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Sea traffic management: Moving forward the digitalization of maritime traffic flow

L. Calabria[1,2*], J.A. Giménez[1,3], V. Del Río[1,4], G. Ferrús[1,5], J.M. Lara[1,6], N. Alonso[1,7]

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ABSTRACT

Sea Traffic Management Validation (STM) is a co-funded project by the European Commission within the Connecting Europe Facility Programme of the Trans-European Transport Network. STM aims to implement at a wide scale digitisation of maritime transport, enabling efficient and real-time information exchange among relevant agents. Through data exchange among key actors like shipping companies, shore centres and ports, STM is developing an innovative framework based on digital information sharing (maritime routes, voyage plans, port operations timestamps, etc.) which will facilitate the transition of the shipping industry to a more efficient, safe and sustainable transport sector.
STM actions will be tested during the Validation phase of the project by means of the installation of new equipment on 300 ship bridges, 13 European ports and 5 shore centres. This paper comprises a reflection of the key developments of the project, putting them into context with IMO's digitization objectives and associated regulation. The paper also gathers industry's interests related to ship-owners and ports expectations in order to facilitate end-user adoption of the proposed STM services and technological solutions.

1. Introduction.

During the last decade, the development of technologies bound to the collection, processing and information exchange in real time has experienced a revolution, both in terms of capacity and functionalities, as well as in terms of the useful extension of this practice to multiple economic sectors. Along with the increasing corporate usage of the internet since the beginning of this century, the range of technologies, the interoperability between different elements and the rise on connectivity reliability of all kind of devices and platforms, have favoured the emergence of new applications and extraordinary added value services for the competitiveness of organizations.

In this context, the maritime transport sector is not an exception in this evolution and integration of new technologies in their business models. Actually, one of the features of this industry consists on the existence of constant information exchanges between the numerous actors involved in every logistic process. The critical content of those packages of information pinpoints, among others, the requirements on connectivity and interoperability in secure and prompt conditions. Despite the great advances made in this industry, responsible of the carrying of more than the 80% of the goods in the international trade, the challenges and new opportunities for improvement are still huge.

Thus, digitalization is a key factor in the maritime industry evolution, having as an objective the optimization of the

[1]Fundación Valenciaport. Avda. Muelle Turia S/N 46024 Valencia, Comunidad Valenciana (SPAIN)
[2]R&D Project Manager Tel. (+034) 963939400. E-mail Address: lcalabria@fundacion.valenciaport.com
[3]Energy in Ports & Safety Director Tel. (+034) 963939400. E-mail Address: JAGimenez@fundacion.valenciaport.com
[4]General Manager Tel. (+034) 963939400. E-mail Address: vdelrio@fundacion.valenciaport.com
[5]R&D Project Manager Tel. (+034) 963939400. E-mail Address: gferrus@fundacion.valenciaport.com
[6]R&D Project Manager Tel. (+034) 963939400. E-mail Address: jlara@fundacion.valenciaport.com
[7]R&D Project Manager Tel. (+034) 963939400. E-mail Address: nalonso@fundacion.valenciaport.com
[*]Corresponding author: L. Calabria. Tel. Tel. (+034) 663843314.

processes of secure interaction between the network of participants in the logistic chain. On the one hand, undertakings as the called e-maritime in the European domain that work to foster the harmonization of the electronic transmission of information with the aim of placing European maritime sector in the avant-garde of new technologies appliance. On the other hand, international actions as the so-called e-navigation which boost an improvement in safety at seas with the use of digital information.

The aim of this paper is to describe the main characteristics of the concept of "Sea Traffic Management" (STM) which objectives lie in the enhancement of the safety of maritime transport system, the reduction of its related carbon footprint and the empowerment of the European domestic market.

Hereafter the document describes the STM concept; in section two, a context setting of the Technological Situation in the Maritime-Port Industry is analysed, section three is devoted to identify the potentials for the maritime domain, the fourth section explains the concepts and services developed in STM as invigorators of the sector. Section five deals with the restrictive factors for the development of STM and the conclusions drawn are described in the last section.

2. Context of the Technological Situation in the Maritime-Port Industry.

Currently, the maritime transport sector is facing significant challenges that might have a great impact in the management and the infrastructures field: the increase in the capacity of vessels, the unbalance between commercial flows between the different geographical areas of producer and consumer countries respectively, the strategic alliances within the ship-owners, the opening of new commercial routes, etc. These and other factors shape a sector in constant evolution, which makes it necessary to articulate tools that permit the enhance in efficiency at the same time that guarantees safety and environmental protection. With this purpose various international authorities have activated numerous programs and initiatives addressed to foster innovation in the maritime industry in order to facilitate its competitiveness against the other modes of transport.

This is the case of initiatives as the so-called e-navigation, which frames STM and its predecessors' projects Monalisa and Monalisa 2.0. The leading head of this action is the International Maritime Organization (IMO) and it is supported by the following organizations: International Hydrographic Organization (IHO), International Committee Radio-Maritime (CIRM), International Association of Lighthouse Authorities (IALA), International Chamber of Shipping (ICS), Baltic and International Maritime Council (BIMCO) y International Electro technical Commission (IEC). The involvement of this type of institutions reflects the general interest on these matters and hints on the needs that must be resolved.

Spotlighting other innovative sectors as the automobile, it becomes evident the great impact of the technological transformation which is oriented to the improvement of the user experience. In this sense, the companies have found in mobile devices a perfect ally to provide new solutions faster to their clients and more profitable for their business models. The connectivity of cars by means of the software in mobile phones lead to the introduction of innumerable functions and applications at the moment they synchronize. Both the growth of use and the enhanced communications using protocols such as the future 5G, opens up countless possibilities to all the industries. These advancements are leading to a new reality: intelligent and even autonomous vehicles.

The possibility of monitoring every single movement happening in an industrial ecosystem through a network of sensors and the accurate utilization of the information that they provide can contribute significantly to improving aspects such as energy efficiency or safety in certain facilities such as ships, ports, port terminals, etc.

Consequently, ICT appliance to maritime transport is becoming increasingly relevant for the integration of the extent of available systems in the ship and their connectivity to the nearest ships in a way that there could be an improvement in situational awareness and a better coordination between them. Besides, the possibility of transmitting information from the ship to the shore side actors is also growing in importance, allowing to an enhancement in the capacity of fleet management, predictability and planning of port operations and, as a result, a better prediction on the time delivery of the goods transported.

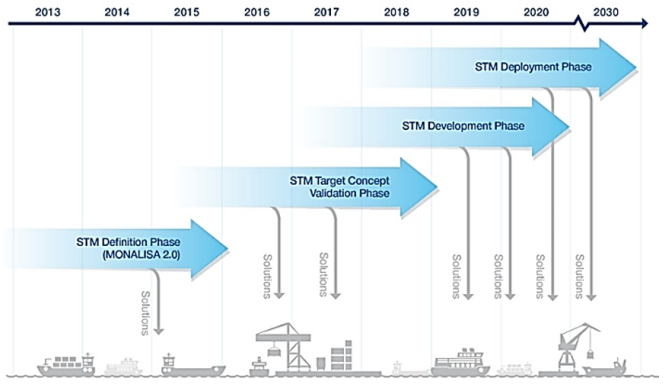
The usage of these technologies result in the production of a great volume of data (billions of messages exchanged and electronic transactions) which carries out a more complex management of that information. In this case, new techniques in data treatment as the developed under the concept of "Big Data" are taking hold in the sector with the aim of extracting value of that information from real-time monitoring of processes, pattern detection or the instantaneous correction of deviations, adapting then the actual business models wisely.

3. Identification of the potentials for the maritime domain.

In view of the range of possibilities offered by new technologies and the evolution of the needs of the maritime industry, the necessity of a system for maritime traffic management becomes palpable. Thereby, in the predecessor project Monalisa 2.0. the concept was defined and a development and deployment plan was drawn, which is presently in the validation phase.

STM suggests an interconnected and digitalized environment between transport agents, ashore and offshore. By means of refining the different concepts defined, in the next phase the aim is to develop the methods to facilitate the coordination and synchronization of the movement of each key piece of the maritime transport system, enhancing the common situational awareness in a way that inefficiencies will be reduced and the safety in navigation and in port operations will be significantly increased. These developments will be tested during the validation phase by the installation of devices in 300 ship bridges, 13 ports and 5 shore centres, which will facilitate the introduction of new technologies and services without changing operational procedures in a first term and with a minimum cost for the shipowners.

Figure 1: STM Implementation Plan.



Source: STM Validation Project.

The availability of devices allowing a common situational awareness to all agents in real time, will not only reduce the waiting times because of the improvement on response-time management but will also increase safety thanks to the improvement of the common situational awareness while reducing the number of incidents and accidents, as well as the efficiency in operational tasks. All in all, a global improvement for the maritime industry can be deduced in terms of cost saving, environmental impact reduction and lives saved.

4. STM Concept and Services as sector?s driving force

Sea Traffic Management is the concept of sharing and using all data from the maritime space in real time, in order to improve safety, environmental performance and efficiency in the maritime transport chain.

STM concept becomes a reality through a set of standards and services that facilitate the information exchange among authorised users in a secured way, in real time. This is endorsed by the setting of a common framework that confers standards for the exchange of information and access management to a set of interoperable services.

In this sense, the operational concepts where the services are merged are the following:

Strategic Voyage Management (SVM) envisions the planning of a complete sea voyage, beginning with an idea that evolves and incorporates various actors connected together through a unique and agreed-on voyage plan. The overall objective of SVM is to optimise the initial planning phase of a sea voyage by enabling a collective and up-to-date awareness of all influencing factors related to the undertaking and success of the planned voyage.

Dynamic Voyage Management (DVM) connects ships, adds intelligent processes, and new tools. DVM provides ship operators with an up-to-date and dynamic flow of information to improve ship efficiency and safety and reduce their environmental impact enabling all authorised stakeholders to be involved with a voyage. This provides a much faster, more secure and transparent way of exchanging information that will optimise the execution of a voyage.

Flow Management (FM) goal is to improve the overall flow of sea traffic through better information and coordination, not control. It leaves all ship decisions with the master and enhances decision-making with information and advice about traffic and safety.

Port CDM is a way of establishing not only a common view of all available information, but also of using this information as a tool to create a common situational awareness and support the involved actors in making efficient collective decisions. This will result in better planning of arrival and departure times and in the improvement of port interaction with the ships in order to optimise the port call.

SeaSWIM (System Wide Information Management) is the Maritime Service Infrastructure that enables the secure environment for information exchange. This includes, on a conceptual level, to define design criteria for technical solutions and application services for interoperable information sharing and service provision for STM.

It is of outmost importance to clarify that SeaSWIM will not be used for information storage but as the liaison between the services, including the information contained and the technical resources to fulfil the objectives. The services developed in the framework of the project can be classified in three big areas:

4.1. Enablers of Secure Information Exchange Services:

SeaSWIM Connector: The functionality of the SeaSWIM Connector is to simplify the connection with SeaSWIM services, i.e. Service and Identity Registry. As it provides a standardised interface to the SeaSWIM services, it hides the complexity of interacting and complying with SeaSWIM principles. The Connector is the “single contact point” for the STM services. Behind the connector, the Maritime Service Infrastructure consists of two central components:

Service Registry: The service registry improves the visibility and accessibility of available maritime information and services. This enables service providers, consumers, and regulatory authorities to share a common view on service standards and provisioned services. can be seen as a sophisticated yellow page phone book or the equivalent of an App Store on iPhone and Google Play for Android. The aim is to easily register, discover and use all relevant maritime services.

Identity Registry: The Registry contains relevant information for authorised stakeholders and enables confidentiality in information transfer processes. All services depend on unique identifiers that define specific users, services and transmitted data objects to avoid conflicts and to provide unambiguous references.

4.2. Services for the improvement of navigational operations:

Sharing of Voyage Plan: consisting on the route Exchange from a ship to whatever ship, port, service provider or shore centre. The ship’s voyage is identified by the so-called Unique Voyage ID (UVID) which will only be shared with the authorized agents nominated by the shipping company.

Route Optimisation: The route optimisation tools will be different in nature with a common purpose to provide more information for the navigator on board. The STM concept will

provide the means to get the ships route optimised from different service providers. The service providers have different focus including best route regarding; the weather forecast, surface currents, fuel consumption, no-go areas regarding draft, areas with sensitive nature, conflicts with other ships routes etc.

Route Exchange Ship-Ship: Introducing route exchange ship-ship, will give the intentions of other ships. The route exchange will solely introduce a new tool which helps the OOW to plan ahead, foresee possible dangerous situations and reduce route detours due to traffic conditions. Nothing in the current "navigational process" will be changed, the master is still responsible and COLREGs are always in force. The route exchange should be used to avoid close quarter situations.

Route Cross-Check: The intended voyage plan is sent to a shore based service provider for cross-checking. The purpose is to include updated regional area information that could affect ships voyage plan. The cross-checking can be done before the vessels departure or before arrival at a certain geographical area. The cross-check can include, but is not limited to, Under Keel Clearance (UKC), air draught, no violation of no-go areas, MSI and compliance with mandatory routeing. No optimization service as such is included in the route validation.

Enhanced Monitoring: Enhanced monitoring will be supported by adding route information and a more detailed service than present VTS can be provided; shore centres will be able to detect if planned schedule is not kept or if ship deviates from planned route. Thus shore centres can monitor that ships are following their planned route and also foresee possible dangerous situations and suggest route modifications (geographic and/or speed) due to traffic or other impeding conditions.

Winter Navigation: Information regarding best route, waiting positions, preparations for assistance, position in convoy, time for departures from port is important for the Icebreaking services. The information should preferably be transmitted directly to ships navigation system. Introducing route exchange will give both Icebreaker services and assisted ships better information in more automated procedures reducing workload and risk for misunderstandings.

Search and Rescue (SAR) Services: Introducing STM in SAR services will greatly improve Maritime Rescue Coordination Centres (MRCC) overview and possibility to control SAR-units in search operations. The MRCC will be able to send areas and routes to SAR-units, which will be directly visible in the electronic charts on-board.

Importing Pilot Routes: By importing and merging the port approach routes when planning the ship´s route, re-planning is avoided. It also means that the bridge officers and pilots will have a shared mental model of the voyage during the piloting stages of the voyage. The service is currently available for all Swedish ports.

4.3. Services for the enhanced port operations:

Port Call Synchronization: To make sure that the ship does not arrive before the port is ready, the ship and the port Exchanges Estimates in order to find the first available time when all resources to handle the port call are available. This is made as early as possible to let the ship adjust the speed and possibly saving fuel. The ultimate goal is just-in-time arrivals, and thus remove the need for anchoring.

Port Call Optimization: The key actors within a port call make their plans transparent to the others. Transparency automatically leads to efficiency in the whole process chain. By sharing towards the surrounding, the port actors increase predictability and create just-in-time processes. This will lead to improved resource utilization for all involved port actors.

5. Constraining Factors.

Sea Traffic Management is inspired on the previous development of Air Traffic Management; however, maritime environment differs significantly to airborne in many aspects; on the one hand, aviation is more flexible when it comes to regulating certain issues; for example, an airplane will be able to increase considerably its speed in case of delay, reaching its destination on time while for a ship it would be nearly impossible due to diverse limiting factors: speed range is reduced, reaction time is longer and meteorological conditions are insurmountable most of the times. Furthermore, airborne space management counts on three spatial dimensions whereas maritime space has only two in order to make route adjustments.

Regarding legal constraints, air traffic control regulation was planned taking into account the future implementation of a traffic management system so the acceptance barriers were minors. However, in maritime regulation there is no provision for such a system; the responsibility and decision-making during navigation revert on the masters. Nonetheless, given the series of constraints on which masters base their decisions at present, STM could result in a good solution.

As in many areas, regulation in maritime industry has been overwhelmed by the rapid evolution of technology. The time for standardization and approval in any change of schema comes along with prolonged deadlines in the case of procedures with high political component that usually take from five to eight years. The pace of technological evolution and the opportunities arisen is much superior to the regulation processes, which means that the services developers must design the most of the times on the base of obsolete architectures.

This means entering a negative circle that hampers to take advantage of potential opportunities. For this reason, the collaborative development and deployment of the services associated with STM would be a great investment opportunity for the shipping companies that could benefit from its advantages, services, data analysis and optimization tools for their ships.

As a matter of fact, in order to help improving the operational costs of shipping companies, IMO decided to launch the e-Navigation initiative using the existing systems in ship bridges as the called Automatic Identification System (AIS) and the Electronic Chart Display and Information System (ECDIS); however, these are systems which architectures are not designed to being able to communicate with others and this is why STM is providing the development of their evolution to make them interoperable.

Conclusions.

Once exposed the potential of the developments that are being carried out in the project and taking into account the limitations faced, STM Validation will serve as a means to demonstrate the benefits that would be obtained from the implementation of maritime traffic management system and to foresee the potential impact that it would have if it was implemented globally.

For this reason, STM's communication infrastructures are being developed in the most flexible possible way, taking into account the needs of both major players and solution designers, creating interoperable systems that are easily adaptable and can achieve the desired connectivity in future developments.

It is also clear that the key task in this project is to resolve the legal obstacles posed by maritime regulation today. To this end, several consultative groups have been set up within the project, hosting experts from different institutions. These experts will advise on the feasibility of technical, operational, regulatory, etc. aspects, serving as a basis for possible regulatory modifications.

Similarly, it will be vitally important to establish good relations with the shipping companies, being these the end-users and those who will determine whether STM will have a positive impact on the competitiveness of their ships while improving the quality of life of their workers.

The STM Validation project will be completed in December 2018 and will bring results that can lead to the refinement of the concept. Although the development of a future global maritime traffic system goes undoubtedly in parallel with STM, it is a long-term journey, with a countless list of issues to be resolved. As seafarers say: "If you go sailing, don't get tired while preparing".

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