Relationships Between e-Navigation, e-Maritime, e-Shipping and ITS

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Abstract. In the paper the Author try to explain relationships and connections Intelligent Transport Systems (ITS). Thanks to advances in information technology, free communication between ocean and land is now available and all maritime society carry forward the e-Navigation for maritime accident prevention, transport efficiency, energy conservation and marine environment protection purpose. The e-Navigation is an International Maritime Organization (IMO) led concept based on the harmonization of marine navigation systems and supporting shore services driven by user needs and is establishing the free communication between land, offshore and vessel for traffic control, survey activity, maritime traffic facility management, vessel monitoring and navigation without any limit of time and space.

Keywords: e-Navigation · e-Maritime · e-Shipping · Marine navigation · ITS · Safety of sea transportation · Transport telematics

1 The IMO e-Navigation

The IMO e-Navigation is defined as "the harmonized collection, integration, exchange, presentation and analysis of marine information on board 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" [4, 11][1].

It should be noted that the term e-Navigation is often used in a generic sense by equipment manufacturers and service providers. This claim should be seen as an aspiration, rather than an indication of compliance.

The e-Navigation is a concept to support and improve decision-making through maritime information management and it aims to [4]:

- facilitate the safe and secure navigation of vessels by improved traffic management, and through the promotion of better standards for safe navigation;
- improve the protection of the marine and coastal environment from pollution;
- enable higher efficiency and reduced costs in transport and logistics;
- improve contingency response, and search and rescue services;

[1] Since 2006 the Author is a member of IMO's Expert Group on e-Navigation.

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– enhance management and usability of information onboard and ashore to support effective decision making, and to optimize the level of administrative workload for the mariner.

The e-Navigation aims to provide digital information for the benefit of maritime safety, security and protection of the environment, reducing the administrative burden and increasing the efficiency of maritime trade and transport [3].

The work conducted by the IMO during the last years lead to the identification of specific user needs and potential e-Navigation solutions. The e-Navigation Strategy Implementation Plan (SIP), which was approved in 2014, contains a list of tasks required to be conducted in order to address 5 prioritized e-Navigation solutions, namely [14]:

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

It is expected that these tasks, when completed during the period 2015–2020, should provide the industry with harmonized information in order to start designing products and services to meet the e-Navigation solutions.

The ultimate goal of e-Navigation is to integrate ship borne and land based technology on a so far unseen level. e-Navigation is meant to integrate existing and new electronic navigational tools (ship and shore based) into one comprehensive system that will contribute to enhanced navigational safety and security while reducing the workload of the mariner (navigator) [1, 12]. The bridge between those two domains will be broadband communication technology which is about to arrive in regular commercial shipping within the next years to come. The constituting element of this integration is a common maritime data model. The existing concept of the Geospatial Information Registry can be adapted to the enhanced scope of a future Marine Information Registry covering additional maritime domains by expansion, amendment and moderate rearrangement. Though the basic philosophy of the IHO S-100 Registry prevails, virtual barriers for maritime stakeholders to associate with the Registry concept must be lowered by all means. This includes options to adopt existing register structures including identifier systems and stewardship for selected areas and elements of additional maritime domains in contrast to the possibly daunting overall third party ownership for a wide scientific field by potential contributors. Besides the recognized international organizations like, IALA, IMO and IHO who are currently discussing the further steps in e-Navigation, a grass root movement may take place with several stakeholders involved populating the Marine Information Registry. Such a grass root movement would truly demonstrate that e-Navigation has been understood and accepted. To allow for the orderly development of that stage of e-Navigation in accordance with the IMO defined goals and aspirations of e-Navigation, it would be required to activate the appropriate IMO instruments already in place to define elementary principles and structure of the Marine Information Registry, to assign roles and responsibilities amongst international organizations and

stakeholders, and thereby facilitate the main pillar of e-Navigation, its "grout", namely the Common Maritime Data Structure (CDMS) [5] (Fig. 1).

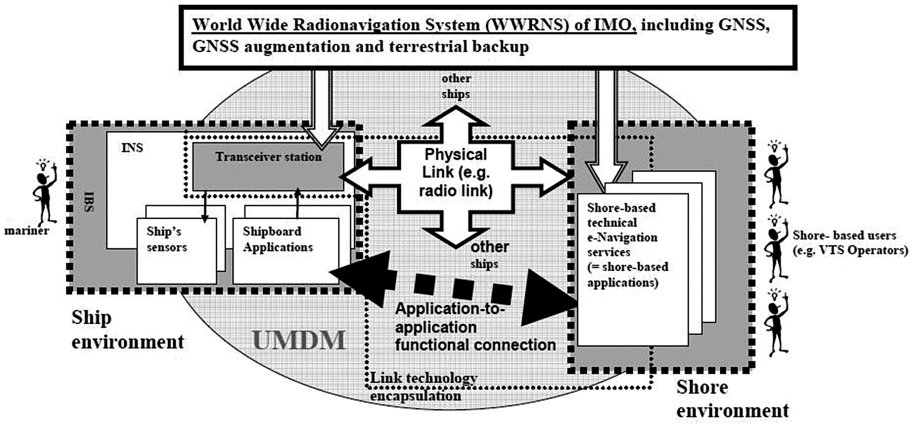

Fig. 1. Conceptual, e-Navigation compliant architecture overview [4, 5, 13]

In e-Navigation it has been decided to develop the Common Maritime Data Structure (CMDS) in the IHO S-100 format. IHO S-100 is based on the ISO 19100 series of geographic information standards. While ISO 19100 is mainly intended for geospatial data, it is believed that S-100 will also be able to handle, e.g., data integration standards such as the IEC 61162-1. The use of GIS (Geographic Information System) has seen unprecedented growth in the last twenty years. With more and more sophisticated, powerful technology becoming cheaper and system memories expanding, which means that we can handle much bigger volumes of data. We can say that GIS is in a golden age. It was once the preserve of the cartographer or surveyor - recently GIS has become a core part of modern sciences and technologies.

2 The EU e-Maritime

Maritime transport is a major economical 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 e-Maritime initiative [9, 11], is seen as a cornerstone for the achievement of the strategic goals of the EU Maritime Transport Strategy 2018 and related policies, recognising the critical role of ICT for productivity and innovation, and anticipating a new era of e-Business solutions, based on integrated ICT systems and tools.

Whereas "e-Maritime" stands for internet based interactions between all the different stakeholders in the maritime sector, 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 should facilitate decision making and information exchange between different stakeholder groups involved in [9, 11]:

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.

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. A specific focus for e-Maritime is increasing the efficiency of compliance to various reporting regulations.

The scope of the EU e-Maritime initiative illustrated in Fig. 2 encompasses the following domains [6, 9, 11]:

1. Improved Administration Domain Applications:
   a. Common Reporting Interface including dynamic integration with Single Windows;
   b. Integrated Maritime Surveillance for cargo and ship movements facilitating EU and national administrations to collaborate in safety, security and environmental risk management;
2. Improved Business Domain Applications:
   a. Improved Shipping Operations;
   b. Improved Port Operations;
   c. Integration into Logistic chains;
   d. Promotion of seafaring profession.

The e-Maritime is aimed at supporting the development of maritime transport in Europe through the development of a framework that will be based on the latest information, communication, and surveillance technologies. In line with the EU transport policy objectives, e-Maritime solutions must offer a complete approach that extends beyond pure transport services addressing logistics, customs, border control, environmental and fishing control operations. The e-Maritime must be considered in its broadest sense as it promises to provide interoperability between all maritime administrative functions, with important applications in commercial activities [6].

Europe's e-Maritime focuses primarily on the shore-based facilitation and on the development of electronic technology, processes and services to facilitate the flow of goods over sea – and consequently the ships that carry these goods – to, from and around Europe. The European Commission intends to develop applications for administrations, ship operations, harbours/ports/terminals, transport logistics and improving life at sea and promoting seagoing [3].

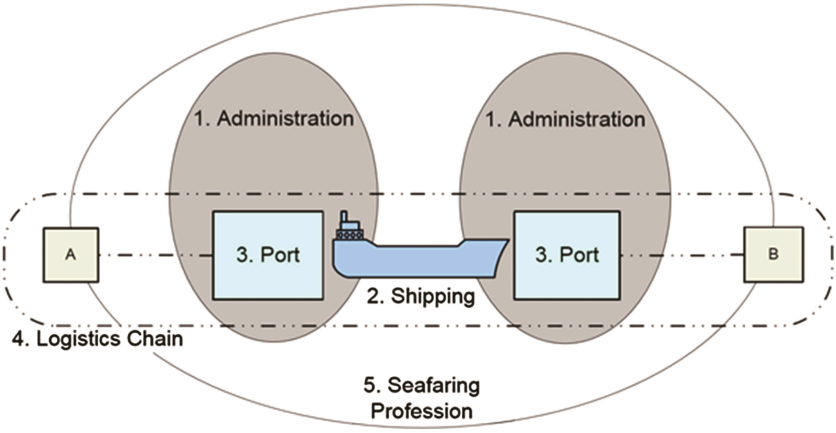

Fig. 2. Integrated view of e-Maritime domains [6]

If the main aim of e-Navigation is to enhance the navigation capabilities of a ship without compromising its efficiency, e-Maritime aims to increase its profitability without compromising its safety. Due to the cooperation of the European partners involved, close coordination had been established between the two initiatives. The EU e-Maritime initiative supported the deployment of e-Navigation services in Europe, while e-Navigation provided a global perspective for the EU initiative. The EU's e-Maritime and IMO's e-Navigation both make use of the same electronic technology, processes and service, and the European Commission wants to make use of those being developed by IMO for e-Navigation wherever possible in the e-Maritime concept development [3].

In summary the e-Maritime initiative aims at optimizing maritime related processes and reducing the administrative work. This will be done by identifying existing practices and regulations and by proposing improvements and simplifications deriving from use of electronic systems and information.

2.1 e-Maritime and ICT

The e-Maritime concept aims at promoting the competitiveness of the European maritime transport sector and a more efficient use of resources through better use of Information and Communication Technology (ICT) tools [2].

The comprehensive use of electronic information and the Internet are changing the world. In maritime transport and transport in general, notifications, declarations, certifications, requests and service orders are increasingly submitted, managed and stored in electronic rather than paper format. Modern ICT systems provide undeniable benefits that are not allowed by paper based information as automated information verification and analysis, processing of data and optimisation routines, easy sharing of information already submitted or stored and so on. However, many of the current processes and regulations, even if electronic, are still based on procedures established for paper transactions decades ago. For example, notifications are still required to be submitted at

certain times, as when using telexes and telefaxes, even if this information has already been received by some other related authorities in a digital format and could be shared [2].

Possible solutions to allow re-use of data already submitted, remove unnecessary reporting obligations and optimise port and ship processes will be discussed in the context of the Digital Transport and Logistic Forum. The Forum, set up by the European Commission, will gather experts, business operators and policy makers in order to identify the needs and prepare for common actions at the EU level for improving freight transport and logistics with more efficient use and reuse of digitalised information currently produced and stored by many different stakeholders. Such actions would aim to improve sharing of information that allows shippers to choose the transport service most suited to their needs, reduce the time and resources absorbed by compliance with administrative requirements and enable transport and logistic service providers to optimise the management of transport assets in real-time, thus facilitating the establishment of environmentally efficient transport and logistic services for all users [2].

2.2 Challenges to Be Addressed by e-Maritime

The following challenges are to be addressed by e-Maritime [6]:

1. The simplification and automation of message exchanges between Maritime Administrations and maritime operators to achieve quantum improvements in maritime safety, security, customs control and environmental protection;
2. The facilitation of commercial transactions in the maritime industry, including the transformation of intermodal networks into efficient open networks with risks distributed amongst operational participants.

The e-Maritime aims to achieve standardisation, security and interoperability of information exchanges between Administrations and maritime operators in Europe. The freeing up of information exchanges arising from e-Maritime will result in a simplification and automation of messages, resulting in real-time digital information becoming available to Maritime Administrations – enabling them to improve their safety, security, customs controls and environmental protection functions. It will also enable them to convey helpful information readily and selectively to maritime operators. Similarly, e-Maritime will reduce the workload on ships' personnel through extensive automation of message exchanges between themselves and administrations.

It is expected that the ICT infrastructure that will be developed to facilitate information exchanges between Maritime Administrations and maritime operators will be available for use by operators to facilitate commercial transactions. The scope for such transactions is virtually limitless. One application would the transformation of intermodal networks into efficient open networks with risks distributed amongst operational participants and without having to incur the major costs of Information and Communication Technology (ICT) infrastructure for each network.

2.3 Objectives of EU Initiative

The EU e-Maritime aims to promote coherent, transparent, efficient and simplified solutions based on advanced information technologies. This would allow reaching the following three policy objectives [2]:

- Improving the safety and security of maritime transport services and assets and environmental protection: Port and ship security and safety increasingly require integrated surveillance, monitoring and control systems, incorporating adequate 'intelligence' for proactive, remedial and cross-border operations;
- Increasing the competitiveness of the EU maritime transport and logistics industry: Improved utilisation of advanced ICT will lead to innovation regarding the quality of shipping services and will facilitate reduction of operational costs and increased competitiveness of the sector. At the same time, the performance of the whole EU transport system can be improved by better integrating waterborne transport into efficient door-to-door transport services in Europe and beyond;
- Reinforcing the human factor: the EU seafaring and maritime professions experience a serious shortage of qualified people. Young people do not go to the sea as they used to. An important factor is the lack of continuing professional education offered to the mariners in a flexible manner at sea and ashore, as well as difficult reconciliation of family life and working life. The e-Maritime solutions can support competence development (improved long-distance training) and improve welfare for seafarers (access to long-distance health services; connectivity with families; etc.).

3 Commonalities

Based on the above mentioned similarities and differences between e-Navigation and e-Maritime concepts, there are some important questions that could be raised by the experts [3]:

- What could be the common synergies and potential benefits for e-Navigation and e-Maritime?
- Should the EU consider adopting e-Navigation solutions at an early stage?
- What support could be given from EU to facilitate the implementation of e-Navigation:
  - using IHO S-100 as the common Data Standard for information exchange?
  - leading the development on automated ship reporting (further develop SafeSeaNet/Single Window)?
  - further development of e-Navigation shore based Maritime Service Portfolio (digital information services to ships such as update of chart, weather, port, safety etc.)?
  - initializing EU Research and Development (R&D) projects on developing viable and functional e-Navigation/e-Maritime models?
  - As the two projects are of similar nature, it is important that close cooperation is maintained between IMO and EU. Both bodies are very important for the benefit

for safety at sea, optimizing maritime related processes and reducing the administrative burden.

4 e-Shipping

The term shipping originally referred to transport by sea, but is extended in American English to refer to transport by land or air (International English: "carriage") as well. "Logistics", a term borrowed from the military environment, is also fashionably used in the same sense.

Nowadays discussion examined some of the factors that influence the regulatory decisions in international shipping and addressed some of the key challenges the shipping industry is facing today in relation to the use of cyber-physical systems on board ships.

We should look at the impact of cyber-physical systems on board ships and how these systems affect navigation, seafarers, safety and security of the vessels. The e-Shipping should be 'user needs led' rather than led by technologists or regulators. Furthermore, it should be added that the success of "e-Navigation" will rely heavily upon the proper involvement of all parties concerned and in particular the seafarers throughout its development and implementation. Additionally, aim of "e-Shipping" is not to replace the seafarers on board vessels, but to assist seafarers in taking more informative decisions thus making the ships safer and more efficient.

Concluding, despite the advanced technological developments, "e-Shipping" has not yet matured and further studies are required especially with regards to maintaining the cyber security which is vital for the ship and the port facilities.

4.1 On-Line Shipping

In the other hand there are quite other meaning for "e-Shipping". The e-Shipping, which is also called "online shipping", is the ordering process of a transport service (usually parcel) made entirely on the Internet. The packing slip is generated instantly online and the collection order of the shipment is sent directly to the shipping department of the carrier. The first companies that have developed this service appeared in the late 1990s in the United States. Since then, the number of e-Shipping offers increased strongly in Anglo-Saxon countries in particular through the development of electronic commerce.

Most major integrators (UPS, DHL, FedEx, TNT) have developed their own e-Shipping tool reserved to their business customers.

The e-Shipping has made possible a new profession, that of the comparison and of intermediation in online delivery of benefits. Several e-Shipping companies (e-Shipping sites) facing small businesses or individuals, and developed rapidly in the late 1990s.

The e-Shipping may apply to all freight services (folds, parcels, heavy or bulky items, pallets, containers) and covers all transport stakeholders (express integrators, postal operators, companies urban race, relay point networks, courier, road freight, air or water etc.).

4.2 e-Freight and Intelligent Transport Systems (ITS)

The European Commission in line with one of the main measures of the 2007 Freight Transport Logistics Action Plan, established a roadmap for the development of an integrated electronic application that is capable of following the movement of goods into, out-of and around the European Union.

This concept 'e-Freight' and will operate within and across all freight transport modes. Through e-Freight there will be a paper-free, electronic flow of information associated with the physical flow of goods. The system will allow tracking of freight along its journey across transport modes and automate the exchange of content-related data for regulatory and commercial purposes. A necessary condition for this is that standard interfaces within the various transport modes are in place and their interoperability across modes is assured.

The implementation of a system for the maritime exchange of information from ship to shore, shore to ship and between all stakeholders, using services such as SafeSeaNet, LRIT (Long-range Identification and Tracking) and AIS (Automatic Identification System), will facilitate safer and more expedient navigation and logistics operations, thereby improving maritime transport's integration with other transport modes.

4.3 e-Customs

While all EU Member States have electronic customs systems, they are not interconnected. The European Commission considers that, if customs legislation were simplified, customs processes and procedures streamlined and IT systems converged, traders would save money and time in their business transactions with customs. In addition to improving safety and security checks, this would contribute to the competitiveness of European business.

The European Commission has adopted two proposals to modernise the EU Customs Code and to introduce an electronic, paper-free customs environment in the EU. The result should be to increase the competitiveness of companies doing business in Europe, reduce compliance costs and improve EU safety and security.

The proposal for a Regulation to modernise the Customs Code would simplify legislation and administration procedures both from the point of view of customs authorities and traders. It would:

- simplify the structure and provide for more coherent terminology, with fewer provisions and simpler rules;
- provide for radical reform of customs import and export procedures to reduce their number and make it easier to keep track of goods;
- rationalise the customs guarantee system; and
- extend the use of single authorisations (whereby an authorisation for a procedure issued by one EU Member State would be valid throughout the Community).

5 Intelligent Transportation Systems (ITS)

Developing an European transport system that is sustainable requires best use to be made of existing infrastructure. Intelligent transport systems (ITS) are vital for this. By integrating technologies for information, communications and control, they enable authorities, operators and individual travellers to make better informed and co-ordinated decisions. For example, ITS can enable more effective planning, help travellers and freight distributors to avoid delays and congestion, and increase the productivity of transport operations. In addition, ITS applications can reduce energy use, accidents and environmental damage.

ITS applications cover all modes of transport and provide a vast range of services:

- in the management of road, rail, air, waterborne and urban traffic, including: advanced information for users; traffic control; incident management; navigation, surveillance and guidance; and vehicle safety and control systems;
- in electronic payment and the enforcement of regulations;
- in the management of public transport, freight movements and other fleet applications;
- in planning and policy-making activities.

Intelligent transport systems are also a key enabler of the integration of different transport modes to provide door-to-door transport services.

Intelligent transportation systems (ITS) are advanced applications which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

The concept of intelligent transportation systems, developed since 80s of the last century includes all modes of transport. Relevant development in road transport is the most advanced. Recently waterborne transport, especially maritime transport (and inland shipping as well) has gained more attention in this regard, in connection with the construction and development of maritime intelligent transport systems [8].

5.1 Maritime Information Technology Standard

This section is dedicated to the distribution of information and resources related to ICT standardization within the area of maritime systems and operations. This is mainly related to ships, ports and authorities' operated infrastructure [7].

e – NAVIGATION, e – MARITIME AND MARITIME ITS = MITS

The e-Navigation is an initiative by IMO to develop a strategic vision for e-Navigation, to integrate existing and new navigational tools, in particular electronic tools, in an all-embracing 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.

The e-Maritime was coined by the European Commission to describe a more extensive initiative. The EU e-Maritime initiative aims to foster the use of advanced information technologies for working and doing business in the maritime transport sector. This will in principle cover all aspects of maritime transport and trade.

The Fig. 3 illustrates the relationship between the two initiatives and it is quite clear that the one is completely enclosed by the other. Also, developments within the ICT work on e-Navigation has further restricted this work to SOLAS related tasks, i.e., only navigational safety and security. This means that, e.g., Single Window technology mostly is out of scope for e-Navigation.

Fig. 3. The relationship between the two initiatives: the IMO's e-Navigation and the EU e-Maritime [7]

Maritime Intelligent Transport Systems [7, 10] is not so well defined, but will for most people be more or less the same as e-Maritime, although on a world-wide level. The MiTS pages will cover what basically is the e-Maritime or Maritime ITS domain.

6 Conclusion

Maritime transport can be said to be the original Intelligent Transport System and developments in this sector should be of interest for ITS research in other modes. A driving force behind this architecture is the international nature of sea transportation and the need to establish standards for information exchanges to further increase efficiency, reduce exhaust gas emissions and fuel consumption and improve the security in the sector. Obviously, reduction of greenhouse gas GHG emissions through operational measures can also reduce costs. This has been realized by the shipping community and the e-Navigation (by International Maritime Organization - IMO) and e-Maritime (by European Union - EU) initiatives testify to this. Both initiatives have identified the information architecture as critical for the future development of the ship transport area. The development of a maritime ITS architecture needs to consider legacy systems, the international nature of shipping, international legislation and standards as well as highly varying quality of service on available communication channels.

Regardless of the body that takes the initiative (IMO, IALA, EU, etc.), all such initiatives like e-Navigation and e-Maritime, that can improve safety at sea are beneficial and should be considered as a desirable.

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