technique pour l'energie Atomique)	www.systematic-paris-region.org/fr/membres/areva-ta-societe-technique-pour-l-energie-atomique-technicatome	France
Grand Port Maritime du Havre	www.havre-port.fr/	France
Corys Training & Engineering Support Systems	www.corys.com/	France
Doris Engineering S.A.	www.doris-engineering.com/prod/home.html	France
Compagnie Fluviale de Transport S.A.	www.cft.fr/	France
SIREHNA	www.sirehna.com/	France
Pemar RD	www.societe.com	France
Biowind Sarl	www.biowindgroup.com/?changelangue=EN	France
Sodena SA	www.epicos.com/EPCompanyProfileWeb/GeneralInformation.aspx?id=21586	France
TL & Associes	www.tl-a.net/	France
Centre Regional D'Innovation et de Transfert Technologique de Basse-Normandie Cotentin	www.researchranking.org/index.php?action=partner&p=danKZ	France
Centre D'Etudes Techniques Maritimes and Fluviales (Institute for Maritime and Waterways Studies)	www.cetmef.equipement.gouv.fr/	France
Institut Francais de Recherche pour L'Exploitation de la Mer	wwz.ifremer.fr/	France
Universite de Strasbourg	www.unistra.fr/index.php?id=accueil	France
Universite de Caen - Basse Normandie	www.unicaen.fr/	France
HSVA – Hamburgische Schiffbau-Versuchsanstalt GmbH	www.hsva.de	Germany
Nielsen + Partner Unternehmensberater GMBH	www.nundp.com/	Germany
Sam Electronics GMBH	www.sam-electronics.de/	Germany
Lutgens & Reimers GMBH & Co. KG	www.luetgens-reimers.de/	Germany
Tutech Innovation GMBH	tutech.net/#1	Germany
Hamburg Port Authority AOR	www.hamburg-port-authority.de/en/Seiten/Startseite.aspx	Germany
Technische Universitat Hamburg-Harburg	www.tuhh.de/tuhh/startseite.html	Germany
PTV Planung Transport Verkehr AG	www.mjc2.com/	Germany
Hochschule Wismar, University of Technology, Business and Design	www.hs-wismar.de/en/homepage/	Germany
SevenCs AG & Co. KG	http://www.sevencs.com/	Germany
Fraunhofer CML	www.cml.fraunhofer.de	Germany
Hochschule Wismar	www.hs-wismar.de	Germany
Marine Soft	www.marinesoft.de	Germany
Environmental Protection Engineering S.A.	http://epe.gr/	Greece

Thessaloniki Port Authority S.A.	http://www.thpa.gr/?lang=en	Greece
Transeuropean Consultants for Transport, Development and Information Technology S.A.	http://www.tredit.gr/site/?lang=en	Greece
National Technical University of Athens	http://www.ntua.gr/index_en.html	Greece
Aristotle University of Thessaloniki	https://www.auth.gr/en	Greece
University of Piraeus Research Centre	http://www.unipi.gr/	Greece
Athens Univ. of Economics & Business	http://www.aueb.gr	Greece
Marorka ehf	www.marorka.com	Iceland
NECLE - Nautical Enterprise Centre Ltd	http://www.nauticalenterprise.ie/	Ireland
Transas	http://www.transas.com/	Ireland
University College Cork	www.ucc.ie	Ireland
Irish Exporters Association	http://www.irishexporters.ie	Ireland
Dublin Port Company	http://www.dublinport.ie/	Ireland
Livorno Port Authority	www.portauthority.livorno.it/	Italia
European Commission - Joint Research Centre	ec.europa.eu/jrc/	Italia
CONSAR – Italian Shipowners Research Consortium	www.consar.net	Italy
Consorzio IB Innovation	www.interporto.it/consorzio_ib.asp	Italy
D'Appolonia	www.dappolonia.it/en	Italy
Telespazio S.p.A	http://www.telespazio.com/	Italy
Thetis S.p.A.;	http://www.thetis.it/wp/?lang=en	Italy
Valsts Akciju Sabiedriba Latvijas Juras Administracija *Maritime Administration of Latvia MAL	http://www.jurasadministracija.lv/	Latvia
Valsts Akciju Sabiedriba Latvijas Juras Administracija *Maritime Administration of Latvia MAL	http://www.jurasadministracija.lv/	Latvia
Maritime Administration of Latvia	http://www.jurasadministracija.lv/eng	Latvia
Vilniaus Gedimino Technikos Universitetas	http://www.vgtu.lt/	Lithuania
Technische Universiteit Delft	http://www.tudelft.nl/en/	NL
Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek – TNO	http://www.tno.nl/	NL
Svitzer A/S	http://svitzer.com/	NL
Caris Geographic Information Systems BV	http://www.hydrographicsocietybenelux.eu/nl/corporate/6-caris	NL
Ministry of Transport, Public Works and Water Management. Rijkswaterstaat - DVS Centre for Transport and Navigation	http://www.rijkswaterstaat.nl/en/	NL
ECORYS Nederland B.V. - Transport division	http://www.ecorys.com/	NL
KSD - Koninklijke Scheepsagentuur Dirkzwager	www.dirkzwager.com/	NL
Marin - Maritime Research Institute Netherlands	www.marin.nl/web/show	NL
Port of Rotterdam	www.portofrotterdam.com/en/Pages/default.aspx	NL
STC - Scheepvaart en Transport College b.v.	www.stc-group.nl/	NL
TNO - Netherlands Organisation for Applied Scientific Research	www.tno.nl/en/	NL
Sarnia Maritime	http://sarnia.nl/	NL
CETLE - Centre for the development of Transport and Logistics in Europe	www.cetle.info/	NL

Det Norske Veritas AS (now DNV-GL)	www.dnvgl.no/	Norway
MARINTEK - Norsk Marinteknisk Forskningsinstitutt AS	www.sintef.no/home/MARINTEK	Norway
Marlo AS	www.marlo.no/	Norway
The Royal Ministry of Fisheries and Coastal Affairs - Fiskeri- og Kystdepartementet	www.regjeringen.no/	Norway
Kongsberg Norcontrol IT	www.kongsberg.com/en/kds/kncit/	Norway
Norwegian Maritime Administration	http://www.sjofartsdir.no/en/	Norway
Norwegian Coastal Administration (NCD)	http://kystverket.no/	Norway
Met-no - Norwegian Meteorological Institute Marine Forecasting Centre	http://met.no/	Norway
Fugro Oceanor - Oceangraphic Company of Norway	http://oceanor.com/	Norway
SINTEF	www.sintef.no	Norway
CMR - Christian Michelsen Research AS	http://cmr.no/	Norway
Aptomar AS	www.aptomar.com	Norway
Kongsberg Seatex AS	www.km.kongsberg.com	Norway
Via Donau - Osterreichische Wasserstraßen-Gesellschaft MBH	www.viadonau.org	Österreich
Centrum Techniki Okretowej S.A.- Ship Design and Research Centre S.A.	www.cto.gda.pl/en/	Poland
IST - Instituto Superior Tecnico	https://tecnico.ulisboa.pt/en/	Portugal
LNEC - Laboratório Nacional de Engenharia Civil	www.lnec.pt/pt	Portugal
Instituto de Soldadura e Qualidade	www.isq.pt	Portugal
Administraco do Porto de Lisboa/Lisbon Port Authority	www.portodelisboa.pt	Portugal
"Ovidius" University of Costanta - Center for Advanced Engineering Sciences	www.univ-ovidius.ro	Romania
Isdefe - Ingeniería de Sistemas para la Defensa de España	www.isdefe.es	Spain
Instituto Nacional de Técnica Aeroespacial – INTA	www.inta.es	Spain
GMV – Innovating Solutions	www.gmv.com	Spain
Consultores Investigación Tecnológica S.L. (CIT)	http://tefles.eu/?page_id=51	Spain
Portic Barcelona S.A	http://www.portic.net/	Spain
Acciona Infraestructuras S.A.	http://www.acciona-infraestructuras.es/	Spain
Ingenieria de Sistemas Para la Defensa de Espana, S.A.	www.isdefe.es	Spain
Consultrans S.A.	www.consultrans.es/en	Spain
Port Authority Gijon	https://www.puertogijon.es/	Spain
Fundacion de la Comunidad Valenciana para la Investigacion, Promocion y Estudios Comerciales de Valenciaport	http://www.fundacion.valenciaport.com/	Spain
Portel Servicios Telematicos S.A	www.portel.es/en	Spain
Sasemar - Sociedad de Salvamento y Seguridad Maritima	www.salvamentomaritimo.es	Spain
Portel Servicios Telematicos, S.A	http://www.portel.es	Spain
Compañía Trasmediterránea	http://www.trasmediterranea.es	Spain

THAB – True Heading AB	www.trueheading.se	Sweden
SMA - Swedish Maritime Administration	www.sjofartsverket.se	Sweden
SSPA Sweden AB	www.sspa.se	Sweden
WMU - World Maritime University	www.wmu.se	Sweden
Chalmers University	www.chalmers.se	Sweden
Göteborg University	http://www.gu.se/english/	Sweden
Technical University of Istanbul - ITU	www.itu.edu.tr	Turkey
BMT Group Limited	http://www.bmt.org/	UK
ICAP Shipping Ltd	http://www.icapshipping.com/	UK
Inchcape Shipping Services Holdings Limited	http://www.iss-shipping.com/	UK
Inlecom Systems Ltd	http://www.inlecom.com/	
MJC2 Limited	http://www.mjc2.com/	UK
Market & Opinion Research International Limited	http://www.ipsos-mori.com/	UK
Shipserv Ltd	http://www.societe.com/	UK
CLMS (UK) Limited	http://www.clmsuk.com/	UK
Canterbury Christ Church University	http://www.canterbury.ac.uk/	UK
ABP Marine environmental research Ltd	www.abpmer.co.uk	UK
MCA - Maritime and Coastguard Agency	www.gov.uk/government/organisations/maritime-and-coastguard-agency	UK
QinetiQ	www.qinetiq.com	UK
University of Strathclyde	www.strath.ac.uk	UK
Global Policy Institute	http://www.global-policy.com	UK
Imperial College of Science, Technology and Medicine	www.imperial.ac.uk	UK

Table 5: Main Actors in the EU TEN-T projects

Organisation	website	Country
Kingdom of Belgium	www.flanders.be	Belgium
Antwerp Port Authority	www.portofantwerp.be	Belgium
Republic of Bulgaria	www.mtitc.government.bg	Bulgaria
Port Authority of Cyprus	www.cpa.gov	Cyprus
CYPRUS PORTS AUTHORITY	www.cpa.gov.cy	Cyprus
Danish Maritime Safety Administration	www.dma.dk	Denmark
GateHouse A/S	www.gatehouse.dk	Denmark
Port of Tallinn	www.portoftallinn.com	Estonia
Finnish Transport Agency	http://portal.liikennevirasto.fi	Finland
Port of HaminaKotka	www.haminakotka.fi	Finland
French Republic	www.developpement-durable.gouv.fr	France
Grand Port Maritime de Marseille	www.marseille-port.fr	France
Jacobs University Bremen	www.jacobs-university.de	Germany
Signalis	www.signalis.com	Germany
DBH Logistics IT AG	www.dbh.de	Germany
Free and Hanseatic City of Hamburg, State Ministry for Economy, Transport and Innovation	www.hamburg.de/europaeische-union	Germany
Hamburg Port Authority	www.hamburg-port-authority.de	Germany

UNICONSULT, Universal Transport Consulting GmbH	www.uniconsult-hamburg.de	Germany
blitzrind digital expertise	www.blitzrind.de	Germany
Hellenic Republic	www.ypoian.gr	Greece
Italian Republic	www.mit.gov.it/mit/site.php	Italy
RINA SPA	www.rina.org	Italy
Ministry of Infrastructure and Transport - Directorate-General for Maritime and Inland Waterways Transport	www.mit.gov.it	Italy
Grimaldi Group	www.grimaldi.napoli.it	Italy
Terminal San Giorgio SRL	www.terminalsangiorgio.it	Italy
CAP spa	www.cap.it	Italy
IB	www.gruppo-ib.com	Italy
Municipality of Ancona	www.comune.ancona.it	Italy
Chamber of Commerce of Genoa	www.ge.camcom.gov.it	Italy
Republic of Latvia	www.mod.gov.lv	Latvia
Klaipeda State Seaport Authority	www.portofklaipeda.lt	Latvia
Freeport of Riga Authority	www.freeportofriga.lv	Latvia
Instituto Portuário e dos Transportes Marítimos, I.P.	www.imarpor.pt	Portugal
IPTM – Instituto Portuario e dos Transportes Maritimos	www.imarpor.pt	Portugal
APL, Lisbon Port Authority	www.portodelisboa.pt	Portugal
PORT OF LEIXÕES	www.portodeleixoes.pt	Portugal
Ministério das Obras Publicas, Transportes e Comunicações	www.potugal.gov.pt	Portugal
APP – Associação dos Portos de Portugal	http://www.portosdeportugal.pt/	Portugal
Romanian Naval Authority	www.rna.ro	Romania
Rosmorport Kaliningrad Branch	mamenko@portkld.ru	Russia
Slovenian Maritime Administration	www.up.gov.si	Slovenia
Puertos del Estado	www.puertos.es	Spain
Port Authority of GIJON (PAG)	www.puertogijon.eu	Spain
PLAZA S.A	www.plazalogistica.com	Spain
Zaragoza Logistics Center (ZLC)	www.zlc.edu.es	Spain
Instituto Tecnológico de Aragón (ITA)	www.ita.es/ita/	Spain
CIMNE	www.cimne.com	Spain
COMPASS IS	www.compassis.com	Spain
Valencia Port Authority	www.valenciaport.com	Spain
Kingdom of Sweden	www.sjofartsverket.se	Sweden
Swedish Maritime Administration	www.sjofartsverket.se	Sweden
SAAB TransponderTech AB	www.transpondertech.se	Sweden
SSPA Sweden AB	www.sspa.se	Sweden
Chalmers tekniska högskola AB	www.chalmers.se	Sweden
Sweden (Coordinator: Swedish Maritime Administration)	www.sjofartsverket.se	Sweden
United Kingdom	www.gov.uk/government/organisations/department-for-transport	UK
Essex County Council	www.essex.gov.uk	UK

Table 6: Main Actors in INTERREG projects

Organisation	website	Country
AG Port of Oostende	www.portofoostende.be	Belgium
Danish Maritime Safety Administration	www.dma.dk	Denmark
Federal Waterways and Shipping Administration	www.bmvi.de	Germany
Flensburg University of Applied Sciences	www.fh-flensburg.de	Germany
Jade University of Applied Sciences	http://www.jade-hs.de/en/university-of-applied-sciences/	Germany
VEJ - Verkehrsregion Nahverkehr Ems Jade	http://www.vej-info.de/	Germany
Erlebnis Bremerhaven GmbH, Bremerhaven Tourisik and Magistrat Bremerhaven	www.bremerhaven.de	Germany
Weserfähre GmbH	www.weserfaehre.de	Germany
Hanze University Groningen, UAS	http://www.hanze.nl/	Netherlands
University of Groningen, Faculty of Spatial Sciences	http://www.rug.nl/frw/?lang=en	Netherlands
Gemeente Oldamb	www.gemeente-oldambt.nl	Netherlands
OV Bureau Groningen Drenthe	http://www.ovbureau.nl/	Netherlands
Damen Shipyards	www.damen.com	Netherlands
Rederij Doeksen	www.rederij-doeksen.nl	Netherlands
TESO	www.teso.nl	Netherlands
Rijkswaterstaat, Ministerie Infrastructuur en Milieu	www.rijkswaterstaat.nl	Netherlands
NHL Hogeschool Leeuwarden, Maritiem Instituut Willem Barentsz	www.nhl.nl	Netherlands
Norwegian Coastal Administration	www.kystverket.no	Norway
Rogaland County	http://www.rfk.no	Norway
University of Stavanger	http://www.uis.no/	Norway
Dept. of Shipping & Maritime Technology, Chalmers University of Technology	www.chalmers.se	Sweden
Swedish Maritime Administration	www.sjofartsverket.se	Sweden
SSPA Sweden AB	www.sspa.se	Sweden
World Maritime University	www.wmu.se	Sweden
Värmlandstrafik AB	http://www.varmlandstrafik.se/	Sweden
University of Karlstad	www.kau.se/en	Sweden
Viktoria Institute	http://www.viktoria.se/%E2%80%8E	Sweden
Trinity House (on behalf of the General Lighthouse Authorities of UK and Ireland)	George Alan Shaw george.shaw@gla-rrnav.org	UK
Trinity House (on behalf of the General Lighthouse Authorities of UK and Ireland)	www.trinityhouse.co.uk	UK
Dales Integrated Transport Alliance	http://www.dalesconnect.net	UK
Metro	http://www.wymetro.com/	UK
Institute for Sustainability	www.instituteforsustainability.co.uk	UK
Gravesham Borough Council	www.gravesham.gov.uk	UK
SEStran	www.sestran.gov.uk	UK

Table 7: Main Actors in European Development Fund projects

Organisation	website	Country
Albanian Institute of Transport	www.ital.gov.al	Albania
Port of Rijeka Authority	www.portauthority.hr	Croatia
Zadar Port Authority	www.port-authority-zadar.hr	Croatia
Intermodal Transport Cluster	www.shortsea.hr	Croatia
Cyprus University of Technology	www.cut.ac.cy	Cyprus
Maritime Institute of Eastern Mediterranean,	www.marinem.org	Cyprus
Danish Maritime Authority	www.dma.dk/	Denmark
Estonian Maritime Administration	www.vta.ee/	Estonia
Aalto University	www.aalto.fi/	Finland
Finnish Transport Agency	www.fta.fi/	Finland
Kymenlaakso University of Applied Science	www.kyamk.fi/	Finland
Association for the development of vocational Training in Transport (AFT)	www.aft-iftim.com	France
Chamber of Commerce and Industry Marseille Provence	http://%20www.ccimp.com	France
Decentralized Administration of Crete (DAC)	www.apdkritis.gov.gr	Greece
NTUA	www.ntua.gr	Greece
Igoumenitsa Port Authority	www.olig.gr	Greece
Patras Port Authority	www.patrasport.gr	Greece
Institute for transport and logistics foundation (ITL)	www.fondazioneITL.org	Italy
Interporto Bologna (IPBO)	www.bo.interporto.it	Italy
Campania Region (CR)	www.regione.campania.it	Italy
Rete Autostrade Mediterranee	www.ramspa.it	Italy
Ancona Port Authority	www.autoritaportuale.ancona.it	Italy
Taranto Port Authority	www.port.taranto.it	Italy
Malta Transport Centre	www.transport.gov.mt	Malta
Moere and Romsdal County	www.visitmr.com ; www.mrfylke.no	Norway
Norwegian Coastal Administration	www.kystverket.no	Norway
Runde Environmental Center	www.rundecentre.no	Norway
Gdynia Maritime University	www.am.gdynia.pl/en/	Poland
Maritime Institute in Gdansk	www.im.gda.pl/	Poland
Maritime Office in Gdynia	www.portgdansk.pl	Poland
Maritime University of Szczecin	www.am.szczecin.pl/	Poland
National Institute of Telecommunications	www.nit.eu	Poland
TIS	www.tis.pt	Portugal
Luka Koper (LK)	www.luka-kp.si/eng	Slovenia
Prometni institut Ljubljana	www.prometni-institut.si	Slovenia
Valenciaport Foundation (VPF)	www.fundacion.valenciaport.com	Spain
Universidad Politécnica de Valencia (UPV)	www.upv.es	Spain
Velenciaport Foundation	www.fundacion.valenciaport.com	Spain
Centre for Innovation in Transport	www.cenit.es/eng/inici_eng.htm	Spain
Chalmers University of Technology	www.chalmers.se/smt/en	Sweden
SSPA Sweden	www.sspa.se	Sweden
Swedish Maritime Administration	www.sjofartsverket.se	Sweden
Swedish Transport Agency	www.transportstyrelsen.se	Sweden

Table 8: Main Actors in DG MARE projects

Organisation	website	Country
Secrétariat général de la mer (France)	http://www.gouvernement.fr/secretariat-general-de-la-mer-sgmer	France
WS Atkins	www.atkinsglobal.com/	UK
European Commission EuropeAid Cooperation Office	https://ec.europa.eu/europeaid/home_en	Belgium
Swedish Coast Guard	http://www.kustbevakningen.se/sv/the-swedish-coast-guard/	Sweden
Finnish Border Guard	http://www.raja.fi/en	Finland
Agenzia Spaziale Italiana	http://www.asi.it/en	Italian

Table 9: Main Actors in National projects

Organisation	website	Country
Prisma Electronics SA	www.prismaelectronics.eu	Greece
Mobics Ltd	www.mobic.gr	Greece
Kavala Institute of technology	www.teikav.edu.gr	Greece
Institute of research and technology Thessaly IRETH	www.ireteth.certh.gr	Greece
National University of Athens	http://www.di.uoa.g	Greece
Institute of communication and computer systems	http://www.iccs.gr/eng/	Greece
Computer Technology Institute and Press "Diophantus"	www.cti.gr	Greece
Danaos Management SA	www.danaos.gr	Greece
ANEK lines SA	www.anek.gr	Greece
Kongsberg Satellite Services	www.ksat.no	Norway
Kongsberg Norcontrol IT	www.kongsberg.com	Norway
Kongsberg Seatex AS	www.km.kongsberg.com	Norway
Norwegian Shipowner Association	www.rederi.no/en	Norway
University Centre at Svalbard	www.unis.no	Norway
MARINTEK	www.sintef.no/home/MARINTEK	Norway
StatoilHydro (now Statoil)	www.statoil.com/en	Norway
SINTEF	www.sintef.com	Norway
NTNU	www.ntnu.no	Norway
Telenor	www.telenor.com	Norway
Store Norske	www.snsk.no	Norway
Norwegian Coastal Administration	http://kystverket.no/	Norway
The Norwegian Defence Research Establishment (FFI)	www.ffi.no/en	Norway
BW Gas ASA	www.bwgas.com	Norway
Høegh Fleet Services AS	www.hoegh.com	Norway
Jebsen Management AS/Aboitiz Jebsen Bulk Transport Corp	www.jebsens.com	Norway
Seaspan Ship Management Ltd	www.seaspancorp.com	Norway
Wallem Shipmanagement Ltd.	www.wallem.com	Norway
Barber Ship Management	www.barbership.com	Norway
EMS Ship Management	www.sealandia-group.com	Norway
Thome Ship Management Pte Ltd	www.thome.com.sg	Norway
V.Ships	www.vships.com	Norway
Wilh. Wilhelmsen ASA	www.wilhelmsen.com	Norway

Annex 4: Glossary for e-maritime/e-navigation

API	Application programming interface (API) is an interface that a software program implements in order to allow other software to interact with it, much in the same way that software might implement a user interface in order to allow humans to use it.
e-Business	Electronic business, or e-business, is the application of information and communication technologies in support of all the activities of business. The term "e-business" was coined by IBM's marketing and Internet teams in 1996. e-Business is, in its simplest form, the conduct of business on the Internet. It is a more generic term than e-Commerce because it refers to not only buying and selling but also servicing customers and collaborating with business partners (B2B) and administrations (B2A).
e-Certificate	An electronic certificate in a standardised format, [potentially] recognised by a certification authority
e-Document	An unstructured document (e.g. a PDF file) that can be sent electronically
e-Freight	According to EU Freight Logistics Action Plan, "e-freight", denotes the vision of a paper-free, electronic flow of information associating the physical flow of goods with a paperless trail built by ICT. It includes the ability to track and trace freight along its journey across transport modes and to automate the exchange of information for regulatory or commercial purposes.
e-Government	Electronic government or e-government consists of digital interactions between a government and citizens, government and businesses/Commerce, government and employees, and also between government and governments /agencies. e-Government also known as e-gov, digital government, online government refers to the use of internet technology as a platform for Administrations to exchange information, providing services and transacting with citizens, Businesses (A2B), and other Administrations (A2A).
Electronic data interchange (EDI)	The transfer of structured data, by agreed message standards, from one computer system/ trading partner to another without human intervention. It is used to transfer electronic documents or business data in a more structured may than by mere e-mail; for instance, organizations might replace bills of lading and even cheques with appropriate EDI messages.
EGNOS	EGNOS is the European Geostationary Navigation Overlay Service, is Europe's first venture into the field of GNSS and a precursor to Galileo, Europe's independent global satellite navigation system currently under development. EGNOS is an open system operational and available for use. On 1st of October 2008, the EC launched the EGNOS Open Service with free access for citizens and businesses.
Electronic data interchange (EDI)	The transfer of structured data, by agreed message standards, from one computer system/ trading partner to another without human intervention. It is used to transfer electronic documents or business data in a more structured may than by mere e-mail; for instance, organizations might replace bills of lading and even cheques with appropriate EDI messages.
e-maritime	e-maritime is the internet based interactions that take place between all the different stakeholders in the maritime sector.

e-Message	A message in UN/EDIFACT or XML format, compliant to IMO standardised Forms (FAL Forms) or other standards.
e-navigation	The IMO definition of e-navigation is "…the harmonised collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and protection of the marine environment".
EU e-maritime initiative	The EU e-maritime initiative is aimed at supporting the development of European capabilities, strategies and policies facilitating the adoption of upgraded "e-maritime" solutions in support of an efficient and sustainable waterborne transport system fully integrated in the overall European transport system. Upgraded e-maritime solutions will facilitate decision making and information exchange between different stakeholder groups involved in it by: 1. Improving the safety and security of maritime transport services and assets and environmental protection. 2. Increasing the competitiveness of the EU maritime transport industry and strengthening the EU presence on the international scene. 3. Integrating sustainable waterborne transport services into efficient door-to-door transport services in Europe and beyond. 4. Reinforcing the human factor particularly supporting competence development and welfare for seafarers.
EU e-maritime: MOS - Maritime Operational Services	EU e-maritime is to be based on open platform and standards to ensure interoperability between different maritime-related applications. This network should enable administrative (B2A) and commercial (B2B) communications between ships, between ships and shore, including port communities, administrations, operators, freight forwarders and other hinterland actors. (DGMOVE Focal Point Meeting 2/12/2008).
EU e-maritime Strategic Framework	The e-maritime Strategic Framework (EMSF) is currently being developed by the eMar project to provide a coherent view of the way Maritime Transport could operate at a future date (say 2020), exploiting internet based solutions to support the development of an efficient and sustainable waterborne transport system fully integrated throughout Europe.
FRONTEX	The European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union.
GNSS	Global Navigation Satellite Systems (GNSS) is the standard generic term for satellite navigation systems that provide autonomous geo-spatial positioning with global coverage.
GPS	The Global Positioning System (GPS) is a U.S. space-based global navigation satellite system. It provides reliable positioning, navigation, and timing services to worldwide users on a continuous basis in all weather, day and night, anywhere on or near the Earth.
Interoperability	The ability of two or more systems to exchange information and to use that information *(IEEE Glossary*).
ISPC	International Ship and Port Facility Security Code is an amendment to the Safety of Life at Sea (SOLAS) Convention (1974/1988) on minimum security arrangements for ships, ports and government agencies.
Maritime Cloud	A communication framework enabling efficient, secure, reliable and seamless electronic information exchange between all authorised maritime

	stakeholders across available communication systems.
OASIS	Organization for the Advancement of Structured Information Standards, a not-for-profit consortium that drives the development, convergence and adoption of open standards for the global information society.
OMG™	International computer industry consortium. The OMG Task Forces develop enterprise integration standards for a wide range of technologies.
Ontology	In the context of service oriented architecture ontology can be considered to be a model that represents a set of concepts within a domain together with the relationship between these concepts
Port Community System (PCS)	A PCS is an electronic platform that connects the multiple systems operated by a variety of organisations that make up a seaport or airport community. It is shared in the sense that it is set up, organised and used by firms in the same sector – in this case, a port community. (IPCSA – formerly EPCSA) A system that provides ICT connection between all actors involved in port operations (vessel, cargo, truck and train), mainly in a business-to-business (B2B) context. It mainly manages interactions between operators in the B2B or Business domain. Port Community Systems provide at least EDI message interchange and interconnection with National Single Windows. In addition some of the following services may be provided: message processing, dispatching, validation, reformatting, merging, etc.; re-use of commercial and public data for facilitating document fulfilment, web applications for e-fulfilment and data consultation; tracing of documents and services; booking and freight services; cargo tracking facilities; traffic statistics; coordination of multi-actor activities.
RFID	Radio-frequency identification (RFID) is the use of an object (typically referred to as an RFID tag) applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves.
SafeSeaNet	A European vessel traffic monitoring and information system established in order to enhance: Maritime safety, Port and maritime security, Marine environment protection, and Efficiency of maritime traffic and maritime transport. SafeSeaNet was established as a centralised European platform for maritime data exchange, linking together maritime authorities from across Europe. It enables European Union Member States, Norway, and Iceland, to provide and receive information on ships, ship movements, and hazardous cargoes. Main sources of information include Automatic Identification System (AIS) based position reports, and notification messages sent by designated authorities in participating countries.
Semantic Interoperability	The ability to automatically, correctly and accurately, interpret the information exchanged, in order to produce results as defined by the end users of both systems. To achieve semantic interoperability, both sides must refer to a common reference model for information exchange. The content of the information requests must also be unambiguously defined.
Ship reporting formalities and communications	Business to Administration (B2A): When a ship arrives in, stays or departs from a port, information must be provided to the port/national authorities for administrative purposes (e.g. crew and passenger list, cargo declaration, dangerous goods, etc.). The receiving side involves various national and/or local competent authorities (such as customs, security, environmental safety agencies, etc.). Business to Business (B2B): In addition to reporting to the competent authorities, a ship has the need to

	communicate with a number of other services and business partners (e.g. terminal operations, traffic management, logistics services, etc.). There is a strong interest of ship-owners, operators and port communities to use a common system for the various counterparts and situations, in order to reduce the investments and the possibility of errors. [MIELE]
Single Window (SW)	"A facility that allows parties involved in trade and transport to lodge standardised information with a single entry point to fulfil all import, export, and transit-related regulatory requirements" - UN Centre for Trade Facilitation and Electronic Business. A Single Windows can be a European Single Window (such as SafeSeaNet), a National SW, a Port Community System, a Customs SW, a Ship-owner SW, or a Classification SW. These systems handle mainly, if not exclusively, the interactions between the operators (*Business*) with the public authorities (*Administrations*), the B2A interactions or the Administration domain. It is assumed that local or regional Single Windows such as Port Single Windows integrate into National Single Windows
Situational Awareness	Situational awareness is to understand the impact of information you obtain, events that occur, and your own actions. Situational awareness can be obtained with the help of several different technologies.
SOAP	Simple Object Access Protocol for exchanging structured information on web services.
Syntactic Interoperability	Two or more systems are capable of communication and exchange of data, through specified data formats and standard communication protocols.
Taxonomy	In the context of service oriented architecture, taxonomy can be considered as a means of classification together with the principles underlying such a classification and which can be hierarchical in nature.
TEN-T	Trans-European Transport Network known as TEN-T. The European Commission adopted the first action plans on trans-European networks (transport, energy and telecommunications) in 1990. The transport network envisages coordinated improvements to primary roads, railways, inland waterways, airports, seaports, inland ports and traffic management systems, so as to provide integrated and intermodal long-distance high-speed routes for the movement of people and freight throughout Europe.
UML	Unified Modelling Language is a standardised (ISO/IEC19501:2005), general-purpose modelling language in the field of software engineering.
UN/EDIFACT (United Nations/Electronic Data Interchange For Administration, Commerce and Transport)	The international Electronic Data Interchange (EDI) standard developed under the United Nations and maintained by the UN Centre for Trade Facilitation and Electronic Business (UN/CEFACT). EDIFACT has been adopted by the International Organization for Standardization (ISO) as the standard ISO 9735 and provides a set of syntax rules to structure data, an interactive exchange protocol (I-EDI), standard messages which allow multi-country and multi-industry exchange.
Wi-Fi	A trademark of the Wi-Fi Alliance that may be used with certified products that belong to a class of wireless local area network (WLAN) devices based on the IEEE 802.11 standards.
WiMax	Worldwide Interoperability for Microwave Access is a telecommunications technology that provides wireless transmission of data using a variety of transmission modes, from point-to-point links to portable and fully mobile

	internet access.
World Wide Web Consortium (W3C)	Consortium that develops interoperable technologies (specifications, software, and tools).
XML (Extensible Mark-up Language)	A mark-up language that defines a set of rules for encoding documents in a format that is both human and machine-readable based on an open standard. A mark-up language is a modern system for annotating a text through “tags” (such as typesetting instructions, structural markers or presentation semantics). It is used for defining data elements on a Web page and business-to-business documents. A software module called an XML processor (or a parser) is used to read XML documents and provide access to their content and structure. [The] Mark-up [language] is typically omitted when the text is displayed for end-user consumption.

Annex 5: Acronyms and Abbreviations related to e-maritime

A2A	Administration to Administration.
A2B	Administration to Business.
AEO	Authorised Economic Operator.
AIS	Automatic Identification System.
API	Application programming interface.
B2A	Business to Administration.
B2B	Business to Business.
BoL	Bill of Lading.
BPEL	Business Process Execution Language
BPMN	Business Process Modelling Notation
CCS	Cargo Community System
CEN	Comite Europeen de Normalization
CSA	USA Container Security Initiative
C-TPA	USA Container Security Initiative.
D2D	Door to door
DGTREN	Directorate-General for Energy and Transport of the European Commission.
ebXML	e-business Extensible Mark-up Language
EC	European Commission
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange For Administration, Commerce and Transport
EGNOS	European Geostationary Navigation Overlay Service.
EMSA	European Maritime Safety Agency.
EMSF	e-maritime Strategic Framework
EO	Earth Observation (satellite based)
EPS	Environmental Performance System
ESPO	European Sea Ports Organisation
ETV	Emergency Towing Vehicle
EU	European Union
EUROSUR	European Border Surveillance System
FRONTEX	European external border surveillance system
FTP	File Transfer Protocol
GS1	Global Standards organisation for supply and demand chains
GNSS	Global Navigation Satellite Systems.
GPS	Global Positioning System.
ICT	Information and Communication Technologies
IMO	International Maritime Organization.
IR	Infrared
ISO	International Organization for Standardization.
ISO 28000	Auditing Security Management Systems and the Supply Chain

ISO 28001	Best Practices for Implementing Supply Chain Security, assessments and plans.
ISPC	International Ship and Port Facility Security Code.
IT	Information Technology
ITS	Intelligent Transport Systems
LRIT	Long Range Identification and Tracking
MARPOL	International Convention for the Prevention of Pollution from Ships
MAS	Maritime Assistance Service
MBA	Master of Business Administration
MDS	Maritime Digital Services
METIS	MEdiTerranean Introduction of GNSS Services
MIM	Maritime Information Management
M-TRADE	Multimodal TRAnsportation supported by EGNOS
MOS	Maritime Operational Services
MoS	Motorways of the seas
NSW	National Single Window
OASIS	Organization for the Advancement of Structured Information Standards.
OMG™	International computer industry consortium.
P2P	Peer to Peer
PCS	Port Community System
PEP	Port Exit and Exit Profile
PORTBASE	Rotterdam and Amsterdam Port Community System.
PortNet	PortNet system that is used nationwide for vessel traffic in Finland
PSW	Port Single Window
RFID	Radio-frequency identification
SAD	Single Administrative Document.
SAR	Synthetic Aperture Radar/Search and Rescue
SAWSDSL	Semantic Annotations for WSDL and XML Schema Semantic
SCM	Security Capability Maturity Model
SESA	Semantically Enabled Service Oriented Architecture
ShortseaXML	XML message standard for data exchange between parties in the short sea transport chain.
SICIS	Shared Intermodal Container Information System
Single Window	[A single window system enables international (cross-border) traders to submit regulatory documents at a single location and/or single entity.]
SME	Small to Medium Enterprise
SOA	Service Oriented Architecture (SOA)
SOAP	Simple Object Access Protocol.
SPC	Single Point of Contact
SSN	A European vessel traffic monitoring and information system.
STCW	Standards of Training, Certification and Watchkeeping for Seafarers
STD	Single Transport Document

TEN-T	Trans-European Transport Network.
UAV	Underwater Autonomous Vehicle
UDDI	Universal Description, Discovery and Integration (UDDI) repository
UML	Unified Modelling Language.
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
VTM	Vessel Traffic Management
W3C	World Wide Web Consortium.
WCO	World Customs Organisation.
WCO SAFE	WCO Framework of Standards to secure and facilitate global trade.
Wi-Fi	A trademark of the Wi-Fi Alliance.
WiMax	Worldwide Interoperability for Microwave Access.
WSDL	Web Services Description Language
XMI	The standard serialisation of UML models.
XML	Extensible Mark-up Language

Annex 6: Acronyms and Abbreviations related to e-navigation

Acronyms and Abbreviations

AIS	Automatic Identification System
COLREG	Collision Regulation
DGNSS	Differential Global Navigation Satellite Systems
DGPS	Differential Global Positioning System
ECDIS	Electronic Chart Display and Information System
EIS	European Index Server
EMSA	European Maritime Safety Agency
ENC	Electronic Navigational Chart
ESA	European Space Agency
EU LRIT DC	EU LRIT Data Centre
GALILEO	Global Navigation Satellite System (GNSS)
GIS	Geographical Information Systems
GMDSS	Global Maritime Distress and Safety System
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
HAZMAT	Hazardous Materials
IALA	International Association of Lighthouse Authorities
IBS	Integrated Bridge Systems
IDE	International LRIT Data Exchange
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organisation
IMO	International Maritime Organization
INS	Integrated Navigation Systems
ISS	International Space Station
ITU	International Telecommunication Union
JRCC	Joint Rescue Coordination Centre
LORAN	LOng-RAnge Navigation
LRIT	Long Range Identification and Tracking
MCCIS	Maritime Command, Control and Information System
MCTS	Marine Communications and Traffic Services
MMSI	Maritime Mobile Service Identity
MOPS	Minimum Operational Performance Standards
MRS	Mandatory Reporting System or Maritime Reporting System
MS	Member State
MSC	(IMO) Maritime Safety Committee
MSI	Maritime Safety Information
MSSIS	Maritime Safety and Security Information System
NAS	Navigation Assistance Service
RADAR	Radio Detection And Ranging
RCC	Rescue Coordination Centre
RENC	Regional Electronic Chart Co-ordinating Centre
RIS	River Information Service
SAR	Search And Rescue
SRIT	Short Range Identification and Tracking
SSAS	Ship Security Alert System
SSN	SafeSeaNet
STMID	Shore-based Traffic Monitoring and Information Database

TSS	Traffic Separation Scheme
UNCLOS	United Nations Convention on Law of The Sea
VMS	Vessel Monitoring System
VNS	Volumetric Navigation System
V-RMTC	Virtual Regional Maritime Traffic Centre
VTMIS	Vessel Traffic Management and Information Services
VTMS	Vessel Traffic Management System
VTS	Vessel Traffic Services
WWRNS	World Wide Radio-Navigation System