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ARTICLE

Global maritime surveillance and oceanic vessel traffic services: towards the e-navigation

F. Xavier Martínez de Osés[1] · Àfrica Uyà Juncadella[1]

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Abstract
Vessel traffic services (VTS) operators can control the movements of ships in local coastal areas, and also have the technological ability to track vessels internationally, since all merchant vessels are currently equipped with global tracking systems. Digital information processing and satellite communications are powerful tools that the maritime sector is eager to take advantage of in relation to safety, environmental protection and efficiency. This paper reviews current regulations and infrastructures within the VTS and the main European Union (EU) projects that have utilized the potential of the digital era and satellite technology. Through assessment of future trends, it also proposes, for the first time, that there will be the need for a new approach to global maritime traffic services, in view of anticipated issues in future developments within this sector. This approach will consider the creation of an oceanic vessel traffic services, where all personnel would exchange information, without state borders, between ships and onshore centres worldwide. This also raises the issues of how a new technological paradigm will fare against ancient barriers of legislative scope.

Keywords E-Navigation · Vessel traffic services · AIS · Satellite

1 Introduction

When the port of Liverpool set up a radar station in 1948, in order to facilitate the boarding of pilots from the cutter, it became the pioneer of European VTS. Some years later, Long Beach and Le Havre established similar systems that combined a radar and VHF to facilitate port operations and, gradually, other ports followed them (Hughes

✉ F. Xavier Martínez de Osés
fmartinez@cen.upc.edu

Àfrica Uyà Juncadella
africa.uya@upc.edu

[1] Faculty of Nautical Studies of Barcelona, Universitat Politècnica de Catalunya, Barcelona, Spain

1998). That way, a traffic surveillance system was achieved, one that allowed the real-time information exchange between ships and the shore. However, maritime traffic surveillance systems did not gain international recognition from the International Maritime Organization (IMO) until 1985, with the publication of an IMO resolution; the term "vessel traffic services" (VTS) was then adopted by the IMO to describe *the range of systems operated by coastal states over specified areas of sea adjacent to their ports or coasts under which ship traffic is subject to the supply or exchange of information or the giving of advice or, possibly, of instructions by coastal stations with a view to enhancing the safety and efficiency of that traffic.*

Governments monitoring marine traffic in congested areas have implemented vessel traffic services; by keeping track of vessels movements, they ensure navigational safety in a limited geographical area. Within the EU, Member State authorities are required to ensure vessels use VTS in compliance with the regulations in force; its relevance has been stated in literature by different authors (Bootsma and Polderman 1987; Ustaoglu and Furusho 2002).

European regulations also require the use of an automatic identification system (AIS) when in this areas, which is used by the authorities to compile a traffic scheme used in the decision-making process of managing marine traffic in the whole area (Chen 2014).

Although through development of new technical systems and its implementation into shipping offers support and improves the safety of navigation, a new trend can be noticed. New systems have to be integrated into the existing ones to offer a wide range of new possibilities; the most important initiative dedicated to these aspects is the e-Navigation initiative (Baldauf et al. 2011).

This paper has been based on one of the most well-known projects on these topics, the Sea Traffic Management (STM), which pertains directly to the provision of vessel traffic services. As part of a proposal submission and to better understand the evolution and trend of the VTS, three methodological phases have been established in the contexts of time: past, present and future.

The remainder of this paper is organized as follows: Sect. 2 begins with the IMO and its recognition of the VTS concept, while Sect. 3 outlines new tools that currently allow a greater control of maritime traffic and which procedures and agreements have been established to coordinate these tools at European level. In Sect. 4, the future trend is analysed, considering how the digital era is incorporated extensively within the maritime sector, opening new scenarios for global maritime navigation; any new system must address an uptake of new technologies within the entire sector and needs to include VTS centres. Sect. 5 proposes a new concept to address the issues that will affect these centres soon. Finally, in Sect. 6, the conclusions will provide reasons for this new concept.

2 Background of the VTS system

Even when VTS were internationally recognized in 1985, the first official recognition of the information exchange system between ships and shore authorities by the IMO did not happen until 1968. At the time, the Inter-Governmental Maritime Consultative Organization (IMCO) adopted, through the Assembly of the Maritime Safety

Committee, the Resolution A.158 (ES. IV) and this recommendation was received by ports as a valuable contribution to port safety and its approaches. In this sense, it promoted two points addressed to governments in favour of safety: one, which is particularly relevant for oil terminals or dangerous goods, and the second being, the use of the, estimated time of arrival (ETA), which also helps to manage the arrival of ships. The birth of the principles that have been maintained to support the VTS services can be seen: to contribute to safety, increase efficiency and protect the marine environment.

The IMO Resolution A.578(14) adopted on 20 November 1985, in terms of the Guide, was a definitive stage for the vessel traffic services, where the need for ships to report ashore was highlighted when approaching a port and within territorial waters: in narrow channels, in areas of heavy traffic, when dangerous goods are involved or in sensitive areas. In general, operational procedures and VTS planning were outlined. Eight years later, the first edition of the VTS Manual came from the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) in 1993.

The last direct resolution of the IMO was in 1997, 12 years later, when the Guidelines for VTS version were revoked through the Resolution A.857(20), two annexes were added, some technical criteria on VTS, and addressed, for the first time, the hiring procedures, necessary qualifications and training of the personnel that operates within the VTS centres. However, it is an established fact that the last definition of VTS system continues in force from 1997, so a hiatus of 22 years has more than justified its urgent review. And this was recognized by the IALA in 2017 in the 43rd Session of the VTS Committee, which prepared a draft already sent to the IMO Council but is in the approval phase.

The VTS system according to the guide of the 1997 IMO[1] Annex 1, point 1.1.1 was defined as "a service implemented by a Competent Authority, designed to improve the safety and efficiency of vessel traffic and to protect the environment. The service should have the capability to interact with the traffic and to respond to traffic situations developing in the VTS area". And in its point 1.1.4 define: "VTS area: the delineated, formally declared service area of the VTS. A VTS area may be subdivided in sub-areas or sectors", depending on factors such as traffic density, traffic patterns, type of service requirements and surveillance.

In Chapter 4 of the VTS manual of the IALA and according to the same Resolution of the IMO A.857(20), two types of VTS are described: (i) Coastal VTS: control of maritime traffic in a determined area. This includes traffic in Traffic Separation Scheme (TSS), regulated by the IMO. It can be found in Spain, for example, as the Finisterre VTS, which controls the Finisterre TSS. (ii) Port VTS: Mainly dedicated to port entry and departures. It may be the case that the same VTS centre exercises Coastal and Port control.

Governments need to encourage masters of ships navigating in areas for which VTS are provided to make use of such services, but not encroach upon the master's responsibility for safe navigation, perhaps because when the COLREG was written in 1972 (IMO 1972), the VTS system had not yet been standardized (1985). So, the COLREG does not contemplate any interaction with a VTS (García Fernández et al. 2004). However, the need for a VTS system, although it has had different stages in history, is unquestionable today and its purpose is to contribute inter alia to marine safety, life at sea, the efficiency of navigation and the protection of the environment, the

[1] IMO (1997) - Resolution A.857(20).

International Convention for the Safety of Life at Sea (SOLAS) Chapter V, Regulation 12 since 1997 (IMO 2004).

Only the radio and the handling of the radar are contemplated in the profession of VTS; nonetheless, with the obligatory use of the AIS on board vessels, it is also observed as an essential tool for the control of the traffic from shore. Certainly, VTS did not undergo any substantial change until the automatic identification system (AIS) equipment appeared.

It is recognized by the Resolution MSC.74(69) adopted on 12 May 1998 Annex 3: Recommendation on performance standards for a universal shipborne automatic identification system, that the AIS should improve the safety of navigation, aiding the efficient navigation of ships, the protection of the environment and the operation of vessel traffic services (VTS). AIS was defined as a VTS tool, that is, from ship to shore for traffic management. Its invention and implementation on board ships have allowed for a large-scale ground-based view of merchant shipping in real time, and this enormously helpful tool has become essential for VTS centres.

3 Present tools for large-scale maritime traffic control

In 1999, after the motor tanker ERIKA accident in front of the French coast, in which 30,000 tonnes of fuel were spilled, the European Union adopted some directives aimed at preventing accidents at sea and consequent marine pollution. One of them was Directive 2002/59, (EC 2002), to establish a community system of monitoring and information of maritime traffic in order to improve the safety and effectiveness of such traffic. It included recommendations for a better response by governments to incidents, accidents or potentially dangerous situations at sea, and specifically search and rescue operations, but also demanded an increase in the prevention and detection of pollution by ships.

At the same time, the EMSA was being established through Regulation (EC) No. 1406/2002 of June 27, 2002, and, as soon as it began operating in 2003, it was granted the responsibility for establishing and operating a new maritime monitoring and traffic system; This is how SafeSeaNet (SSN) was born.

The process for the creation of SafeSeaNet began in 2004 based on the short-range AIS transponders, designed to provide information about a ship to other ships or ground stations automatically. However, its evolution was waiting for the end that year, when the AIS would be mandatory for vessels.[2] Over several stages, from 2004 to 2009, this system was installed, enabling Member States to exchange information through the AIS, including sharing incident reports and other data such as cargo or estimated times of arrivals to port.

In 2006, the AIS entered a global dimension, thanks to the long-range identification and tracking (LRIT). The AIS, which combines the reception of data by VHF/HF radio antennas and satellite signals and, concurrently, the IMO made amendments to the SOLAS V 19.1 Convention (EMSA 2007), via MSC 202 (81), urging authorized Centres to promptly put in place the Resolution MSC.211 (81) adopted on 19

[2] As follows on SOLAS Chapter V: Safety of navigation, Regulation 19 Carriage requirements for shipborne navigational systems and equipment. 2.4 p. 370.

May 2006. Annex 14: Arrangements for the timely establishment of the long-range identification and tracking system, within a timeframe of 2 years.

The EU was inclined towards having its own independent service covering all its territories. To give legal status to international agreements at a Community level, the Treaty of Lisbon (2007/C306/01) was signed in December 2007. Two space programs were developed: GALILEO, focused on Search and Rescue (SAR), and COPERNICUS[3], divided into six services, one of which would be directly related to maritime safety, including the tracking of objects at sea, the tracking of incidents and accidents and the location and identification of vessels.

In 2010, a great advance was made with the development of the graphic interface. The AIS information could be displayed on a map, geographic information system (GIS), as an electronic nautical chart, offering a quick description of a large part of maritime activity in real time. Its benefits included the ability to zoom from the EU level to specific quays within a port, to visualize the historical positions of vessels and obtain information at different levels among the Member States.

This terrestrial control network, which was gestated at sea level, based on the AIS, is complemented at a spatial level with the development of satellite systems. The creation of LRIT, became part of the global long-distance identification and tracking system for ships, under the coordination of the IMO. The system was initially created for maritime safety purposes but was soon expanded for use in areas such as search and rescue (SAR) and protection of the marine environment. Ships send automatic position reports every 6 h, which are received by Inmarsat or Iridium type satellites, and are transferred securely to the data centres managing the LRIT information on behalf of the flag States. The Maritime Safety Committee (MSC) of the IMO makes political and technical decisions about the LRIT system at the international level, where it has given its coordination to the International Mobile Satellite Organization of (IMSO). However, at European level EMSA would become the International Data Exchange (IDE) operator, the message routing distributor between Data Centre (CDs), which collect, store and supply information from users around the world through an internet-based network.

The LRIT is a bi-directional monitoring and communications system only for government agencies and their representatives, which locates ships and exchanges information as a closed loop. As this information is not visible among nearby vessels, it is not considered an aid to navigation, but it is considered a useful tool from the shore, hence the importance of VTS centres being recognized users and having access to information.

The AIS is a unidirectional monitoring system that transmits information via VHF broadband, visible by all nearby vessels, so it is considered an aid to navigation. It was in December 2000, with the maturity of the AIS system, that the revision of Chapter V of SOLAS began to include new requirements related to the incorporation of the AIS equipment on board and, with the establishment of Regulation 19, set out the different periods of adoption according to specific tonnage. The equipment became incrementally mandatory, with deadlines ranging from the end of 2004 until 2008, according to the SOLAS Chapter V, prescriptions, applicable to on-board equipment.

However, it began to develop around the same time as the consolidation of LRIT, 2007, the satellite AIS, an AIS operated by commercial platforms aimed at different

[3] Previously known as GMES (Global Monitoring for Environment and Security), is the European Program for the establishment of a European capacity for Earth Observation and Monitoring.

users but with the same purpose, to expand the coverage of location and identification of a vessel at sea. Gradually different countries were launching their low-orbit satellites to achieve greater coverage and avoid gaps. The development was such that the International Telecommunication Union (ITU) allocated two VHF channels.

Ships can be registered sailing around the earth, and this trend is increasing not only due to the increase of the world fleet (UNCTAD 2017), but also because of the increasingly extensive use of the AIS equipment on board different vessels other than merchant ships, thus providing an increase on the safety of navigation levels.

The world fleet from 2005 to 2018 (EMSA 2018), considering total number of ships, by type and size, from less than 500 GT until up to more than 60,000 GT provide a graph of the world's fleet derived from data contained in the statistics from Equasis database[4]:

Figure 1 does not show that the world fleet is growing, but it does show that the registration and control of ships are increasing. Equasis provides data from most of the world's merchant ships.

Currently, we can search the global traffic of ships that shows AIS signal and obtain an image of the maritime density. This information is obtained through the internet in real time and free by consulting the pages of MarineTraffic, as an example, that was launched in 2007. But if we go further, Member States through the SSN of the EMSA can obtain various data both AIS and LRIT in real time and also historical data. To illustrate this, an image of the density of traffic in Europe in 1 year has been selected. Figure 2 shows that 31,783 ships were monitored during the year 2019, in the Mediterranean and the colour scale corresponds to the traffic density. The overlapping black marks are the real-time traffic since it was accessed. The general cargo ship Holandia arrived at Tarragona port on October 14, 2020. This image was unthinkable 10 years ago.

It can be recapitulated that there are clear examples of willingness to monitor and visualize maritime traffic worldwide. With the development of computer science, IMO was sensible enough to perceive that these advances that were taking place on land should also occur at sea. The Strategic Plan of the Organization for the period 2008–2013 (Resolution A.989(25) adopted on 20 November 2007), recognized that technological developments had created new opportunities.

The Implementation Plan of the Electronic Navigation Strategy (SIP) was approved in November 2014 through the MSC 94th Session, 17–21 and contained a list of tasks necessary to address five electronic navigation solutions. The so-called e-Navigation, namely: improved bridge design, standardized and automated reporting, integrity of bridge equipment and navigation information, presentation of available information in graphical displays and improved communication of VTS service portfolios. These tasks for reforms were scheduled to be completed by 2019, contributing to harmonized information of the maritime industry. Well-designed on-board systems and close cooperation with land-based management tools and mechanisms would help make maritime navigation and communications safer and more reliable, while increasing transparency and accessibility to information.

[4] This report provides a picture of the worlds merchant fleet derived from data contained in the Equasis database. Ship types are general cargo, specialized cargo, Ro-Ro, bulk carriers, oil and chemical tankers, gas and tankers, passenger ships, offshore vessels, service ships and tugs.

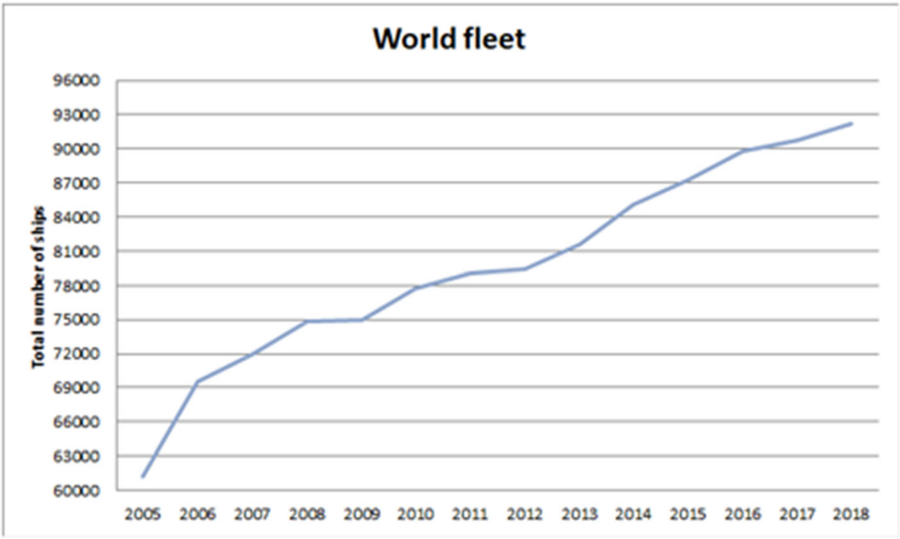

Fig. 1 World fleet. Source: authors from EMSA annual report published per years from 2005 to 2018

The first International Conference on e-Navigation was organized under the auspices of the IALA and the Danish Maritime Authority in 2011 (IALA 2017), in close cooperation with the concerned maritime administrations of the IMO Member States and international organizations. Since then, other conferences and workshops have been held annually in different places to continue the advances in electronic navigation and increase the participation of more countries, but e-Navigation has not yet brought any specific device or apparatus but simply an idea in general of the need to standardize procedures and exchange information using satellite and digital internet technology.

4 Towards e-Navigation: identifying the global VTS

In 2006 the IMO approved the proposal of seven Member States[5] (IALA 2018) to develop an e-Navigation strategy understood not as an electronic navigation, but as the harmonization of information in electronic format in bridge equipment, nautical charts, electronic aids, communications and onshore infrastructure. Analysed this need in a broader e-maritime spectrum (Graff 2009).

E-Navigation is defined as: "harmonised collection, integration, exchange, presentation and analysis of maritime information on-board and onshore by electronic means to enhance berth-to-berth navigation and related services, for safety and security at sea and protection of the marine environment", according to the first formal definition registered by the IMO in 2008, MSC.85/26/Add.1 Annex 20. Strategy for development and implementation of e-Navigation. Since 2008, e-Navigation has been considered the future. However, its implementation is far from simple as the Secretary General of the

[5] Described on the Navguide 2018 8th edition. IALA. Chapter 4. E-Navigation. Page 67.
[0] Keynote address by Kitack Lim, Secretary-General of IMO at e-Navigation Underway conference on 2nd February 2016.

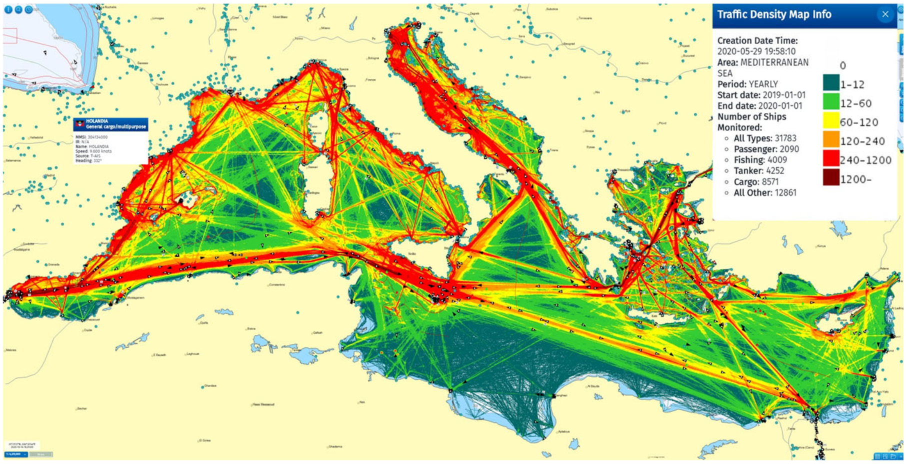

Fig. 2 Arrival of a ship in Tarragona port, tracked by LRIT and overlay of information from traffic density maps during the yearly period from 01/01/2019 to 01/01/2020. Source: SafeSeaNet Ecosystem GUI by Maritime Rescue Co-ordination Centre (MRCC) Tarragona, Spain

IMO (Lim 2016) recognized it in 2016[6]; even now, 8 years later in 2019, e-Navigation remains on the horizon.

The IMO (2019) is the only institution identified to define the technical, operational and legalities necessary to define and enforce the general framework for the implementation of electronic navigation. The development of e-Navigation is a collective task among stakeholders in the maritime sector, but the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and the International Hydrographic Organization (IHO) are essential. There are interested parties in each country that must submit their proposals, not only the government representatives but also commercial agents, ports, members of the marine business chain, universities, equipment manufacturers and marine software technology.

At European level, with the projects subsidized or co-financed by the EU, different protocols based on proposals related to e-Navigation have been developed to address these five goals. Among these, there is the possibility of creating a wide navigation area where vessels and VTS can share tactical information and navigation planning.

In this sense, the Sea Traffic Management, STM, is undoubtedly the most important for its size and permanence over time. It was born in 2010 under the name of "Motorways and electronic navigation by intelligence at sea" (MONALISA), developed by the Swedish Maritime Administration and supported by the European Commission for 2 years. It sought to define a set of systems and procedures to guide and monitor maritime traffic in a manner like the management of air traffic. In the past, air traffic services have been compared with vessel traffic services in numerous interesting articles, including Proctor (1973) and Bootsma and Polderman (1987).

This evolved into MONALISA 2.0 until 2015, which was joined by other EU countries. In 2016, the MONALISA project continued until the end of 2018, but was renamed Sea Traffic Management (STM). The STM started with a phase called "Definition", and then it was assigned the "Validation Project" phase, within the conclusive time space in 2018. Its future projection envisages two different stages, the Development, and the final Deployment, with a view to completion in 2030. The project harbours expectations that, in the next 12 years, the STM will be in service in the maritime sector. However, EU co-financing plans have neglected the project; even in 2019, no budget item has gone directly to the STM project a part of a 6-month extension,[7] (STM 2018). But the Baltic sector continues to join forces to carry out this plan, seeking the complicity of companies, ship-owners, agents of the maritime sector and different authorities.

STM seeks to create an organized traffic management entity tracking all ships at sea using the AIS signal and therefore on the digital cartography, the Electronic Chart Display and Information System (ECDIS) on which the targets are presented and radar to monitor the distribution of ship routes from port to port, on the basis that, knowing the route plans of the ships onshore, alternative routes could be suggested (STM Midterm 2017). In addition, the optimization of the flow of traffic, port call synchronization, could contribute economically and ecologically to lower fuel consumption and reduction of greenhouse gas emissions (FNB-UPC 2017).

Route Exchange allows share parameters such as meteorological conditions, risks of collision, forecast of zones with heavy traffic, avoidance of navigation hazards and even contemplation of the possibility of remote assistance, if requested by a captain. Voyage plan route exchange is also considered an advantage for ships in navigation that can know the routes of those around them (Velasquez Correa et al. 2018), Route Cross-check. Thus, the STM is a concept that starts from that global visualization of maritime traffic, and therefore is clearly considered as a VTS tool but on a larger scale.

Other projects have coexisted to work on this standardized maritime digitalization: The EfficienSea, with its motto “Getting Connected” in reference to the computer cloud, Maritime Cloud, was captained by the Danish Authorities in 2015 and then evolved into EfficienSea2 until April 2018, carrying out tests in the Arctic and the Baltic Sea with the first generation of homogenized electronic navigation between Sweden and Denmark. In 2017, the Maritime Connectivity Platform (MCP), was launched to unify the two European projects, the STM and EfficienSea2 in terms of electronic information (IALA-EFFICIENSEA 2017), and in which Korea[8] also joined by expanding the spectrum.

The MCP has introduced a consortium, the Maritime Connectivity Platform Consortium (MCC), providing neutrality and independence for participants. The initial consortium includes a range of non-commercial organizations and in the consolidation of this important consortium, the Secretary General of the IMO and the Secretary General of the IALA were present at the e-Navigation conferences held on board the ferry Pearl Seaways while sailing back and forth from Copenhagen to Oslo in February 2019 (IMO 2019).[9]

Its progress and results have been reflected in articles, workshops and conferences, awaiting the day when regulations would be mandatory and therefore its

[7] Although the Secretary General Kitack Lim, expressed his support: “STM goes hand in hand with IMO goals” and “I give my full personal support to STM” at the STM Validation Project Final Conference at the International Maritime Organization in London, 13–14 November 2018.

[8] Korea was chosen to hold the 19th International Conference of the IALA in June 2018.

[9] The Secretary-General Mr. Kitack Lim of the IMO and the Secretary-General M. Francis Zachariae of the IALA on the e-Navigation Underway International Conference under the title of “Paving the Way for a Digital Maritime World”, from 6 to 8 February 2019.

implementation would be extensive and real, something that only the IALA and the IMO can do. It will be essential to activate all legislative and operational resources to regulate this technology including the training of the personnel that will use it.

5 The global VTS and the role of the oceanic VTS

The implementation of a VTS is mandatory only within the territorial sea of the coastal states, as regulated by the SOLAS Chapter V, Regulation 12; thereby, it already excludes international waters. The Convention of the UNCLOS'82 is the cornerstone that defines the jurisdiction of the coastal states endowing them with the power to adopt laws for the safety of navigation and regulation of traffic.[10]

Currently, the maximum range of a maritime traffic control system, in any case, can only be exercised while the vessels are in inland waters and not beyond the TS, Territorial Sea, that is, 12 miles. For controls within the EEZ, Exclusive Economic Zone, up to 200 miles, and international waters, the approval of the IMO is necessary, and in these cases are TSS, areas of passage with mandatory reporting. The services that a VTS can offer in these areas are three, at the most basic level, (i) the information service (INS), (ii) the navigational assistance (NAS), which involves the decisions taken by the ship and finally (iii) the traffic organizational service (TOS) based on preventing the development of a risk situation. They are associated with the VTS types as follows, the INS for Coastal VTS and the TOS and NAS for the Port VTS and inland waters. This scheme of division of VTS, although it may seem that it is spatial, its limits are more legislative than geographical as they are divided according to the degree of involvement of the VTS with traffic.

The future scenario of e-Navigation goes beyond 12 miles and the areas monitored by a VTS. The e-Navigation raises VTS communications as a key factor and also contemplates long range without determining distance, but it identifies six areas to provide a maritime service: port areas and approaches; coastal waters and confined or restricted areas; open sea and open areas; areas with offshore and/or infrastructure developments; Polar areas; and other remote areas. Communications equipment also includes long range, such as HF and satellite systems, (IALA 2013). Therefore, a long-range VTS is expected. However, in the e-Navigation Strategy Implementation Plan of the IMO (2018), MSC.1/Circ.1595 in its page 12 stated that a key factor in the e-navigation concept is to *identify the possible communications methods that might be used and testbeds*; these required regulatory framework and technical requirements for implementation. The status of testbeds is under consideration.

This paper proposes that the state of the Global VTS (GVTS) in the form of a counterpart at sea such as the Global Maritime Distress and Safety System (GMDSS). The future VTS services will manage information and communications at any point of the maritime surface and therefore acquire a greater geographical dimension, which goes beyond the coastal VTS. For this reason, the creation of the role of the "Oceanic VTS" as a new formula to approach the planetary paradigm is proposed for the first time. The name "Oceanic VTS",

[10] United Nations Convention on the Law of the Sea. Part II. The Territorial Sea and the Contiguous Zone. Section 1. General Provisions. Section 2. Territorial Sea Limits. Article 3. Width of the territorial sea and Section 3. Innocent Passage Through the Territorial Sea. Article 21. Laws and regulations of the coastal State regarding innocent passage.

[0] Navguide 2018. 8th Edition. Chapter 2 – Concepts and accuracy of navigation. 2.3 Phases of navigation. P.13.

Table 1 Synthetic table within the VTS. Source: Authors

	PAST: 1948-1996	**PRESENT: 1997-2017**	**PLANNED FUTURE: 2018-2030**
	Terrestrial	Terrestrial-Satellite	Satellite
References	**1968** Resolution A.158 (ES.IV) Recommendation on port Advisory Services (PAS)		
	1985 Resolution A.578 (14) Guidelines for VTS		
	1993 1st IALA VTS Manual		
		1997 Resolution A.857 (20) Guidelines for VTS and SOLAS Ch. V Regulation 12.	
		2000 Revision of SOLAS Ch. V Rg.19 (AIS for ships)	
		2004-2006 Resolution MSC.211(81) (LRIT)	
		2007 COPERNICUS	
		2008 MSC.85/26/Add,1 Annex 20	
		2014 MSC 94/18/8 Development and implementation of e-Nav.	
			2018 IALA Navguide 2018
Means	**VHF**	**VHF / HF**	**VDES**
	RADAR	**RADAR**	**RADAR SAT**
		CCTV (Close circuit TV)/FLIR (Forward-looking infrared)	**CCTV/FLIR**
		PC (Computers)	**PC**
		PHONE	**PHONE/Smartphone/Satellite**
		AIS	**AIS SAT**
		ECDIS	**ECDIS**
		LRIT	**LRIT**
		NAVTEX	**STM**
	Port	Territorial sea (TS)	Beyond TS
	PORT VTS	COASTAL VTS	**OCEANIC VTS**

with the idea of establishing agreement of the exact meaning of the definition of the word itself registered by the IMO defining navigation as "the process of planning, recording and controlling the movement of a craft from one place to another" on the Resolution A.915(22), and as a tribute to one of the three navigation phases (IALA 2018), navigation in restricted waters, coastal navigation and oceanic navigation.[11]

The current VTS centres would continue to perform the same functions with more modern equipment, sharing information with the same actors in the maritime industry but in a more digitized and standardized way. Maintaining these strategic positions in port areas or points on the coast will be highly qualified and qualified personnel with full accreditation under the auspices of the IALA.

Nowadays VTS plays an essential role for safety in the geographical areas it manages, but it will be even more so as it reaches the Oceanic dimension that we propose, sharing information among other VTS centres, global traffic management (Ustaoglu and Furusho 2002) that would also perform functions on the high seas with the idea of avoiding collisions (Corbet 1992).

More than a thousand satellites surround the globe with a wide range of purposes. The GNSS, is the generic term for a satellite system that provides specific positions worldwide, time and speed, with multimodal purposes. The IMO recognized it as a component of the World Wide Radio Navigation System (WWRNS) with the Resolution A.1046 (27), so that the recipients meet the requirements to provide position. These receivers, combined with other equipment, provide essential information for ships in navigation, Position, Navigation and Timing (PNT), which is why there, are deployed as satellite systems that cover the entire planet, promoted according to the areas of the world. We find GPS and GLONASS among others, used in the maritime sector to navigate but also to identify onshore who is sailing.

At the European level there is the family of satellites that work for purposes of surveillance, control, analysis, research or services covering multiple aspects. The COPERNICUS program together with the European Space Agency (ESA) has maritime safety as one of its designated roles (EMSA 2019).

The STM project is enabled by current equipment that is part of navigation, AIS, Radio, ECDIS but recognizes that the satellites will interact increasingly, extending the coverage and its benefits. VHF Data Exchange System (VDES) and the satellite AIS are an example. The format to send information is in IP format through any communication channel that allows it and all stakeholders, users, ships, ports and maritime companies can change information especially in collaborative port decision-making (Lind et al. 2018) and the VTS will also participate.

They must therefore address the location of the VTS system and its operators, in the same way that the IMO (2018) already contemplates it in its general architecture of e-Navigation.[12]

E-Navigation requires serious investment in technology. The IALA via the Guideline 1107 on planning and Reporting of e-Navigations Testbeds have recognized the need for investing more time and effort into this issue, noting that much work is required to move from concept to reality, and that many test beds will be required to discover the best solution.

To synthesize and summarize what this article has extracted, Table 1 is configured.

[12] MSC.1/Circ.1595. Figure 1. Overarching e-navigation architecture.

6 Conclusions

Gateways between ships and shore agents are an essential service for the efficient, organized and safety management of ship traffic. From its origins, when radio equipment and radar screens were used to combine real-time traffic control through a screen and the possibility of voice interaction, 73 years has passed. Now it is not attempted without an AIS device based on VHF signals on an electronic chart. Nevertheless, the use of the digital data and satellites is steadily increasing reaching the entire planet providing us with a world stage. The maritime sector has named e-Navigation the need to have a reach with these new technologies seeking to exchange information in a secure manner, standardize procedures and coordinate relations between all those involved in port operations and ships.

With this image of ship traffic in real time and on a large scale, the scenario is a global VTS system with a view to a wider spectrum, beyond the 12 miles, without geographic limits, following scales of ships and ports of departure and arrival. This paper envisages an acceptance of the global VTS system, GVTS. Also, the new role of the VTS without geographical limits, the oceanic VTS that should address their same tasks using new technologies interacting with a ship regardless of its position, or from port to port. Although it must be covered by law (Plant 1990), starting with the United Nations, continuing with the Memorandum of Paris, which should combine all the regions so that the control of the ports can be coordinated and standardized, and ending with an update of local laws, if we understand the laws as a descending pyramid.

The Sea Traffic Management project is the embryo of long-range information exchange for the sake of efficiency, economic savings, safety of maritime traffic and environmental protection, a vivid example of what the trend will be. This innovative project, together with the new ones to come, need the constant support of the EU with its co-financing and the IMO recognition to address the technological challenges that lie ahead.

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