



Vessel Traffic Services projected as Oceanic VTS beyond the Territorial Sea

A. Uyà Juncadella^{1,*}, F. X. Martínez de Osés¹

ARTICLE INFO

Special Issue:

11th International Conference on
Maritime Transport;
May 27-29, 2026.
Barcelona School of Nautical Studies
(FNB-UPC), Spain

Article history:

Received 27 May 2026;
in revised from 28 May 2026;
accepted 01 Jun 2026.

Keywords:

Vessel Traffic Services; VDES;
Satellite; Surveillance; Legislation.

ABSTRACT

The study of the evolution of Vessel Traffic Services (VTS) reveals that there are new challenges to face, in light of the fact that they are, currently, not only part of the dynamics of commercial ports but also of the control and surveillance of other maritime areas. New technologies, concurrent with growing concern for protecting the oceans, generate legislation, surveillance systems and maritime traffic organisation accordingly. From their inception to the present, the scope has been increasing, and, to facilitate this dimension, new regulations and supporting technology have been required. Whilst, 77 years ago, port control was through visualisation equipment of maritime traffic through the radar (Radio Detection and Ranging) screen and voice communication through Very High Frequency (VHF) radio communications, without the protection of any international regulation, the surveillance area now extends through the territorial sea and utilises digital and satellite technology. The applicability of VTS has become increasingly widespread in coastal areas throughout the world. By focusing, on the one hand, on recent regulations, both national and international, and, on the other hand, on modern technologies that use satellites, a new dimension of VTS has been recognised, with powers projected beyond the territorial sea. This is a further step towards the recognition of the VTS that will monitor the world's oceans.

© SEECMAR | All rights reserved

1. Introduction.

Analysing the evolution of VTS from its origins to the present, with consideration of its future allows the detection of a trend. A correlation can be established, over time, between the equipment and technology used, the services provided and the scope area, in parallel with the study of the corresponding legislation. The evolution of these three pillars, equipment-services-and scope area, allows testing of a process: How shore services interact with maritime traffic in waters beyond national jurisdiction of coastal states. The study focuses on assimilating the regulations, as a fourth pillar, created by the International Maritime Organization (IMO) since VTS were inaugurated, from 1948 to the current time, as a maritime traffic surveillance system and

determining what influence they exert on the VTS area and the services provided. To this end, the analysis begins with the national regulations of 2023, the publication of Royal Decree 186/2023 (MITMA, 2023), which approves the Regulations for the Management of Maritime Navigation and continues with the study of the new routing measures and ship reporting systems in northern Europe by the IMO, through the Navigation, Communications and Search and Rescue (NCSR) 11/3 of 2024 (IMO, 2024). In addition, a record of new trends in ocean protection will be included. A further aim is to determine the range of equipment and emerging technology that the VTS will use, illustrating the progress. While, once, the telephone and computers were part of the VTS operator console (IMO, 1997), a significant change came with the Automatic Identification System (AIS) equipment (IMO, 1998). The application of the AIS system has been increasing since 1998 in all type of vessels and other aids to navigation (AtoN), thereby generating increasing signal errors, prompting the study of whether VHF Data Exchange System (VDES) is an emerging solution.

¹Department of Nautical Science and Engineering. Barcelona School of Nautical Studies (FNB). Universitat Politècnica de Catalunya – BarcelonaTech. ORCID: A. Uyà Juncadella, 0000-0003-3934-4866; F. X. Martínez de Osés, 0000-0001-9997-6246.

*Corresponding author: A. Uyà Juncadella. E-Mail: africa.uyà@upc.edu.
Co-author e-mail: francesc.xavier.martinez@upc.edu.

2. The Four Pillars.

2.1. Equipment and technology.

The origin of the maritime traffic surveillance system can be traced back to the mid-20th century, specifically after World War II. The development of radar and its civil applicability made it possible to accurately monitor and track maritime traffic at port approaches. A combination of radar screen equipment with the transmission of radio messages referring to navigation in real time was recorded at the port of Douglas, Isle of Man, in 1948 (IALA, 2025). Quickly recognised as a powerful tool to facilitate operations, reduce delays and increase the efficiency of port traffic flow, the system began to be installed in other areas of the world.

The combination of RADAR (visual) display equipment with the transmission of RADIO (voice) messages related to navigation in real time was the start of this process and what defined VTS. As new technologies emerged, they were incorporated into the VTS operator console equipment.

IMO Resolution A.578(14) of 1985 registered radar, VHF, direction finder and other equipment as technical means, without further specifications. It was not until the Resolution A.857 (20) that the "components" for VTS operators were published (IMO, 1997). These were computers, telephone, telex, Closed Circuit TV (CCTV), Forward-Looking Infrared (FLIR), visual and others. The technology and equipment that were being incorporated into the ships were, subsequently, VTS equipment. In this sense, the AIS was recognized as a tool for traffic management ship-to-shore (IMO, 1998).

During the first decade of the 2000s, the Long-Range Identification and Tracking (LRIT) system for ships was adopted. In 2009, the global vessel identification and tracking system became mandatory for all passenger and cargo ships over 300 gross tonnages. Nowadays, LRIT is in accordance with SOLAS regulation V/19-1.

Later, under the European Maritime Safety Agency (EMSA) umbrella, it would become a system for controlling ships from shore-based VTS consoles that included two complementary maritime monitoring systems, firstly, the SafeSeaNet (SSN) to track vessels and exchange of data between Member States, and then, the CleanSeaNet (CSN) for monitoring marine pollution via satellite through the European Union's Copernicus Earth Observation Space Programme.

Satellite technology leads to new scenarios for increasing surveillance and communications globally.

The increased use of maritime tracking technology to exchange data via VHF radio waves, has compromised AIS, due to detected errors or even spoofing in the signal.

VDES is presented as the next-generation, high-speed digital radio system for the maritime community. The 2015 World Radiocommunication Conference revised Appendix 18 of the Radio Regulations, relating to the VHF maritime radio frequency band, to designate the frequency channels to be used for VDES in accordance with the latest version of the International Telecommunication Union Recommendation (ITU-R) M.2092, (IALA, 2022b).

It vastly improves upon the basic tracking technology of standard AIS by enabling two-way, global broadband communication between ships and the shore.

Only a month ago, on May 22nd, the IMO adopted a resolution to introduce the VDES into the IMO regulatory framework, during the 111th session of the Maritime Safety Committee (MSC 111). The new regulation is expected to enter into force on 1 January 2028. Also on the horizon is the Sea Traffic Management (STM), which promotes the possibility of exchanging ship-to-ship and ship-to-shore routes via ECDIS (IMO, 2021b) and under the International Hydrographic Organisation (IHO) standards S-100, this would be the S-421. By compiling the equipment and technology that have been part of VTS consoles over the decades, Fig. 1 depicts: which ones did not exist (0), which ones began to exist or are beginning to disappear (1), which ones began to be implemented (2), and which ones are consolidated technology over time (3).

Figure 1: Technology for VTS.

Technology/years	1948	1980	1990	2000	2010	2020	2030
VHF/HF	3	3	3	3	3	3	3
RADAR	3	3	3	3	3	3	3
Phone analogical	3	3	3	3	3	1	1
CCTV/FLIR	1	3	3	3	3	3	3
PC internet	0	0	1	3	3	3	3
NAVTEX	0	1	2	3	3	1	0
AIS	0	0	0	1	3	3	3
LRIT	0	0	0	0	1	3	3
Radar sat	0	0	0	0	1	3	3
ECDIS	0	0	0	0	1	2	3
Phone digital	0	1	1	2	3	3	3
VDES	0	0	0	0	0	1	2
STM	0	0	0	0	0	1	1

Source: Authors.

2.2. Services provided.

The services provided by the VTS have also changed and evolved throughout history. The VTS began as a recommendation on port advisory services through the Resolution A.158 (ES.IV) of 1968.

As the IMO developed, Resolution A.531(13) (*General Principles for Ship Reporting Systems* adopted in 1983) and Resolution A.572(14) (*General Provisions on Ships' Routeing* adopted in 1985) provided the frameworks under which Vessel Traffic Services (VTS) assumed the responsibility for implementation. These services included key functions such as gathering data on the fairway and traffic situations, as well as receiving ships' reports.

All data collection was for evaluation and giving information, navigational assistance and traffic organisation services and for the support of allied activities.

These functions evolved into the provision of specific, trade-marked services, giving rise to INS, Information Service, TOS, Traffic Organisation Service, and NAS, Navigational Assistance Service, as standalone services. The VTS could provide at least an information services (Plant, G.1990) and could include other services, according to the terms of the service agreement (IMO, 1997). The control and surveillance of arrivals and departures at ports extended to passage in the Traffic Separation Schemes (TSS). Vessels sharing their navigation plan included of the Es-

timated Time of Arrival (ETA) at the VTS area or departure from a dock or anchorage in the VTS area.

All of this led to the idea that the services provided by a VTS would be allied services (IMO, 2021a) supporting all maritime traffic. The VTS operator who performs these functions is now an internationally recognised, highly qualified profession under the International Organization for Marine Aids to Navigation (IALA) standards.

The concept of sharing the travel plan was not limited to an ETA, but extended to the next port of call (NPOC) with complete details of the cargo, the ship's conditions and the crew. Monitoring and tracking a vessel from port to port, along its entire route, is now possible due to developing technology. Although the VTS system is not yet standardised worldwide, tracking can currently be maintained within European waters (Union, O.J. of the E., 2019). Sharing information digitally will facilitate the concept of route exchange as well as specialisation in the supervision of electronic information as digital technology advances and new standards, such as S-200 of IHO, are implemented.

Although the integration of digital technology within the maritime sector is a long-standing objective, its practical implementation has historically lagged behind terrestrial advancements. To accelerate the sector's digital transformation, the International Maritime Organization (IMO) introduced the concept of e-Navigation as early as the beginning of the 2000s (IMO, 2006). Concurrently, IALA published dedicated guidelines to support and standardize this initiative. Now spanning over two decades, the evolution and adoption of e-Navigation have been extensively analysed across various literature (Martínez de Osés, F.X. & Uyà, À., 2021).

2.3. Scope area.

The scope of surveillance and control of a maritime zone through the VTS is something that is directly linked to the technology and the legislation that regulates it. This started within the port as support for the pilots, but surveillance was then extended to include approaches to port, this is how the port or harbour VTS and Coastal VTS were distinguished (IMO, 1997), and the VTS area could be divided into sectors. Currently, the VTS area is considered a VTS area as a whole.

In 1979, the International Maritime Organization (IMO) adopted the International Convention on Maritime Search and Rescue (SAR Convention), which subsequently entered into force in 1985. The primary objective of this convention was to develop a global framework that encourages international cooperation and delineates specific SAR regions of responsibility for each coastal state. This framework ensures the standardization of maritime rescue coordination globally, regardless of the accident's location, by legally mandating signatory coastal states to establish adequate search and rescue infrastructure. Consequently, land-based facilities—specifically Vessel Traffic Services (VTS) centres tasked with emergency coordination—extended their operational surveillance zones well beyond the limits of national sovereign waters. This framework was later reinforced by the adoption of the Global Maritime Distress and Safety System (GMDSS), which complemented

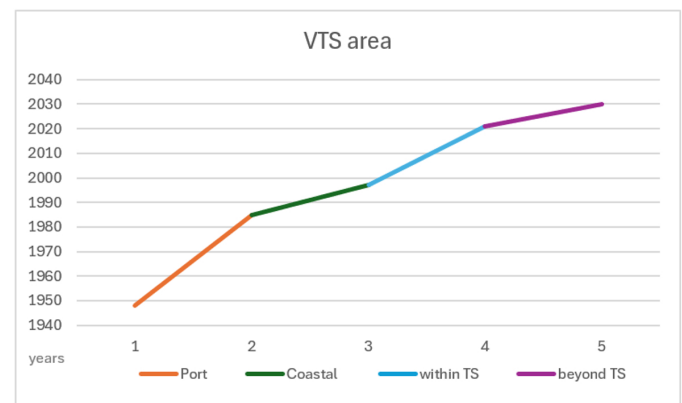
existing rescue protocols by integrating assigned geographical areas with a comprehensive, global telecommunications network. Crucially, a conceptual distinction must be maintained between the humanitarian mandate of safeguarding life at sea and the regulatory surveillance of commercial maritime traffic.

The boundaries of these maritime zones are intrinsically linked to international legal frameworks, with the 1982 United Nations Convention on the Law of the Sea (UNCLOS) serving as the foundational instrument defining coastal state jurisdiction. Within this framework, the territorial sea—extending up to 12 nautical miles from the baseline—constitutes the primary jurisdictional area wherein VTS zones are established to monitor and regulate maritime traffic.

However, this virtual line does not prevent ships from reporting before crossing it; moreover, reports two hours prior to arrival mean that a ship-shore connection is already established at a distance. The concept of the VTS beyond territorial waters began to take shape around 2012 and has been evolving ever since (IALA, 2022a). Evidence of this lies in recent regulations that equip the VTS with new capabilities to interact with vessels beyond 12 nautical miles.

Figure 2 depicts the evolution of the VTS area from its beginnings within the port to the present day.

Figure 2: Scope area of the VTS.



Source: Authors.

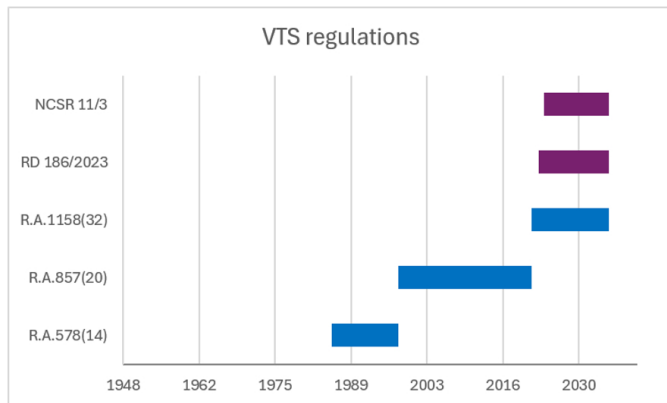
2.4. Regulations.

The institutional recognition of Vessel Traffic Services (VTS) was a protracted process characterised by significant regulatory delays. Although the operational origins of VTS date back to 1948, official recognition by the International Maritime Organisation (IMO) was not granted until 1968. Furthermore, the initial iteration of the Guidelines for Vessel Traffic Services was not published until 1985—thirty-seven years after the system's inception. This original framework was revoked twelve years later, culminating in the adoption of the current definitive standard twenty-four years thereafter: Resolution A.1158(32), Guidelines for Vessel Traffic Services, in 2021 (IMO, 2021a). Parallel to IMO resolutions, VTS operations are governed by the International Convention for the Safety of Life at Sea (SOLAS), Chapter V. Initially introduced in 1997 as an appendix

to Regulation 8, VTS was subsequently allocated its own dedicated mandate under Regulation 12 in 2000.

The further consolidation of VTS services into a holistic framework is demonstrated through two distinct case studies: the first examining a national regulation, and the second focusing on an international framework. Nationally, this is exemplified by the publication of Royal Decree 186/2023, which approves the Regulations for the Management of Maritime Navigation within Spanish waters. Internationally, IMO — through the Sub-Committee on Navigation, Communications and Search and Rescue (NCSR) document 11/3 of 2024 — published routing measures and ship reporting systems in northern Europe, framing VTS operations outside of Dutch territorial waters. Crucially, both regulatory instruments contemplate an advanced level of interaction that transcends mere surveillance; they codify the authority to control traffic and issue mandatory instructions, where necessary, to designated vessels operating beyond coastal state jurisdictions.

Figure 3: Main regulations for VTS.



Source: Authors.

3. Main Results.

The recent national regulation demonstrates that the royal decree is a document that simplifies the bureaucratic burden by introducing a simplified system called “despacho”. Beyond this administrative improvement, the central focus of the study is in relation to the use of Spanish maritime spaces outside the territorial sea as a place of anchorage by chemical and gas product tankers, or other vessels, carrying substances potentially polluting the marine environment, but not bound for any port or terminal located in Spain, as set out in Articles 44 and 45, within Chapter VIII of the Royal Decree 186/2023. This process involves direct and periodical contact between ships and the Rescue Coordination Centre as VTS. At the international level, the 12th session of the NCSR (IMO, 2024) agreed new measures regarding the participation of ships in a VTS area outside of Dutch territorial waters, applied as a result of the record of accidents involving container ships to prevent container loss and aiming to reduce the risk of maritime accidents in strong wind conditions. New areas are being established beyond the territorial sea, which require control and surveillance. These are

included in the new Ocean Treaty agreement under the UNCLOS (United Nations Convention on the Law of the Sea), in Particularly Sensitive Sea Areas (PSSA) designated worldwide and in Areas To Be Avoided (ATBA) adopted by the IMO. The technology that allows for a greater and more stable range of communication is the VDES, a radiocommunication system capable of exchanging digital data both between ships and ships and shore services, with higher data transmission rates than AIS. The proposed new VDES waveforms outperform existing AIS signals in mitigating satellite positioning disruptions and achieving greater accuracy (Šafář J. et al., 2020). The IMO has already established the integration of VDES into SOLAS.

4. Conclusions / Contributions.

The findings of this study demonstrate a clear trajectory toward a broader conceptualisation of vessel traffic management, identified in the literature as Oceanic VTS (Uyà, 2022). This evolving model features a global reach, leveraging satellite-based technologies to facilitate communications and surveillance on a planetary scale. Modern regulatory frameworks now officially and legally link the extraterritorial operations of certain vessels to shore-based stations, including VTS centres. Concurrently, these emerging standards codify three critical developments: firstly, that VTS centres actively perform functions beyond the 12-nautical-mile territorial sea limit; secondly, that they possess the technological capacity to execute these mandates; and finally, that their operational scope has expanded from traditional surveillance toward active intervention in international waters. Collectively, these advancements have established a foundational framework for globalised VTS operations, aligning with broader academic discourse (Ustaoglu et al., 2002). Furthermore, emerging technologies point toward the implementation of the VHF Data Exchange System (VDES) and the surveillance of marine protected areas on the high seas — objectives that are uniquely dependent on satellite architecture. Ultimately, regulatory and technological instruments remain dynamic mechanisms; analysing their evolution clarifies current maritime trends and equips the industry to navigate impending operational challenges.

The critical dimensions of this historical evolution are synthesized in Table 1, which consolidates the core findings of this study by mapping the four analytical pillars across the investigated timeline.

Table 1: Key dimensions of VTS development.

Key Development Dimensions	1950s	1980s	2000s	2020s	2030s (Projected)
Equipment & Technology	VHF/HF, RADAR	NAVTEX	Automatic Identification System (AIS)	LRIT, Satellite RADAR, ECDIS	VDES, Sea Traffic Management (STM)
Services Provided	Voice and visual signaling	Maritime information, organisation & assistance	Unified maritime architecture	Global tracking, digital charting	Synergizing Global VTS Connectivity and Massive Data Exchange
Scope area	Port-level	Coastal waters/TSS	Traffic management	Long-range traffic management	Global scope
Regulatory Framework	Initial SOLAS Convention	GMDSS Agreement	Mandatory AIS carriage requirements	e-Navigation strategy	Maritime Digital Ecosystem

Source: Authors.

References.

- IALA (2022a) ‘G1089 PROVISION OF A VTS’, *Guideline 1089*, pp. 1–12.
- IALA (2022b) ‘G1117 VHF DATA EXCHANGE SYSTEM (VDES)’, *Guideline*.
- IALA (2025) ‘VTS Manual’, *IALA Manual*, pp. 1–45. Available at: <https://www.iala.int/product/m0002/>.
- IMO (1997) *Resolution A.857(20) Guidelines for Vessel Traffic Services, A 20/Res.857*.
- IMO (1998) *Resolution MSC.74(69) adoption of new and amended performance standards, MSC 69/22/Add.1*.
- IMO (2006) ‘Resolution MSC.202(81) ADOPTION OF AMENDMENTS TO THE INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA, 1974, AS AMENDED THE’, (May), pp. 1–7.
- IMO (2008) ‘MSC 85/26/Add.1 ANNEX 20. Strategy for the development and implementation of e-Navigation’, *MSC 85/26/Add.1*, pp. 1–15.
- IMO (2021a) *Resolution A.1158(32) GUIDELINES FOR VESSEL TRAFFIC SERVICES*.
- IMO (2021b) *WORK PROGRAMME. MSC 104/15/7 Proposal for a new output to amend the revised ECDIS performance standards (resolution MSC.232(82)) to facilitate a standardized digital exchange of vessels’ route plans Submitted*. IMO.
- IMO (2024) *Routeing Measures and Ship Reporting Systems, NCSR 11/3*.
- Martínez de Osés, F.X. and Uyà Juncadella, À. (2021) ‘Global maritime surveillance and oceanic vessel traffic services: towards the e-navigation’, *WMU Journal of Maritime Affairs*, 20(1), pp. 3–16. doi:10.1007/s13437-020-00220-0.
- Ministerio de Transportes, M. y A.U. (2023) *Real Decreto 186/2023, de 21 de marzo, por el que se aprueba el Reglamento de Ordenación de la Navegación Marítima, Boletín Oficial del Estado (B.O.E)*. Available at: <https://www.boe.es/eli/es/rd/2023/03/21/186>.
- Plant, G. (1990) ‘International legal aspects of vessel traffic services’, *Marine Policy*, 14(1), pp. 71–81. doi:10.1016/0308-597X(90)90038-S.
- Šafář, J. et al. (2020) ‘Performance Bounds for VDES R-mode’, *Journal of Navigation*, 73(1), pp. 92–114. doi:10.1017/S0373463319000559.
- Union, O.J. of the E. (2019) *REGULATION (EU) 2019/1239 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 establishing a European Maritime Single Window*.
- United Nations (2023) *Agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction*.
- Ustaoglu, B.S. and Furusho, M. (2002) ‘The importance and contributions of the VTS towards the establishment of the global safety management system for the safety of the maritime transportation.’, *International Association of Maritime Universities (IAMU)*, pp. 1–66.
- Uyà, A. (2022) *Vessel Traffic Services, towards e-Navigation. The role of Oceanic VTS in Global Maritime Surveillance*. Edited by U.P. de Catalunya and D. de C. i E. Nàutiques. Universitat Politècnica de Catalunya. Available at: <http://hdl.handle.net/21-17/370239>.