

AIS 2.0 – A NEW MARITIME TELECOMMUNICATIONS NETWORK

L Moltsen and S Pielmeier, Sternula, Denmark

SUMMARY

A second generation of the popular AIS vessel tracking system is about to be deployed globally. The new technology is formally known as *VHF Data Exchange System* or *VDES*, but we also use the popular term, *AIS 2.0*. Standardisation has been completed under IALA and ITU, global radio spectrum has been allocated, and IMO is working to integrate the new technology in the SOLAS convention.

The new technology adds 30 times extra open data capacity to the AIS system, and it will be a combined terrestrial/satellite network. New AIS ship terminals and coastal radio transceivers from leading equipment providers will enter the market in 2022. The world's first commercial AIS 2.0 satellite will be launched by Sternula in late 2022 and will offer global non-realtime connectivity from 2023.

AIS 2.0 will facilitate a global digital transformation of the maritime sector from big container ships to smaller coasters, fishing vessels, and leisure crafts. A range of maritime digital services can now be realised, improving operational efficiency, enabling fuel-saving digital solutions, and paving the way for autonomous shipping.



Figure 1. The *STERNULA-1* satellite (top, artwork) and *Tukuma Arctica* (bottom) arriving in Aalborg, Denmark.

1. INTRODUCTION

There is a need for maritime digitalisation to happen. Digital solutions will enable increased operational efficiency and better productivity. A number of key digital services have been identified in the IMO e-Navigation Strategy Implementation Plan [1], incl. port call procedures, distribution of navigational warnings, and VTS services. However, the maritime sector is generally lagging far behind comparable terrestrial industries when it comes to the level of digitalisation and automation.

Why is it so? The two main reasons are:

– Connectivity at sea is generally difficult and costly. In near-shore waters, vessels may of course rely on cellular networks from shore, but in the oceans the only option is a satellite connection, which is rather limited and expensive compared to fiber-optic cabling on land. In the high-end maritime segment, the cost and overhead of connectivity is not necessarily significant, but for the broader segment, it prevents the deployment of digital solutions.

– Safety at sea is a vital requirement. When a vessel leaves harbour, it will be in a state of potential emergency if anything goes wrong. This means that maritime digital services need to be deployed on strictly certified hardware and via secure networks. An open internet connection cannot be used for critical onboard systems, in particular the bridge installations. Imagine that someone was able to hack into the ECDIS and manipulate the position of the vessel to be a few miles off. This could have catastrophic consequences. The shipping company that intends to exploit digital solutions would need its own ICT specialists to ensure that firewalls and other cyber-security tools are in place.

As a result, the maritime industry is much more conservative than land-based industries when it comes to the use of ICT, and highly manual procedures are used for services that could be digitalised. The Danish Meteorological Institute produces up-to-date ice charts for waters around Greenland, and shipping companies can subscribe to these. The production of ice charts has become increasingly automated, but the delivery today is via an email with an attached file. The ice chart can then be used in a separate monitor next to the ECDIS or printed on paper. It would be much more effective, if ice charts were delivered periodically in a form that could be visualised directly in the ECDIS. Data formats do exist in draft form (IHO S-411), but secure connectivity between the weather authority and the onboard ECDIS is not possible.

The new VHF Data Exchange System (VDES) [2] has been developed as a new enabling technology for digitalisation on top of the widely used Automatic Identification System (AIS) [3]. Where AIS is a digital vessel tracking service with its own data channels and radio spectrum, VDES is a telecommunications standard with open data capacity for any maritime digital service. Both have radio spectrum in the VHF band around 160 MHz and work via a standard VHF antenna. The data capacity of VDES is approximately 30 times higher than AIS due to more advanced channel implementation.

2. ARCHITECTURE AND STANDARDS

Figure 2 illustrates how AIS and VDES can support different use cases. AIS (dashed arrows) is transmitted by ships to other nearby ships, which may use the ECDIS to present the data. The same AIS messages may be picked up by coast radio stations and/or by satellites. AIS was never designed for satellite, but it turned out to be possible to collect AIS data from satellites in Low-Earth Orbit (LEO) of 500-600 km.

VDES (solid arrows) can be used by the maritime authority to distribute e.g. navigational warnings, including weather and ice information. In near-shore regions in GMDSS area A1, coastal radio is used, and in GMDSS areas A2-A4, satellite connectivity is used. VDES is in fact designed with special satellite data channels in both up- and down-link.

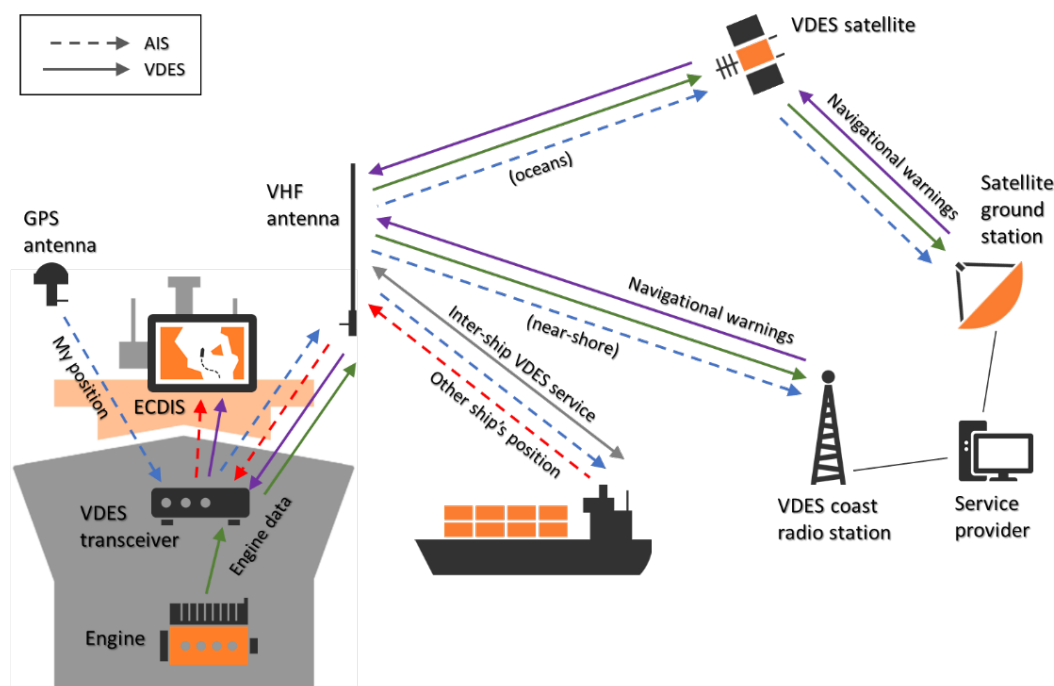


Figure 2. AIS and VDES used for different use cases.

The satellite element of VDES is specified as “VDE-SAT” and the terrestrial element (both ship-to-ship and ship-to-shore) is “VDE-TER”,

The new allocation of radio spectrum for AIS and VDES was agreed at the ITU World Radio Conference 2019 and has been specified in [2] for the combined AIS and VDES system. The spectrum allocation is shown in Figure 3.

The channels AIS1, AIS2, and Long Range AIS are used in accordance with the AIS specification [3]. The VDE-SAT and VDE-TER channels as well as ASM1 and ASM2 are used in accordance with the VDES specification [2]. Note that ASM (Application-Specific Messages) may be transmitted also via AIS channels and via VDE-SAT and VDE-TER channels.

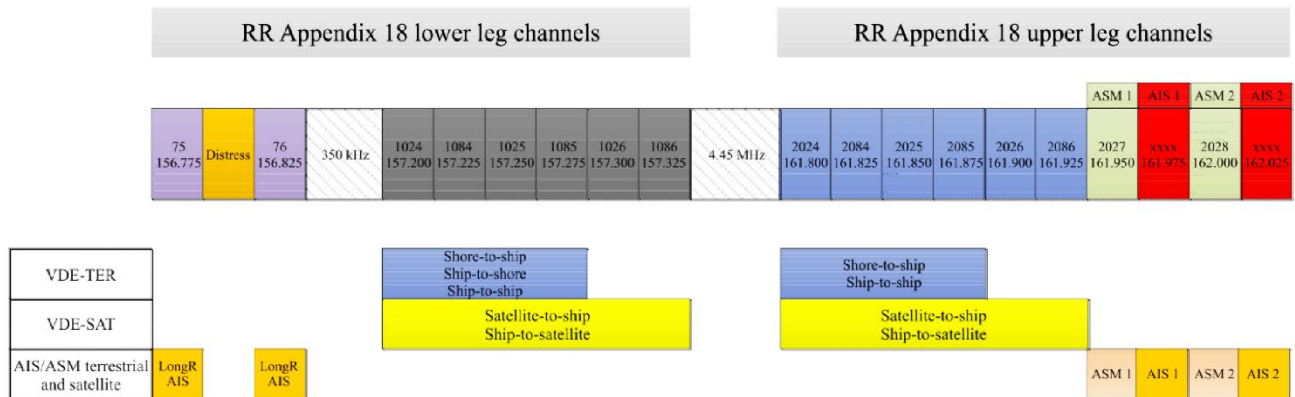


Figure 3. The allocation of radio spectrum for AIS and VDES. Source: [2].

The development of the VDES standard has primarily been carried out by the IALA e-Navigation working committee. For the VDE-SAT element, the NorSat-2 project by Space Norway has been instrumental for the approval of VDES as an ITU recommendation.

3. USE CASES AND TIMING

With the new VDES upgrade to AIS, an affordable and secure global connection will be realised. This enables a range of digital services. Traditional AIS in which connectivity and the tracking service is combined, is comparable with early GSM phones in which connectivity and voice/SMS services were combined. In the same way, VDES and its open connectivity is comparable with modern telephony, where open connectivity enables a range of apps and services.

Table 6			
List of proposed Maritime Services for use in MSP			
Service No	Identified services	Domain coordinating body	Identified responsible service provider
1	VTS Information Service (INS)	IALA	VTS Authority
2	Navigational Assistance Service (NAS)	IALA	VTS Authority
3	Traffic Organization Service (TOS)	IALA	VTS Authority
4	Local Port Service (LPS)	IHMA	Local Port/Harbour Authority
5	Maritime Safety Information Service (MSI)	IHO	National Competent Authority
6	Pilotage service	IMPA	Pilotage Authority/Pilot Organization
7	Tug service	TBD	Tug Authority
8	Vessel Shore Reporting	TBD	National Competent Authority and appointed service providers
9	Telemedical Assistance Service (TMAS)	TBD	National Health Organization/dedicated health Organization
10	Maritime Assistance Service (MAS)	TBD	Coastal/Port Authority/Organization
11	Nautical Chart Service	IHO	National Hydrographic Authority/ Organization
12	Nautical Publications Service	IHO	National Hydrographic Authority/ Organization
13	Ice Navigation Service	WMO	National Competent Authority/Organization
14	Meteorological Information Service	WMO	National Meteorological Authority/Public Institutions
15	Real-time hydrographic and environmental information Service	IHO	National Hydrographic and Meteorological Authorities
16	Search and Rescue Service	TBD	SAR Authorities

Figure 4. Table 6 of the IMO e-Navigation Strategy Implementation Plan [1].

As mentioned in the introduction, VDES was developed to meet the needs defined in the IMO e-Navigation Strategy Implementation Plan [1]. Figure 4 shows “Table 6” of this document, listing 16 specific digital services that should be offered by relevant maritime authorities.

However, as indicated by Figure 2, there are many commercial services e.g. within preventive maintenance and “Internet-of-Things” that could be implemented over VDES. The main characteristics of good use cases to be realised via VDES are:

- Scalability: VDES can be expected to be on board every vessel within the next decade and solutions for the broader segment (large container ships as well as smaller coasters or fishing vessels) are a good match.
- Low volume: VDES has limited data capacity, and if the use case demands hundreds of data records every second, another technology would be better suited.
- Secure connection: VDES prevents IP connections, which also limits certain use cases, but which on the other hand means that the level of security is high (like a built-in firewall).
- Mobility: VDES works over the VHF antenna, which does not need accurate pointing towards a satellite. This means that use cases for moving vessels will be better than connectivity for fixed marine infrastructure, where a fixed satellite dish could be mounted (and provide higher data rates).
- Non-realtime (early): In the beginning, while satellite constellations are still under deployment, connectivity will be periodic. In time, however, realtime connectivity will be available globally via satellite. This means that it will be an excellent means to connect with autonomous vessels.
- Broadcasting: VDES is particularly well suited for services that broadcast information in a wider area.

The timing of VDES availability in the North Sea is illustrated by Figure 5. VDE-SAT and VDE-TER coverage in this region corresponds to GMDSS area A2 and A1, respectively, because VDE-TER will be available over VHF coastal radio. Sternula will launch its first satellite in the second half of 2022 and early connectivity will be available from 2023. We expect that all coastal nations in the region would have coastal AIS installations upgraded to “AIS 2.0” by 2026.

Ship equipment supporting VDES will enter the market already from 2022. Saab has already announced that its R6 Supreme model will support VDES, and Kongsberg has been supplying test equipment for the NorSat-2 project. Other maritime equipment providers are expected to follow in near future.

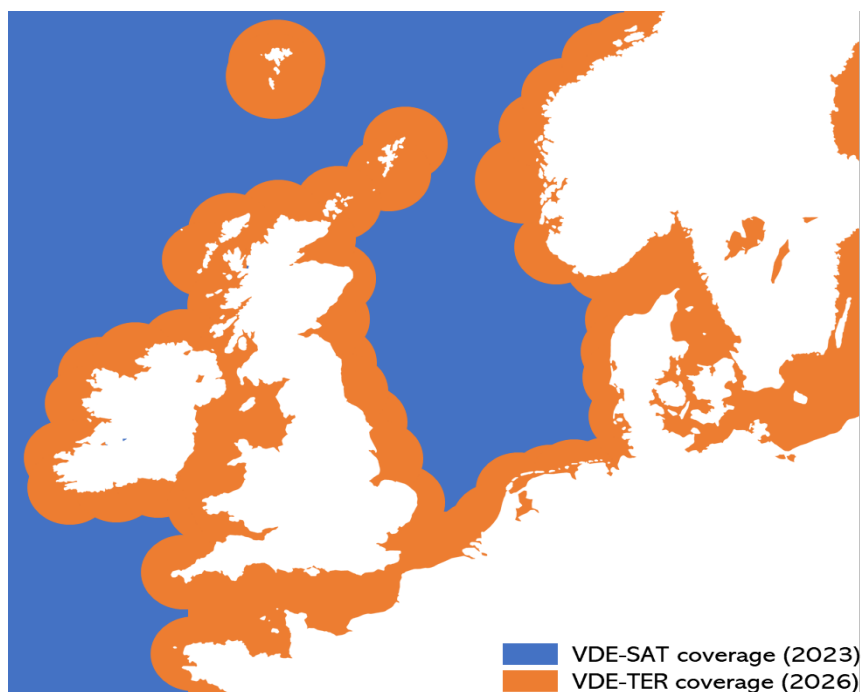


Figure 5. Expected timing of VDES (VDE-SAT and VDE-TER) in the North Sea region.

4. CONCLUSIONS

This article presents important aspects of the development of the next generation of AIS, in particular the new VDES specification. We use “AIS 2.0” as a popular term to highlight that VDES is the natural extension of AIS in much the same way as mobile technologies have developed from 1G to 5G.

We expect that VDES is going to kick-start many new digitalisation initiatives worldwide. It will co-exist with and supplement other connectivity options to allow a digital transformation of the maritime industry. VDES will be the foundation of future maritime connectivity: The type of connectivity which is available anywhere at low cost and with a high level of security. Other technologies will take over when there is a need for higher data rates or other special requirements.

AIS 2.0 will be a key enabler of maritime digitalisation and autonomous shipping within this decade.

5. REFERENCES

1. IMO, ‘e-Navigation Strategy Implementation Plan – Update 1’, *www.imo.org*, May 2018.
2. ITU, ‘Recommendation ITU-R M.2092-1, Technical characteristics for a VHF data exchange system in the VHF maritime mobile band.’, *www.itu.int*, February 2022
3. ITU, ‘Recommendation ITU-R M.1371-5: Technical characteristics for an automatic identification system using time division multiple access in the VHF maritime mobile frequency band.’, *www.itu.int*, February 2014

6. AUTHORS BIOGRAPHY

Lars Moltzen holds the current position of CEO at Sternula. He is responsible for overall management and business development in the organisation. Mr. Moltzen holds a Masters’ degree in Computer Science and Mathematics from Aalborg University, Denmark, and has been conducting research in telecommunications networking, operations, and automation for more than 20 years. He is the author of many conference and journal papers as well as one patent within 3G access control. Since 2003, he has been an active entrepreneur and a founder of a number of tech start-ups. His latest start-up is Sternula, which is the world’s first commercial satellite operator to offer global AIS 2.0 coverage.

Stefan Pielmeier holds the current position of CTO and board member at Sternula. He is responsible for technical leadership, R&D, and operations. Mr. Pielmeier holds a Masters’ degree in Electronic Engineering from University of Erlangen, Germany. He is an experienced engineer and project manager with extensive knowledge in radio/telecommunications and standardization. Mr. Pielmeier is the chairman of IALA’s working committee for VHF Data Exchange System (VDES), and he is actively supporting the Danish maritime and frequency authorities in standardisation issued under ITU and IMO.

