GUIDELINE

G1117

VHF DATA EXCHANGE SYSTEM (VDES) OVERVIEW

Edition 2.0

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DOCUMENT HISTORY

Revisions to this IALA document are to be noted in the table prior to the issue of a revised document.

Date	Details	Approval
December 2016	1st issue	Council 63
December 2017	Edition 2 Updated to reflect technical developments in VDES and to reflect transmission aspects (addressed / broadcast)	Council 65

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1. INTRODUCTION

1.1. PURPOSE OF THE DOCUMENT

This Guideline provides an introduction to the VHF Data Exchange System (VDES) at an overview level. It does not include technical details.

This document is intended to assist in the understanding, development and promotion of VDES.

1.2. BACKGROUND

AIS is well recognized and accepted as an important tool for safety of navigation and is a carriage requirement for SOLAS vessels (Class-A). With increasing demand for maritime VHF data communications, AIS has become heavily used for maritime safety, maritime situational awareness and port security. As a result, overloading of AIS 1 and AIS 2 created a need for additional AIS channels. Using the VHF marine band (International Radio Regulations Appendix 18) AIS can broadcast data to vessels in the vicinity of the AIS unit. AIS can also transmit an addressed message.

International Telecommunications Union (ITU) has recognised the efficiency and the necessity for digital communications, has produced technical standards and has revised the VHF marine band (Radio Regulations Appendix 18) to designate channels for data transmission. It is recognized that both analogue voice communications and digital communications will share the band. The VDES, as envisioned by IALA and presented to ITU, addresses the identified need to protect AIS along with essential digital communications contributions for e-Navigation and GMDSS Modernization.

The VHF marine band (Radio Regulations Appendix 18) was initially used for transmission of voice communications on 25 kHz channels. The ITU introduced the first marine data transmission system, DSC (Digital Selective Calling)[1] to help ensure that calling and distress communications attempts were successful. VHF DSC transmits data at 1.2 kbps, slow by modern data standards, but very robust. At the request of the IMO to improve safety of navigation, ITU introduced another VHF data transmission system, AIS[2], which provides navigation and identification data for ships, shore stations, aids to navigation and search and rescue devices at 9.6 kbps.

ITU introduced a standard[3], with options for 25 kHz, 50 kHz and 100 kHz channels at data rates up to 307.2 kbps in order to improve spectrum efficiency in 2012. Both voice and data communications coexist in the VHF marine band. The developments in maritime radio technology, including the introduction of software defined radios (SDR) coupled with enhanced capabilities for digital data exchange over existing VHF marine band spectrum resulted in the development of the VHF Data Exchange System (VDES). VDES builds on the experience gained through the development of AIS, and also provides the capability to transmit to a specific vessel (addressed); to all units in the vicinity (broadcast); to a group of vessels (addressed); or to a fleet of vessels (addressed).

Consequential to WRC-15, the ITU standard for VDES, Recommendation ITU-R M.2092-0, was approved. A remaining outstanding issue is the approval of the satellite component for the VDE channels which is targeted for approval at WRC-19.

1 Recommendation ITU-R M.493

2 Recommendation ITU-R M.1371

3 Recommendation ITU-R M.1842

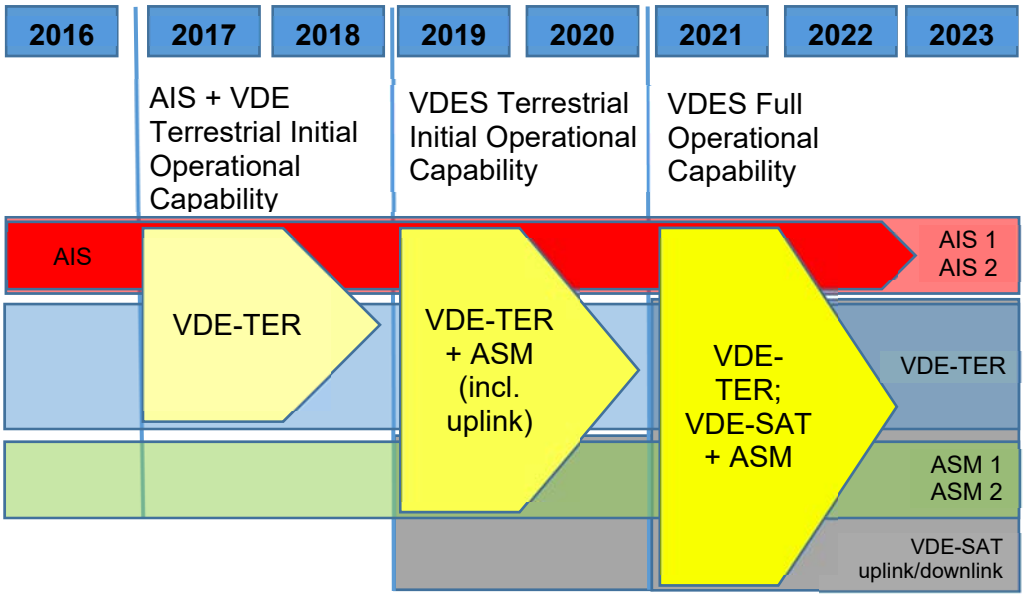


Figure 1 Implementation of VDES

The introduction of VDES is expected to happen through four operational phases:

1 (2016) AIS exists as defined by ITU.R M.1371-5 on the AIS frequencies, and Coastal Stations use the ASM and VDE frequencies for Voice VHF.

2 (2017-2018) Post WRC-15 - AIS+ASM: Regionally, where there is an urgent need for offloading the AIS VDL from significant ASM traffic, it is recommended to allow the introduction of 4-channel AIS + ASM devices. These devices may receive and transmit ASM on the ASM1 and ASM2 frequencies, but shall discontinue their transmit capability, using the existing GMSK modulation after January 1st 2019 unless a software upgrade enables them to participate in the modulation and access scheme agreed for the ASM frequencies. Note that the ASM frequencies will need to be shared with the VHF voice service from Coast Stations in many areas during this time frame.

3 (2019) the WRC-19 will consider and decide regarding VDE-SAT.

4 (2019-2020) Post WRC-19 operational capability established. Note that both the ASM and VDE frequencies may still need to be shared with the voice VHF service in many areas.

5 (2021+) When a satellite service is developed, full operational capability of the VDES including the Satellite frequencies can be achieved.

1.3. OVERVIEW

The VHF Data Exchange System (VDES) is seen as an effective and efficient use of radio spectrum, building on the capabilities of AIS and addressing the increasing requirements for data through the system. New techniques providing higher data rates than those used for AIS is a core element of VDES. Furthermore, VDES network protocol is optimized for data communication so that each VDES message is transmitted with a high confidence of reception. VDES increases the capability for digital data exchange in a manner similar to AIS, which includes provision of data to vessels in a geographic area (broadcast), to a specific vessel or a group of vessels in a geographic area (addressed) or to a fleet of vessels (addressed).

In this document, when communications from ship to shore are referenced, this includes ship to satellite to shore and shore to satellite to ship. It is noted that, following WRC-15, the full satellite capability of VDES is still under development and will be reviewed at WRC-19.

2. GENERAL DESCRIPTION

The VDES should improve the safety of life at sea, the safety and efficiency of navigation, and the protection of marine environment and enhance maritime safety and security. These goals will be achieved through efficient and effective use of maritime radiocommunications, incorporating the following functional requirements:

1 As a means of AIS.

2 As a means of radiocommunications equipment through exchange of digital data between ship and ship, ship and shore including satellite via AIS, Application Specific Messages (ASM) and VHF Data Exchange (VDE).

3 As a means of applications external to the VDES equipment itself. These applications use AIS, ASM or VDE separately or combined.

2.1. SYSTEM CONCEPT

The VDES concept was originally proposed to address emerging indications of overload of the VHF Data Link (VDL) of AIS and simultaneously enable a wider seamless data exchange for e-navigation, potentially supporting the modernization of GMDSS. In addition, VDES could support the increasing communications requirements identified through the development of e-Navigation, as documented in the e-Navigation Strategic Implementation Plan (SIP).

The purpose of e-navigation is to enhance berth-to-berth navigation and related services for safety and security at sea and protection of the marine environment. e-navigation seeks to enhance maritime safety through simplification and harmonization of information. In addition, e-navigation seeks to facilitate and increase efficiency of maritime trade and transport by improved information exchange.

The VDES system concept recognises the parallel work being carried out related to e-navigation maritime service portfolios (MSP). Where applicable, these MSP are referenced in this user requirements document.

Table 1 identifies the e-navigation maritime service portfolios (MSP) as defined by IMO e-navigation strategic implementation plan (SIP) (NCSR1/28/Annex 7).

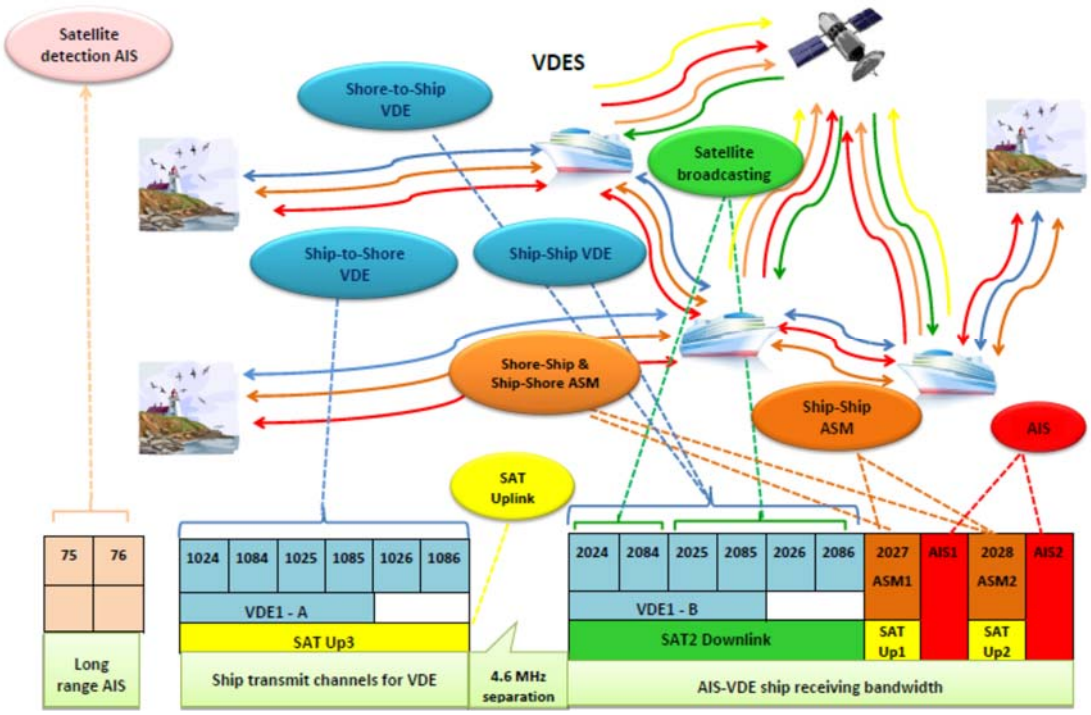
MSP reference	Service
MSP 1	VTS Information Service (IS);
MSP 2	VTS Navigation Assistance Service (NAS)
MSP 3	VTS Traffic Organization Service (TOS)
MSP 4	Local Port Service (LPS)
MSP 5	Maritime Safety Information (MSI) service
MSP 6	pilotage service
MSP 7	tugs service
MSP 8	vessel shore reporting
MSP 9	Telemedical Maritime Assistance Service (TMAS)
MSP 10	Maritime Assistance Service (MAS)
MSP 11	nautical chart service
MSP 12	nautical publications service
MSP 13	ice navigation service
MSP 14	Meteorological information service
MSP 15	real-time hydrographic and environmental information services

MSP reference	Service
MSP 16	Search and Rescue (SAR) Service

Table 1 Maritime Service Portfolio, IMO e-navigation Strategic Implementation Plan

The system concept, including VDES functions and frequency usage are illustrated pictorially in Figure 2 (full system).

Figure 2 VDES functions and frequency use – full system



2.2. CONCEPT OF OPERATIONS

The key concept of operation of the VDES includes:

1 The VDES provides a capability of data exchange between ships and shore users by terrestrial or satellite link.

2 Data exchange from the ship may occur automatically or manually.

3 Data exchange uses the designated VHF channel(s).

4 Transmission and reception of the data occurs with the minimum involvement of ship's personnel.

5 The VDES includes existing AIS applications.

6 The VDES includes existing ASM.

7 VDES additional capabilities include support of the VHF Data Exchange (VDE).

8 The VDES related applications should support language independent communications (e.g. through the use of a digital data dictionaries).

9 The VDES implements data integrity monitoring at the VDES link level (e.g. check sum).

10 The VDES related applications address cyber security (e.g. authentication, key management and, if required, encryption).

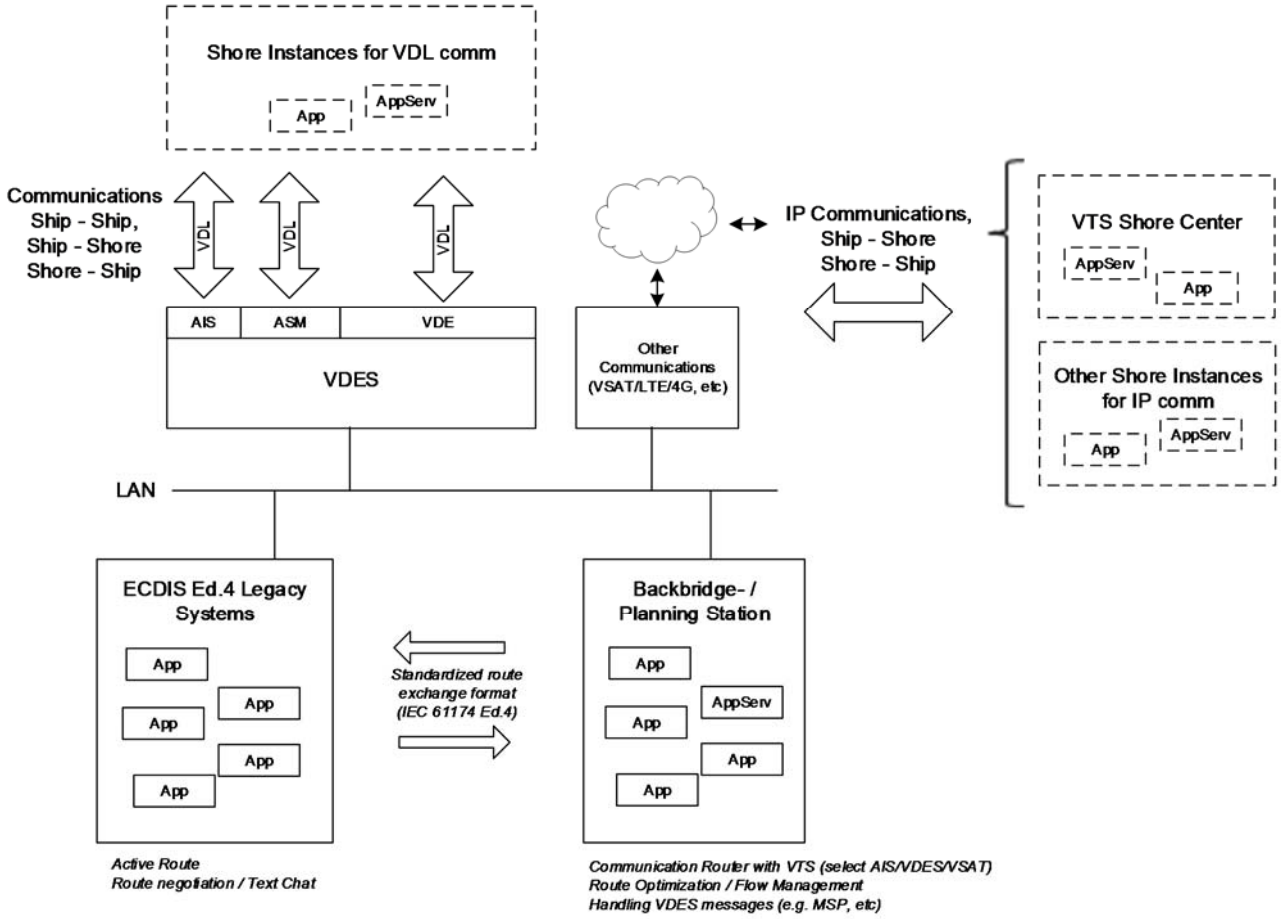
11 The VDES has a high level of availability.

12 The VDES supports machine-to-machine communications (for example, interfaces with external equipment providing applications related to VDES).

13 The VDES related applications enable clear comprehension of the information sent / received through the VDES.

The concept of operations is identified in Figure 3.

Figure 3 Concept for VDES



2.3. GENERAL

The VDES operates according to ITU-R M.2092, which includes the following operational characteristics:

1 The system gives its highest priority to the automatic identification system (AIS) position reporting and safety related information.

2 The system installation is capable of receiving and processing the digital messages and interrogating calls.

3 The system installation operates continuously while under way, moored or at anchor.

4 The system, for the terrestrial links, uses the appropriate time-division multiple access (TDMA) techniques, access schemes and data transmission methods in a synchronized manner.

5 The system is capable of various modes of operation, including the autonomous, assigned and polled modes.

6 The system prioritizes applications and adapts parameters of the transmission (robustness or capacity) while minimizing system complexity.

2.4. SYSTEM OVERVIEW

The VDES includes:

1 Antenna(s), capable of transmitting and receiving data through terrestrial and satellite link.

2 An AIS as set out in resolution MSC.74(69) ANNEX3.

3 A multi-function data communication and timing process that is interoperable with AIS, ASM and VDE.

4 A multi-function transmitter, capable of operating on the designated AIS, ASM and VDE frequencies.

5 Multi-function receivers, capable of operating on the designated AIS, ASM and VDE frequencies.

6 A means to automatically input data from other sources.

7 A means to automatically output data to other devices.

8 A means of ensuring the integrity of the data.

9 A means to automatically or manually update the device software as needed.

10 Functionality of a built-in test equipment (BITE).

2.5. ASSUMPTIONS AND DEPENDENCIES

The applications related to the VDES address the following assumptions and dependencies:

1 VDES operates within the existing AIS environment.

2 VDES respects and supports requirements for GMDSS communications, including SAR, urgency, and safety related messages.

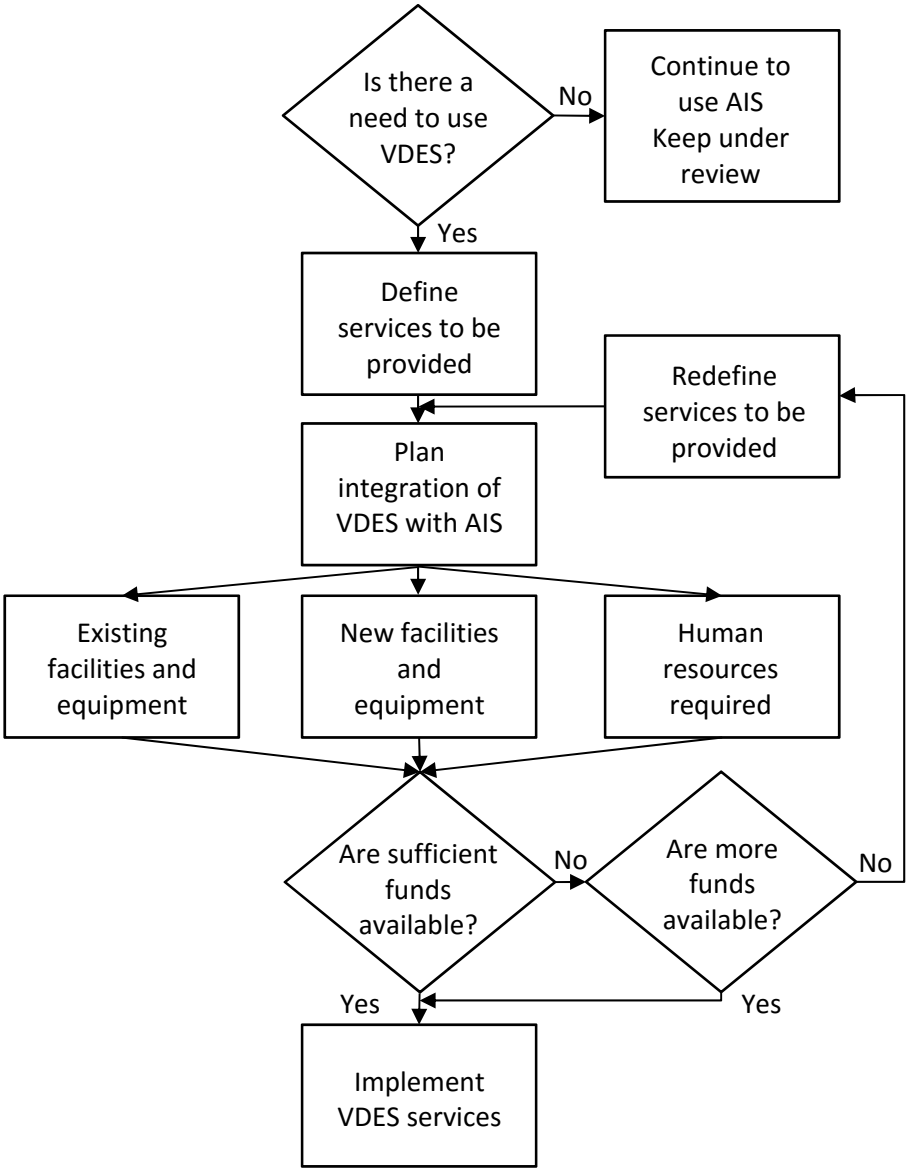
3 VDES applications are uniquely identified.

4 The VDES related applications operate in a manner that ensures there is no unnecessary repetition of messaging.

2.6. VDES SERVICES

Deciding to implement a VDES service follows the decision matrix provided in Figure 4:

Figure 4 VDES implementation decision matrix



The decision for a requirement to implement a VDES shore station may include:

- AIS system load;
- services to be provided;
- existing equipment (for existing sites);
- antenna requirements, including interaction with other services;
- power requirements;
- installation costs (which may include mobilisation, tower access);

Provision of VDES shore stations may be managed through:

- a regular scheduled lifecycle process for existing AIS shore stations;
- through an upgrade of existing AIS shore stations; or
- through the implementation of VDES at a new location where there is no existing AIS shore station.

Table 2 provides further information on considerations for VDES implementation.

Consideration	Detail	AIS recommended	VDES recommended
AIS system load	AIS system load (see measurement technique in note 1)	<50% load[4]	>50% load
Application Specific Messages	Application Specific Messages (ASM) are delayed beyond that acceptable to the users (see note 2)	Service Latency expected	Service Latency not expected
Advanced data transfer services	If the Advanced system data transfer features are required as per the Maritime Service Portfolios	Not required	Are required

Table 2 Considerations for VDES Implementation

Note 1: System load is determined by measuring the number of vessels in the coverage area of an AIS base station (a single slot map) and calculating the sum of the slots consumed in the coverage area based on the expected reporting rates of the vessels in the coverage area (Class A, Class B, AtoN and AIS base station) and the number of Addressed Binary Messages (ABM) and Broadcast Binary Messages (BBM) of all types.

Note 2: Service latency is defined as the delivery of the total service from the initiation of the delivery of the service component to the completion of the delivery of that service component e.g. a single maritime chart update.

The services offered by a VDES system will allow for priority with essential services / safety related services having the highest priority and non-essential / commercial service having the lowest priority.

The transfer of data using VDES should consider that the available VDES data transfer capacity is shared by all users within the coverage range of a VDES base station.

A technical overview of VDES is provided in Annex A.

2.7. DIGITAL COMMUNICATION SYSTEMS

Digital communications permeate our daily lives – both for work and for recreation. The introduction of 'any-time, any-where' access to information through the internet; text based or image based communications; geospatial locating and more is driving demand for faster, more robust, and more integrated, communication solutions.

There are a number of existing and developing communications technologies. These include:

- **NAVDAT**: this system is a development on the current NAVTEX system. The service will support the same major functions as NAVTEX, namely navigational warnings, weather forecasts and emergency information for shipping, but will provide a much greater capacity and data rate.
- **VHF Data Exchange System**: VDES, developed to meet the increasing need for data communication between maritime users and due to the significant rise in VHF data link load with the increasing use of AIS. Provides faster data transfer rates with greater integrity than current VHF data link systems.
- **Digital Selective Calling**: DSC transmits packets of data over existing maritime radio spectrum, on VHF, HF and MF. The system uses maritime mobile service identities and enables direct transmission or group / area transmissions of basic data. DSC is included in the Global Maritime Distress and Safety System (GMDSS) as a distress and calling mechanism.

4 More information on VDL loading is available in Report ITU-R M.2287-0

- **Digital VHF** Digital VHF is the evolution of analogue based mobile radio systems currently used by mariners for voice communication, transmission / reception of distress and safety information, and reception of urgent marine information broadcasts. As well as digitally encoding voice transmissions digital VHF will enable the exchange of digital data messages. This may be a longer-term development.
- **Digital HF**: Digital HF is the evolution of analogue based mobile radio systems currently used by mariners for voice communication, transmission/reception of distress and safety information, and reception of urgent marine information broadcasts. As well as digitally encoding voice transmissions digital HF will enable the exchange of digital data messages. Digital HF, including standards for digital HF.
- **Wi-Fi**: provides local area wireless data transfer using the 2.4 GHz to 5 GHz radio wave band. However, the coverage of this system is limited to within a port or harbour environment.
- **4G**: a mobile telecommunications standard supporting mobile internet broadband, succeeding 3G. Provides mobile broadband with data rates of 100s of Mbps for mobile users. Systems falling under the 4G standard include WiMAX and LTE.
- **5G**: planned evolution of 4G, with data rates expected to be 1 Gbps and an intended delivery year of 2020.
- **Satellite communication systems and services including**:
  - Inmarsat Global Express – GEO satellite constellation. The latest set of services to be offered by Inmarsat including shared channel IP packet-switched internet broadband service with fast data rates provided by satellites in the Ka band with global coverage.
  - Inmarsat C – GEO satellite constellation. Existing short burst data, store and forward system providing low data rates for small message size transfers and also supporting the Global Maritime Distress and Safety Service (GMDSS).
  - Iridium – LEO satellite constellation. Existing low-earth orbiting communications, providing voice and limited internet access.

To address the user requirements identified through e-Navigation, a suite of digital communications options can be used. VDES provides digital communications capabilities for: addressed unicast (point to point); addressed multicast (point to predetermined group of vessels) and broadcast. Table 3 presents different existing or developing digital communications technologies.

Communication Technology	Data rate	Infrastructure	Coverage	Transmission	Maritime / public
NAVDAT	12-18 kbps	Based on NAVTEX	250/300NM	Broadcast	Maritime
VDES VDE	307 kbps	VHF Data link, RR Appendix 18 channels	Line of sight, approx 15NM-65NM Satellite component provides further coverage	Addressed / broadcast	Maritime
VDES ASM	19.2 kbps	VHF Data link, RR Appendix 18 channels	Line of sight, approx 15NM-65NM	Addressed / broadcast	Maritime
Wi-Fi (IEEE 802.11ac)	1,300 kbps	Routers/Access points	50m	Addressed	Public
Digital VHF	9.6 – 19.2 kbps	Base station/mobile radios	Line of sight, approx 15NM-65NM	Addressed	Maritime
Digital HF	19.2 kbps	Base station/mobile radios	Global	Addressed	Maritime

Communication Technology	Data rate	Infrastructure	Coverage	Transmission	Maritime / public
4G (including LTE)	600 Mbps	4G Base stations	5-30km (3-6 NM)	Addressed	Public
5G	1,200 Mbps	5G base stations	5-30km (3-6 NM)	Addressed	Public
GEO Satellite					
Inmarsat C	600 bps	Satellite service	Global, spot beams	Addressed / broadcast	Maritime
Inmarsat GX	50 Mbps	Satellite functioning on Ka band	Global, spot beams	Addressed / broadcast	Cross Industry
LEO Satellite					
Iridium	Up to 134 kbps	Satellite functioning on L band	Global, dependent on constellation size	Addressed / broadcast	Cross Industry (Iridium Pilot Maritime)

Table 3 Comparison of Digital Communications Technologies

3. POTENTIAL USES OF VDES

To assist in identifying possible options for use of VDES a number of potential scenarios have been developed. These are presented to provide context for development and implementation of digital communications, including VDES. The potential uses of VDES presented here are not intended to be an exhaustive list. It is expected that VDES uses will evolve as the system is implemented. The use cases are cross referenced to Maritime Service Portfolios as noted in Table 4.

Potential uses of VDES	MSP Reference
SAR Communications	MSP 9 - Telemedical Maritime Assistance Service (TMAS) MSP 16 - Search and Rescue (SAR) Service
Maritime Safety Information	MSP 5 - Maritime Safety Information (MSI) service MSP 13 - Ice navigation service MSP 14 - Meteorological information service MSP 15 - Real-time hydrographic and environmental information services
Ship Reporting	MSP 8 - Vessel shore reporting MSP 15 - Real-time hydrographic and environmental information services
Vessel Traffic Services	MSP 1 - VTS Information Service (IS) MSP 2 - VTS Navigation Assistance Service (NAS) MSP 3 - VTS Traffic Organization Service (TOS); MSP 4 - Local Port Service (LPS) MSP 6 - Pilotage service MSP 7 - Tugs service
Charts and Publications	MSP 11 - Nautical chart service MSP 12 - Nautical publications service MSP 15 - Real-time hydrographic and environmental information services

Potential uses of VDES	MSP Reference
Route Exchange	MSP 1 - VTS Information Service (IS) MSP 2 - VTS Navigation Assistance Service (NAS) MSP 3 - VTS Traffic Organization Service (TOS); MSP 4 - Local Port Service (LPS) MSP 5 - Maritime Safety Information (MSI) service MSP 6 - Pilotage service MSP 7 - Tugs service MSP 8 - Vessel shore reporting MSP 10 - Maritime Assistance Service (MAS) MSP 11 - Nautical chart service MSP 12 - Nautical publications service MSP 13 - Ice navigation service MSP 14 - Meteorological information service MSP 15 - Real-time hydrographic and environmental information services MSP 16 - Search and Rescue (SAR) Service
Logistics	MSP 7 - Tugs service

Table 4 Potential VDES Uses cross-referenced to IMO SIP MSP

3.1. SAR COMMUNICATIONS

SAR Communications are defined in existing documentation (ref SOLAS IV, SAR 79, IAMSAR Manual, NAVTEX manual and SafetyNet manual).

VDES is a technology that supplements AIS communications, and as such may be used for data communication of Maritime Safety Information (MSI) and supplementary distress communications. VDES supports both addressed (unicast and multicast) and broadcast communications to support SAR response.

When available, the VDES satellite component (VDE-SAT) may be an effective means to extend the VDES to areas outside of coastal VHF coverage. The VDES-SAT may deliver information in a broadcast, multicast or unicast mode to a broad area, addressing many ships using only minimal radio spectrum resources. The VDE-SAT will provide a communication channel that is complementary to GMDSS and the terrestrial components of the VDES system (i.e. coordinated with terrestrial VDES, application specific messages (ASM) and AIS functionalities and their supporting systems).

As a communications medium, VDES may be used to relay distress alerts and locating signals (i.e. SARTs). VDES has also potential to supplement other GMDSS functional requirements which require further development through the GMDSS review process.

In this use case the mix of current communications and developing communications techniques can enhance and improve the sharing of information in prosecution of a SAR incident. This would include text in free form / standard formats; transfer of waypoints / route information[5] for display on on-board equipment; transfer of GIS information / search patterns; images; etc.

The VDES can be used in SAR planning, execution and decision making.

3.1.1. SCENARIO - DISTRESS COMMUNICATIONS – DISTRESS RELAY

Once a distress alert is initiated and the information has been forwarded to a Rescue Coordination Centre (RCC) through the established GMDSS process, the RCC forwards information of the incident to vessels in the area. The

5 IEC standard 61174 Ed. 4 includes route exchange.

forwarding of information, using existing formats, could be provided by various communications means, including VDES. The forwarding of data over a digital communications system such as VDES could facilitate the integration and display of information on external systems on-board (for example, Radar, ECDIS). Information could then be passed to the RCC and other vessels in the area including course to intercept, ETA on-scene, on-scene conditions, sharing of a common operating picture, etc.

3.1.2. SCENARIO - SAR OPERATIONS – INITIATE SEARCH / RESPONSE

SAR Mission Co-ordinator (SMC) develops response to SAR using resources, search plan, etc. Information to prosecute SAR operation is transmitted to the On Scene Commander (OSC) and SAR response units (SRU) (for example information on resources, plan, waypoints for search pattern, SRU responsibilities, etc.). This could be done using VDES, providing a common operating picture and information using standard templates and formats.

3.1.3. SCENARIO - SAR OPERATIONS – INFORMATION EXCHANGE

During a SAR mission, the OSC and SRU provide regular updates on the search / response to the SMC. In addition, the OSC and SRU share information between each other to facilitate the response. The VDES could be used to exchange information on the SAR plan, SAR execution and other pertinent information to facilitate SAR operations. Information could be automatically integrated with, and portrayed on, external systems both ashore and on-board, including the RCC GIS, decision planning and support systems.

Using information from other systems, such as vessel route, information provided could be tailored to be relevant for the vessel based on its route.

In addition, the OSC and SRU could share information between each other to facilitate the response.

3.1.4. SCENARIO - TELE-MEDICAL

A tele-medical happens when a person is injured or sick on-board a vessel or platform and there is a need to communicate with a doctor ashore for medical assistance and prognosis. The conversation with doctor could be by voice, with transfer of images / photos / indication from medical equipment on patient's condition. VDES could be used to transfer advice, images or other information. Where there are language difficulties, VDES could assist with machine to machine communications and/or language independent communication. Information exchange could be integrated with, and portrayed on, external systems on-board or ashore (medical facility).

3.1.5. SCENARIO - MEDEVAC

A MEDEVAC may be necessary to evacuate a severely injured or sick person. VDES may be used to exchange pertinent medical information from the ship to the SRU and destination medical facility. The SAR Mission Co-ordinator (SMC) develops the response to prosecute the MEDEVAC and could use VDES to provide the plan to the ship and responding unit. Information on the status of the patient could be transferred during the MEDEVAC, both voice and from medical equipment on the SRU.

3.2. SAFETY RELATED INFORMATION

Information regarding safety of navigation and protection of the environment can be transmitted through the VDES. Safety related information could use the broadcast aspect of VDES.

This includes Maritime Safety Information (MSI) as defined in IMO SOLAS V, regulation 4 (navigational warnings), SOLAS V, regulation 5 (meteorological services and warnings) SOLAS V, regulation 9 (hydrographic services) and SOLAS V, regulation 31 (Danger Messages). Other references include MSC.1/Circ.1287 rev1; MSC.1/Circ.1288; (additional reference COMSAR Cir.15) the IMO Worldwide Radionavigation System IMO resolution A.706(17) (as amended) sets out the Worldwide Radionavigation System (WWRNS).

Near real-time information on meteorological and hydrographical information may be provided.

In this use case information shall be transmitted in standardised formats that can take advantage of the VDES capabilities (for example - IHO S-124 formats).

The requirement includes the ability to send information to a predetermined area (i.e. NAVAREA and METAREA) or an area of particular interest defined by administration.

3.2.1. SCENARIO - METEOROLOGICAL SERVICES AND WARNINGS / NAVIGATIONAL WARNINGS

It is important to have up to date information on the weather that can be expected along a ship's planned route. VDES could be used to facilitate information exchange relating to the route of the vessel, integrated with, and portrayed on external systems on-board.

3.2.2. SCENARIO - WEATHER OBSERVATIONS

Ships may participate in the provision of weather observations, as noted in MSC.1 Circ. 1293. This is a voluntary observing ship (VOS) scheme with information provided to the World Meteorological Organisation. VDES could facilitate this reporting, with information provided directly from on-board sensors.

3.2.3. SCENARIO - ICE MAPS

Information on sea ice conditions around a vessel is important to help ensure safe passage at sea. Knowledge of areas with sea ice along a ship's planned route allows ships to find the most efficient route at an early stage. Together with prognoses for expected ice movements, ice charts allow mariners to plan ahead and significantly reduce the risk of vessels becoming ice locked. VDES could be used to provide this information, which could then be integrated with, and portrayed on external systems on-board. In addition, information on the latest version of ice maps may be provided from mobile station to mobile station.

3.2.4. SCENARIO - NOTICES TO MARINERS

Notices to mariners are a means to disseminate navigational safety information (as part of maritime safety information). SOLAS V, Regulation 9 (Hydrographic Services) notes that administrations should undertake to arrange the dissemination and update of all nautical information necessary for safe navigation (for example. predictive and real-time tides and currents). VDES could be used to provide this information, and changes to information, with respect to the waterway.

3.2.5. SCENARIO - GNSS AUGMENTATION

SOLAS Chapter V, Regulation 19 notes that all ships, irrespective of size shall have a receiver for a global navigation satellite system or a terrestrial radio navigation system, or other means, suitable for use at all times throughout the intended voyage to establish and update the ship's position by automatic means. IMO Resolutions A.915(22) and A.953(23) provide the requirements for Maritime Radionavigation Systems. Distribution of GNSS augmentation corrections via VDES could allow GNSS users to get timing, integrity data and improved position accuracy.

3.2.6. SCENARIO - CROWD SOURCED INFORMATION

Information from users or ship systems may enhance and/or validate meteorological hydrological and hydrographic information that is made available to other vessels in the area and authorities. VDES could be used to facilitate crowd sourced information.

3.3. SHIP REPORTING

Ship reporting can include mandatory and voluntary reports required for a number of purposes by vessels to various shore authorities. Information on ship reporting is provided in IMO SOLAS V, regulation 11 (ship reporting systems), 19-1 (LRIT), regulation 31 (danger messages), regulation 32 (information required in danger messages), MARPOL and SAR Convention, Chapter 5. Additional information on ship reporting is contained in Resolution A.851(20) and FAL.5/Circ.36.

Information forwarded through VDES may transfer the reports for integration into national and/or regional systems could be sent by VDES. (i.e. SafeSeaNet, VTS). Information may also be sent to the ship agent or owner or a service provider. Ship reporting could use the addressed (unicast and multicast) aspect of VDES.

3.3.1. SCENARIO - SUBMIT ARRIVAL NOTICE

A notice of arrival report is based on known content and could be set in a template form. The aspects of the template report, such as information on the ship particulars, would be pre-populated. Where possible, additional information related to the voyage, such as destination, ETA destination, last port(s) could be populated from other systems that contain such information. Other information that may be provided include ISPS reports; ship crew information; information specifically required by the shore authority. This may be submitted using data populated automatically from other systems or may require manual input by the mariner. VDES could facilitate exchange of information using existing formats.

3.3.2. SCENARIO - SUBMIT UPDATED INFORMATION

As the voyage continues, updated information will be provided. This can include updated estimated time of arrival; change in condition of the vessel; change in route of the vessel. This is a user defined report, which could be based on a set template for 'updated information' or free-text report. VDES could facilitate exchange of information using existing formats. The vessel may be interrogated for information on request, based on its route, operating area or position.

3.3.3. SCENARIO - PROVIDE INITIAL REPORT TO SHORE (PRIOR TO DEPARTURE)

Prior to departure specific, standard information is required. This may include information required for clearance to depart. Reports could be pre-populated from available information where possible. Specific information may be required to be entered manually.

3.3.4. SCENARIO - SECURE SHIP REPORTING

There can be times when it is necessary for secure ship reporting, including times when the vessel may switch off AIS. Using VDES, information could be forwarded through a secure communications link.

3.3.5. SCENARIO - DANGER MESSAGE

The Master of a vessel is required to report dangerous conditions (SOLAS V, regulation 31 and 32), such as: dangerous ice, derelicts, dangers to navigation, tropical storm, severe weather, ice accretion. VDES could facilitate the provision of this information to both shore authorities and other vessels in the area. Information exchange may be integrated with, and portrayed on, external systems on-board.

3.4. VESSEL TRAFFIC SERVICES

Vessel Traffic Services is included in SOLAS Chapter V, Regulation 12, with further information in IMO Resolution A.857(20). Three key services provided by VTS are:

1 Information Service.

2 Navigational Assistance Service.

3 Traffic organisation Service.

An Information Service involves maintaining a traffic image and allows interaction with traffic and response to developing traffic situations. An Information Service should provide essential and timely information to assist the on-board decision-making process.

Information required by the VTS can be both standardised (supported by templates) or specific to a situation. VTS could use both the addressed (unicast and multicast) and broadcast aspects of VDES.

VTS involves maintaining a vessel traffic image, and relies on vessel tracking from sensors such as radar, AIS, CCTV, other VTS centres. The vessel traffic image may be supplement with crowd-sourced information from vessels data (sensor data from ships provided to the shore to expand the traffic image range).

VTS also requires interaction with traffic to respond to developing traffic situations.

VTS relies on the ability to provide essential and timely information; monitor the actions of vessels in the VTS area, including monitoring routes and changes in route; interacting with other VTS centres in the region; interact with other port agencies (allied services).

Ports may also provide a specific Local Port Service (LPS) where it is deemed through a risk assessment that a VTS is not required.

3.4.1. SCENARIO - WATERWAY MONITORING

VTS provides monitoring and other services. VDES may be used to monitor vessels and autonomously provide information to these vessels based on predetermined parameters as defined by the shore authority. In addition, VDES may enable sharing of information on synthetic VTS targets from the VTS to vessels transiting the VTS area. Information exchange may be integrated with, and portrayed on, external systems ashore and on-board.

3.4.2. SCENARIO - INFORMATION SERVICE

Information Service (INS) is provided by broadcasting information at fixed times and intervals or when deemed necessary by the VTS, or at the request of a vessel. The information provided may include safety information as previously defined. Additional information could include specific limitations for navigation in the VTS area (for example manoeuvrability limitations; draft restrictions; channel closures; diving operations). Information exchange may be integrated with, and portrayed on, external systems ashore and on-board.

3.4.3. SCENARIO - NAVIGATIONAL ASSISTANCE SERVICE

The navigational assistance service (NAS) is defined by IMO as **'**a service to assist on-board navigational decision-making and to monitor its effects**'.** NAS may be provided on request by a vessel in circumstances such as equipment failure or navigational unfamiliarity. VDES could be used in the exchange of information during the provision of NAS. Information exchange may be integrated with, and portrayed on, external systems ashore and on-board.

3.4.4. SCENARIO - TRAFFIC ORGANISATION SERVICE

The traffic organisation service (TOS) is defined by IMO as **'**a service to prevent the development of dangerous maritime traffic situations and to provide for the safe and efficient movement of vessel traffic within the VTS area'. The purpose of the TOS is to prevent hazardous situations from developing and to ensure safe and efficient navigation through the VTS area. VDES could be used to exchange this information. Information exchange may be integrated with, and portrayed on, external systems ashore and on-board.

3.5. CHARTS AND PUBLICATIONS

IMO SOLAS Chapter V, Regulation 27 (nautical charts and nautical publications) notes that charts and publications necessary for the intended voyage shall be adequate and up to date. Provision of information on charts and publications could use the addressed (multicast) and broadcast aspects of VDES.

The aim of nautical chart and publication services are to safeguard navigation at sea by providing information such as nature and form of the coast, water depth, tides table, obstructions and other dangers to navigation, location and type of aids to navigation.

The nautical chart and publication services ensure the official distribution, update and licensing of electronic charts and publications to vessels and other users.

Nautical publications include list of lights, sailing directions, tide and current tables, etc.

There may be a requirement for a 'user pay' aspect for some services (i.e. ENC updates).

3.5.1. SCENARIO - UPDATES LINKED TO A SHIPS' ROUTE

An example of this would be a vessel proceeding to a specific location. At the time of sailing, the vessel had all required charts and publications for the voyage. These charts and publications were the most up to date at the time of sailing, however some information may have changed during the voyage. Updated information could be

provided through VDES as the vessel as it continues on its voyage, providing information based on the route of the vessel, and limiting the updates to only that information that has changed. Information exchange may be integrated with, and portrayed on, external systems ashore and on-board.

3.6. ROUTE EXCHANGE

The development of e-navigation has highlighted the opportunity to make effective use of digital data exchange to support safe and efficient vessel movements. Projects such as Mona Lisa, EfficienSea and ACCSEAS have included the development of route exchange. (IEC 61174 edition 4 annex S refers.)

Route exchange could enhance safety by providing early indication of changes in route which may be due to fatigue, weather conditions, or condition of the vessel (possible malfunction).

The use of route exchange could assist with fleet management, whereby information on routes can be exchanged with shore personnel as well as other vessels in the fleet.

In addition, the use of route exchange could assist with route and speed optimisation based on weather and currents; just in time arrival and traffic congestion.

Route exchange could take advantage of the addressed (unicast and multicast) and broadcast aspects of VDES.

3.6.1. SCENARIO - SHIP TO SHIP

This scenario is outside of VTS coverage areas, noting that within a VTS area, route exchange would be through the VTS. Ship to ship route exchange would assist vessels on a transit by predicting when interactions may occur. VDES could assist in the exchange of digital data to facilitate ship to ship route exchange.

3.6.2. SCENARIO - SHIP TO SHORE

To inform shipping and other waterway users of possible hazardous situations shore authorities need information about the intentions of the waterway users, such as their intended route. Based on this information the authorities could organize traffic and, when needed, recommend other routes/possibilities for a safer passage and also provide information about the waterway.

3.6.3. SCENARIO - SHORE TO SHIP

Before ships enter a sea area monitored by a shore authority, information about this area could be provided to assist in a safe and efficient passage. If the route of the vessel is known, information can be tailored to the route. The shore authority could link the vessel planned route with other information received, such as cargo, and adjust the information as may be required. Route plans received from ships can be used for detecting possible traffic congestions and high risk situations in advance. Shore authorities can also send alternative route recommendations to ships when needed. This allows ships to choose the route that is most suitable for its navigation. VDES can facilitate reception of route plans which may be integrated with, and portrayed on, external systems ashore.

3.6.4. SCENARIO - NAVIGATIONAL DISRUPTION

There may be some event or circumstance that impacts the normal operation of the waterway requiring urgent traffic management to ensure continuity of operations. VDES could be used to share information on the circumstance, and proposed alternate routing could assist in effective movement of vessels throughout the incident.

3.7. LOGISTICS / SERVICES

When sailing from berth to berth before, during and after the voyage there are several logistical aspects that must be addressed. Most of these are done by an agent on the shore but are changed because of different reasons. The means of communicating these logistical aspects would depend on the location of the ship / shore elements involved and could include VDES. In cases where cargo is transferred at sea (transhipment) the location

could be out of range of other communications and VDES would be the preferred communication exchange platform.

Information transfer could assist with efficiency of the overall cargo chain (for example the MonaLisa Sea Traffic Management (STM) concept). Logistics/Services could use the addressed (unicast and multicast) aspects of VDES.

Sharing of route information could assist with allied services related to shipping and ship movements - this could include locks, pilotage, tug allocation, shore resources, and other logistical aspects. This use case represents the business to business aspect.

Logistical elements where VDES may be an appropriate communication method include:

- Transfer of vessel loading plan;
- Tug operations;
- Pilotage operations;
- Stores / supplies / ship bunkers required; waste removal.

3.7.1. SCENARIO - LOGISTIC SERVICES – SHIP TO SHORE

Ship arriving at a port forwards revised time of arrival and requests confirmation for stores, fuel, access to waste facilities. Vessel also requires information on pilots and tugs and other aspects for the transit. VDES provides an opportunity for automated exchange of information to support these types of requests.

3.7.2. SCENARIO - LOGISTIC SERVICES – SHORE TO SHIP

As the ship arrives, the shore authority will provide confirmation regarding offloading, loading of the vessel and respond to requests from the ship. VDES provides an opportunity for automated exchange of information to support these types of requests.

4. DEFINITIONS

The definitions of terms used in this Guideline can be found in the International Dictionary of Marine Aids to Navigation (IALA Dictionary) at http://www.iala-aism.org/wiki/dictionary and were checked as correct at the time of going to print. Where conflict arises, the IALA Dictionary should be considered as the authoritative source of definitions used in IALA documents.

5. ACRONYMS

ACCSEAS	Accessibility for Shipping, Efficiency, Advantages and Sustainability (EU research project)
ACK	Acknowledgement
ACM	Address Complete Message
AIS	Automatic Identification System
AIS 1	AIS Default Channel 1 - 161.975 MHz (Ch. 87B//2087)
AIS 2	AIS Default Channel 2 - 162.025 MHz (Ch. 88B/2088)
App	Application
ASC	Assignment Channel
ASM	Application Specific Messages
BBM	Broadcast Binary Messages
BITE	Built in test equipment
CCTV	Closed-Circuit Television
Circ.	Circular (IMO document)

COMSAR	Sub-Committee on Communications and Search and Rescue (IMO)
DSC	Digital Selective Calling
ECDIS	Electronic Chart display & Information System
ENC	Electronic Navigation Chart
ETA	Estimated Time of Arrival
FAL	Facilitation Committee (IMO)
FEC	Forward error correction
GIS	Geographic Information System
GMDSS	Global Maritime Distress and Safety System
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
IAMSAR	International Aeronautical and Maritime Search and Rescue (manual)
IEC	International Electrotechnical Commission
IHO	International Hydrographic Organization
IMO	International Maritime Organization (UN)
INS	Information Service
ISPS	International Ship and Port Facility Security (Code)
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union-Radiocommunication Sector
kbps	kilobits per second
kHz	Kilohertz
LPS	Local Port Service
LRIT	Long Range Identification & Tracking
MARPOL	International Convention for the prevention of pollution from ships (IMO 1973 as amended)
MAS	Maritime Assistance Service
MCS	Modulation and Coding Scheme
MEDEVAC	Medical evacuation
METAREA	Geographical sea region for the purpose of co-ordinating the transmission of meteorological information
MHz	Megahertz
MMSI	Maritime Mobile Service Identity
MSC	Maritime Safety Committee (IMO)
MSI	Maritime Safety Information
MSP	Maritime Service Portfolio(s)
NACK	Not Acknowledgement
NAS	Navigation Assistance Service
NAVAREA	Geographic area in which various governments are responsible for navigation and weather warnings
NAVTEX	Navigational Telex (service)
NCSR	Navigation, Communications and Search and Rescue (IMO Sub-Committee)
OSC	On-scene commander
PI	Presentation Interface

PSK	Phase-Shift Keying
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase-Shift Keying
RCC	Rescue Co-ordination Centre
RA	Random Access
RACH	Random Access Channel
RF	Radio Frequency
RR	Radio Regulations
RTCM	Radio Technical Commission for Maritime Service
SAR	Search and Rescue
SART	Search and Rescue Transponder
SAT	Satellite
Serv	Server
SIP	Strategic Implementation Plan
SOLAS	International Convention for the Safety of Life at Sea, (IMO 1974 as amended)
SRU	Search and Rescue Unit
TBB	Terrestrial Bulletin Board
TDMA	Time-division multiple access
TMAS	Telemedical Maritime Assistance Service
TOS	Traffic Organization Service
UDCH	User Data Channel
UTC	Co-ordinated Universal Time
VDE	VHF Data Exchange
VDES	VHF Data Exchange System
VDL	VHF Data Link
VHF	Very High Frequency (30 MHz to 300 MHz)
VOS	Voluntary observing ship
VTS	Vessel Traffic Service
WRC	World Radiocommunications Conference
WWRNS	World-wide Radionavigation System

ANNEX A TECHNICAL OVERVIEW OF VDES

A 1. INTRODUCTION:

The VHF Data Exchange System (VDES) extends the Automatic Identification System (AIS) as defined in the ITU-R M.1371by adding new technology. VDES is defined in ITU-R M.2092.

This technical overview assumes a basic knowledge of AIS and provides an overview of VDES.

A 2. VDES DESCRIPTION:

VDES is a combination of technologies that includes AIS, ASM and VDE. The VDES Presentation Interface (PI) remains largely the same as the AIS PI but will include several new IEC 61162-1 messages to allow for the configuration of the VDES capability and facilitate the transfer of larger amounts of data.

The primary differences between AIS and the two new VDES technologies, ASM and VDE, are:

1. The Modulation and Coding Scheme (MCS).
2. The Radio Frequencies (RF) used the Radio Frequency bandwidth.
3. The data bandwidth.
4. The methods used by the Link Layer.

A 2.1. THE MODULATION AND CODING SCHEMES

The modulation and coding schemes range from Gaussian Minimum Shift Keying (GMSK) for AIS to π/4 Quadrature Phase-Shift Keying (π/4QPSK) for ASM and π/4QPSK, 8 Phase-Shift Keying (8PSK) and 16 Quadrature Amplitude Modulation (16QAM) for VDE.

The Radio Frequency (RF) bandwidth on the technologies differ with AIS and ASM both having a RF bandwidth of 25kHz per channel and VDE having a bandwidth of 100kHz per channel.

AIS uses AIS1 and AIS2; ASM uses ASM1 and ASM2; and VDE uses VDE1a and VDE1b (refer to figure 2).

AIS and ASM are simplex channels (can carry traffic in one direction at a time) and VDE1a and VDE1b form a duplex pair that allows data to be transferred in both directions at the same time.

A 2.2. THE RADIO FREQUENCIES USED AND BANDWIDTH

At an overview level, the AIS and ASM use 2 X 25kHz channels. VDE can use 2 X 25kHz; or 2 X 50 kHz or 2 X 100kHz channels in the maritime VHF band. The allocated frequencies are as follows:

Technology	Radio Frequencies used	Radio Regulations channel number
AIS 1	161.975 (25kHz)	87B
AIS 2	162.025 (25kHz)	88B
AIS Long Range 1	156.775 (25kHz) (ships are TX only)	75
AIS Long range 2	156.825 (25kHz) (ships are TX only)	76
ASM 1	161.950 (25kHz)	2027
ASM 2	162.000 (25kHz)	2028
VDE 1	157.200 to 157.275 (100kHz) (Ship TX)	1024, 1084, 1025 and 1085 combined
VDE 2	161.800 to 161.875 (100kHz) (Ship RX)	2024, 2084, 2025 and 2085 combined

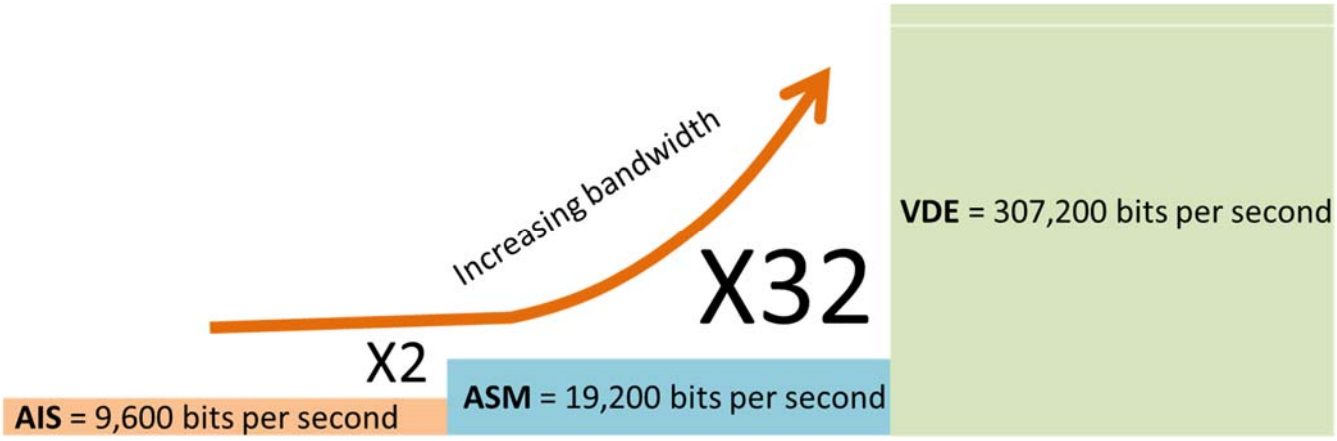
Table 5 Frequencies allocated to VDES

A 2.3. THE DATA BANDWIDTH

The modulation schemes π/4QPSK (ASM and VDE), 8PSK and 16QAM (VDE only) allow more data to be transferred in the same Radio Frequency (RF) bandwidth than was possible with AIS (GMSK).

The increase in data bandwidth is illustrated in Figure 5.

Figure 5 Increasing data bandwidth in VDES



Note: Figures shown reflect raw bandwidth. It is expected that there will be up 33.4 kbps (net bitrate) per vessel.

1.1 THE METHODS USED BY THE LINK LAYER

The ASM and VDE technologies use the same AIS slot map of 2,250 slots per RF channel (4,500 slots for two RF channels used in parallel in AIS and ASM technologies). Due to the larger data bandwidth resulting from the use of π/4QPSK modulation, the number of bits transferred in any one slot is increased in ASM when compared with AIS. The VDE frequencies and the Modulation and Coding Scheme (MCS) are dynamic and are chosen by a combination of the Terrestrial Bulletin Board (TBB) (section A 4 refers) and by the Link Layer.

The Link Layers of AIS, ASM and VDE are different and each are optimised for the data bandwidth available.

The VDE Link Layer is more complex and uses a different Link Layer to facilitate communication between vessels (ship to ship) and between the shore and a vessel (shore to ship).

A 3. FORWARD ERROR CORRECTION

ASM and VDE uses Forward Error Correction (FEC) which allows for the correction of errors in the data transferred in both ASM and VDE. FEC increases the integrity and reliability of the transmission.

A 4. THE TERRESTRIAL BULLETIN BOARD

The VDES technology uses a Terrestrial Bulletin Board (TBB) consisting of 108 bytes to assign the primary operating environment parameters to the Control Station Service Area. This includes which frequencies are being used and the service area dimensions amongst a range of other technical detail. To provide a level of protection to the VDES communication environment, the TBB is authenticated. Authentication confirms that the TBB is transmitted by a trusted entity.

By monitoring the TBB (is there one to be received or not), ships will determine if they are within a Control Station service area. In a control service area the Control Station manages the timing of ship to ship transmissions.

A 5. LOGICAL CHANNELS

When using VDE, one of 5 logical channels are dynamically allocated (shown as logical channel 8, 9, 10, 11 and 12 in the diagram below) by the Link Layer to carry the data in the User Data Channel (UDCH). The TBB (TBB), Assignment Channel (ASC) and Random Access Channel (RACH) are also part of the VDE Link Layer that ensures that the VDE channel is optimally used to carry the user data. Figure 6 provides an example of channel configuration.

Figure 6 Example of a channel configuration

Logical Channel	Hexslot		Logical channel 8	9	10	11	12	Logical Channel	Hexslot		Logical channel 8	9	10	11	12
0	0	0	1	2	3	4	5	0	0	TBB	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
	1	6	7	8	9	10	11		1	TBB	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
	2	12	13	14	15	16	17		2	TBB	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
	3	18	19	20	21	22	23		3	TBB	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
	4	24	25	26	27	28	29		4	TBB	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
1	5	30	31	32	33	34	35	1	5	ASC1	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
2	6	36	37	38	39	40	41	2	6	ASC2	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
3	7	42	43	44	45	46	47	3	7	ASC3	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
4	8	48	49	50	51	52	53	4	8	ASC4	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
5	9	54	55	56	57	58	59	5	9	ASC5	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
6	10	60	61	62	63	64	65	6	10	RACH	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
1	11	66	67	68	69	70	71	1	11	ASC1	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
2	12	72	73	74	75	76	77	2	12	ASC2	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
3	13	78	79	80	81	82	83	3	13	ASC3	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
4	14	84	85	86	87	88	89	4	14	ASC4	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
5	15	90	91	92	93	94	95	5	15	ASC5	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
6	16	96	97	98	99	100	101	6	16	RACH	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
1	17	102	103	104	105	106	107	1	17	ASC1	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
2	18	108	109	110	111	112	113	2	18	ASC2	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
3	367	2202	2203	2204	2205	2206	2207	3	367	ASC3	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
4	368	2208	2209	2210	2211	2212	2213	4	368	ASC4	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
5	369	2214	2215	2216	2217	2218	2219	5	369	ASC5	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
6	370	2220	2221	2222	2223	2224	2225	6	370	RACH	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
1	371	2226	2227	2228	2229	2230	2231	1	371	ASC1	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
2	372	2232	2233	2234	2235	2236	2237	2	372	ASC2	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
3	373	2238	2239	2240	2241	2242	2243	3	373	ASC3	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5
4	374	2244	2245	2246	2247	2248	2249	4	374	ASC4	UDCH1	UDCH2	UDCH3	UDCH4	UDCH5

The Random Access Channel can be used for small data messages allowing the User Data Channels to be available for larger messages.

The User Data Channel is allocated to the user for a number of slots that is related to the size of the data block that has to be transferred.

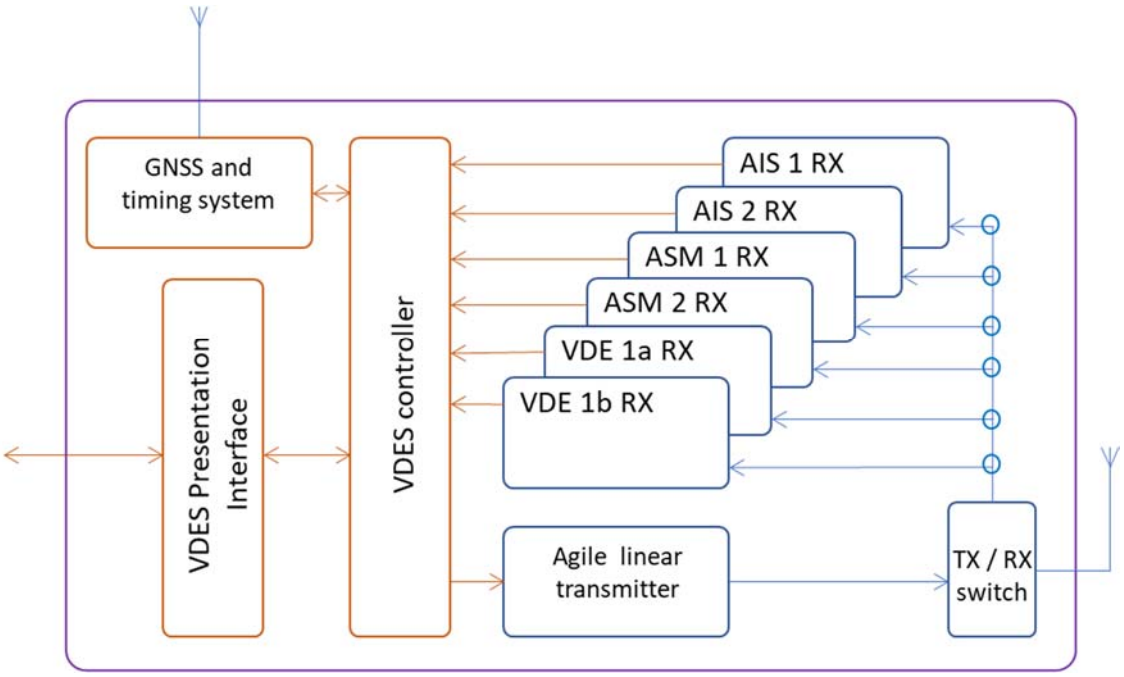
The VDE shore station will normally transmit the TBB at the start of a frame. Just as in AIS, the VDE frame is one minute in duration.

When a ship is outside the service area of a TBB, the ship is able to transmit data directly to another ship using ship to ship mode. A ship will determine it is out of the service area when it does not detect a TBB being broadcast by a VDE Control Station within 15 minutes or the vessel detects it is in a position outside of the service area.

A 6. VDES SHIP AND SHORE STATION

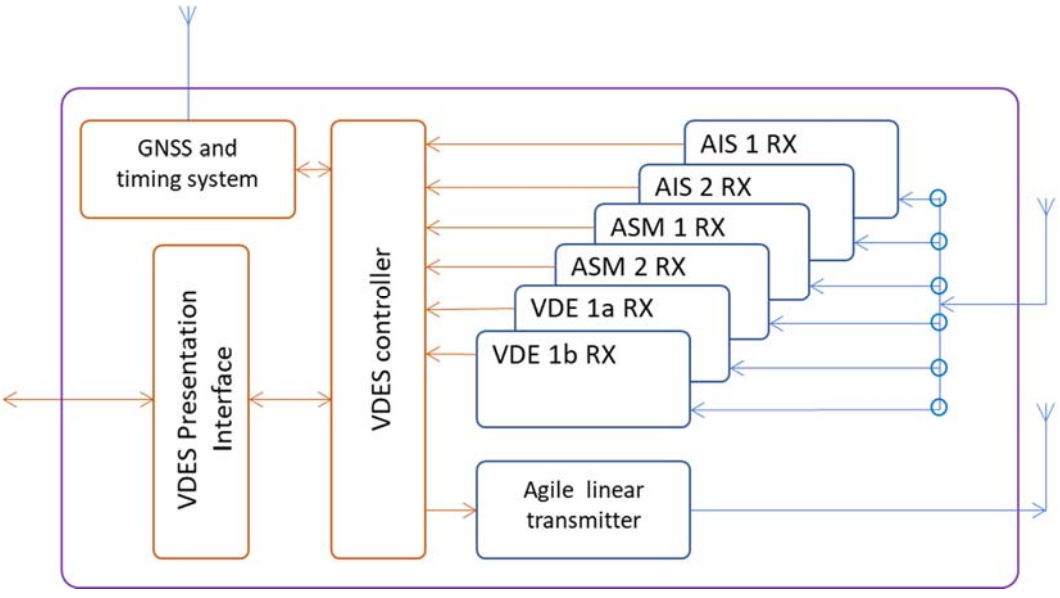
The VDES ship station has the following logical description.

Figure 7 VDES ship station logical description



The VDES shore station has the following logical description

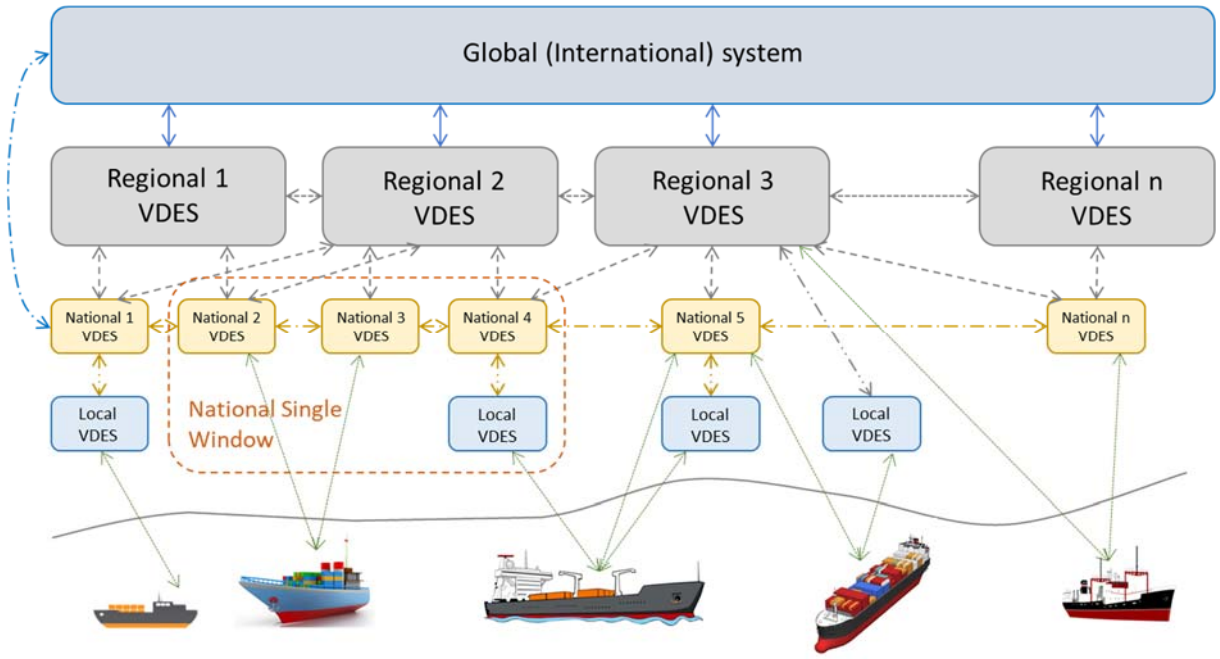
Figure 8 VDES shore station logical description



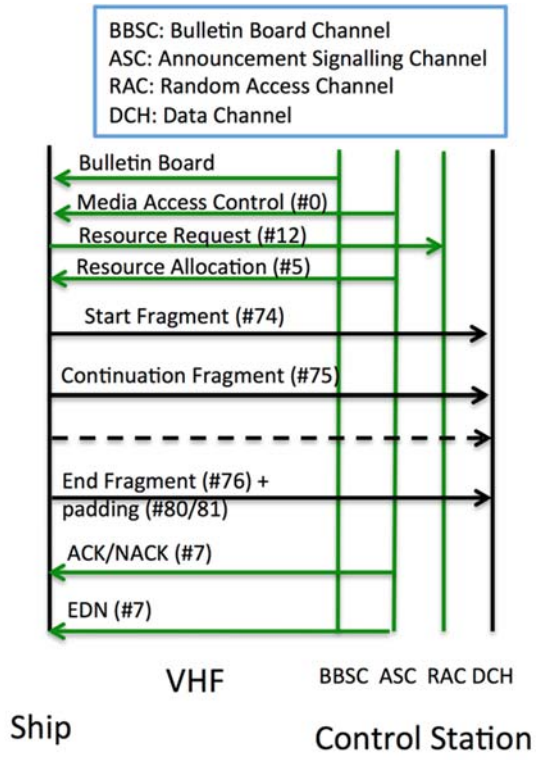
The primary differences between the ship and shore station are in the Presentation Interface, the Link Layer functionality (the shore station is the control station) and the antenna system (the shore station allows for connection to a more complex antenna system by separating the receive and transmit paths to the antenna system).

The VDES fit into the Common Shore Side Architecture (IALA Guideline 1113) in the same manner as does AIS as illustrated below.

Figure 9 VDES into the Common Shore Side Architecture



A 7. EXAMPLE TRANSACTION BETWEEN SHIP AND SHORE



The transfer starts with the ship requesting VDE Control Station resources. The VDE Control Station allocates an exclusive Logical Channel for the transfer. The diagram shows a large multi-fragmented datagram. Normally up to 16 fragments are sent before the VDE Control Station sends a selective NACK indicating which fragments have to be resent. The Logical Channel is kept allocated until all fragments have been received by the VDE Control Station and the final ACK has been received or the retry limit has been exceeded.

The End Delivery Notification is optional and defined in the datagram payload, it is mainly used in store-and-forward systems.

The described transaction is illustrated in the protocol timing diagram (Figure 10).[6]

Figure 10 Ship control station

6 Source – ITU-R M.2092-0

A 8. VDE LINK LAYER MESSAGES

Message number	Direction	Function
0	To ship signalling packets	Media Access Control
1	To ship Announcement/Paging	Paging a specific ship for in-coming datagram
2	To ship Announcement/Paging	Paging a specific ship for mobility management update
3	To ship signalling packets	Multicast resource allocation announcement
4	To ship signalling packets	Unicast to ship resource allocation announcement
5	To ship signalling packets	Unicast resource allocation announcement to ship originated requests
6	To ship signalling packets	To ship Access Denied/Resource de-allocation
7	To ship signalling packets	Control station ACK/ACM
8 and 9	Not allocated	
10	From ship signalling packets	Ship response to Announcement/Paging
11	Allocated to future satellite service	
12	From ship signalling packets	Ship resource request
13	From ship signalling packets	Ship ACK/ACM
14	Allocated to future satellite service	
15	From ship signalling packets	Ship de-allocation request
16	Allocated to future satellite service	
17 to 19	Not allocated	
20	To ship data packet types	Bulletin Board datagram
21	To ship data packet types	Zero padding variable length
22	To ship data packet types	Zero padding single byte
23	To ship data packet types	Group Multicast start datagram
24	To ship data packet types	Area Multicast start datagram
25	To ship data packet types	Network operator text message to all ships
26	To ship data packet types	To ship Start Fragment/Single Fragment
27	To ship data packet types	To ship Continuation Fragment
28	To ship data packet types	To ship End Fragment
29	To ship data packet types	Network operator binary message to all ships
30	To ship data packet types	To ship short unicast message
31 to 39	Not allocated	
40	From ship Data packet formats	Short RA message from ship (with ACK)
41 to 56	Allocated to future satellite service	
57	From ship Data packet formats	Short RA message from ship (without ACK)
58 to 73	Allocated to future satellite service	
74	From ship Data packet formats	From ship Start Fragment/Single Fragment
75	From ship Data packet formats	From ship Continuation Fragment
76	From ship Data packet formats	From ship End Fragment
77 to 79	Not allocated	
80	From ship Data packet formats	Zero Padding Variable length
81	From ship Data packet formats	Zero Padding Single byte
82 to 89	Not allocated	
90	Ship to ship	Ship paging ship
91	Ship to ship	Ship response to Paging

Table 6 VDE link layer messages