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| --- |
| IALA Guideline |

2017-03-04 Ernie says The missing detail is as follows:

1) Details of the Terrestrial Bulletin Board

2) Details of the ASM Terrestrial Link Layer (similar to AIS and being completed by the USCG - Johnny Schultz)

3) Details of the VDE Terrestrial Link Layer (In draft by Krystof Bronk - needs to be aligned with the ITU-R M.1371-5 and ITU-R M.2092-0)

4) Details of the Terrestrial Bulletin Board authentication methodology (four option on the table with the last two being submitted at the Cape Town WG3 intersessional - the last one submitted is probably going to be the accepted implementation)

Once these items are included, the VDES Technical Overview can be released / published (?) and then consideration can be given to combining both VDES Overview documents into a single document.

1???

VHF Data Exchange System (VDES) Technical Overview

Edition 1.0 (Draft)

<Document date>

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

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| Date | Page / Section Revised | Requirement for Revision |
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|  |  |  |

1. INTRODUCTION 5

1.1. Purpose of the document 5

1.2. Background 5

1.3. Overview 6

1.4. VDES Technical Overview 6

1.5. Assumptions and dependencies 7

1.6. VDES SERVICES 7

2. VDES SHORE INFRASTRUCTURE CONSIDERATIONS (PHYSICAL/LOGICAL) 9

2.1. OSI 7 layer implementation 9

2.1.1. Application layer 9

2.1.2. Presentation layer 9

2.1.3. Transport layer 9

2.1.4. Network layer 10

2.1.5. Link layer 10

2.1.6. Physical layer 10

2.2. System topology concept 10

2.3. Radio frequency performance 11

2.3.1. Physical channels 12

2.3.2. Logical channels 12

2.4. ASM and VDE packet format 13

2.5. VDES base station 13

2.6. VDES base station connection 14

3. The TERrestrial Bulliten Board (TBB) 15

4. Terrestrial Link Layer 17

5. Message addressing 17

6. Local, national regional and international networks 18

7. INTEGRITY MONITORING AND AUTHENTICATION 20

8. Message Priority 20

9. Service Layer 20

10. DEFINITIONS AND ACRONYMS 22

List of Tables

Table 1 - Considerations for VDES Implementation 8

Table 2 - Seven layer OSI model 9

Table 3 - ASM and VDE frequencies of operation and bandwidth allocations 11

Table 4 - Channel bandwidth versus symbol rate (kS/s) 11

Table 5 - Channel bandwidth (kb/s) versus Data throughput and Modulation and Coding Schemes 12

List of Figures

Figure 1 - VDES functions and frequency use 6

Figure 2 - ASM and VDE decision matrix 7

Figure 3 - VDES conceptual topology 10

Figure 4 - General ASM and VDE Packet Format 13

Figure 5 - VDES base station components 13

Figure 6 - Multiple VDES base station connection 14

Figure 7 - The CSSA model 15

Figure 8 - Terrestrial Bulletin Board 16

Figure 9 - ASM and VDE Dynamic Naming Service integration 17

Figure 10 - CSSA model 18

Figure 11 - Coverage and Service areas 18

Figure 12- Local VDES network 19

Figure 13 - National VDES network 19

Figure 14 - International VDES network 20

# INTRODUCTION

## Purpose of the document

This guideline provides an introduction to the technical implementation of a VHF Data Exchange System (VDES) environment at an overview level and is supported by the VDES Overview guideline already published.

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

## 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.

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 (RR 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 (Appendix 18 of the International Radio Regulations) 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]](#footnote-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]](#footnote-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]](#footnote-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.

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.

## 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.

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.

The baseline for VDES spectrum allocation is according to the frequency utilisation plan illustrated in Figure 1.



Figure 1 - VDES functions and frequency use

where:

1. Four channels 1024, 1084, 1025 and 1085 are shared between ship-to-shore and ship-to-satellite (VDE-SAT uplink) services
2. Two channels 1026 and 1086 are exclusively reserved for ship-to-satellite communications
3. Four channels 2024, 2084, 2025 and 2085 are shared among shore-to-ship, ship-to-ship and satellite-to-ship (VDE-SAT downlink) services
4. Two channels 2026 and 2086 are exclusively reserved for future satellite-to-ship communications services.

## VDES Technical 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 along with ASM and/or 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).

## Assumptions and dependencies

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

1. ASM and VDE 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.

## VDES SERVICES

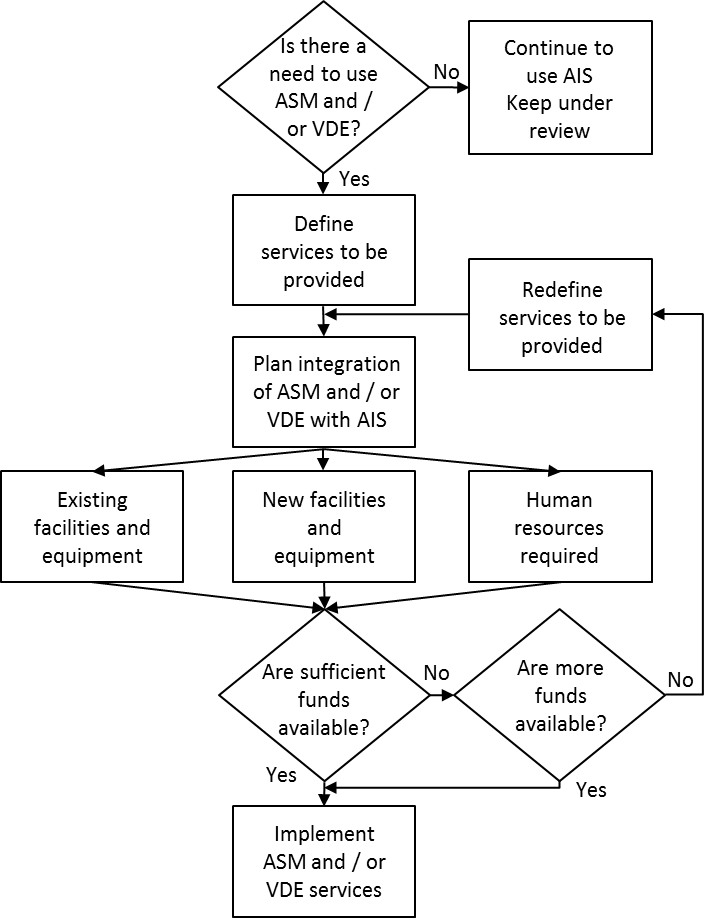
Deciding to implement a VDES service follows the decision matrix illustrated in Figure 2.

Figure 2 - ASM and VDE decision matrix

Table 1 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]](#footnote-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 1 - 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.

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.

**[VDES has no defined method of managing transmitted message priorities (e.g. priority 1 to 32 essential services and 33 to 64 for non-essential services). Priority will be implemented at the application layer with the VDES base station having limited message buffering capability and thus not requiring any priority mechanism]**

**[VDES has no defined method of managing presented load. This is to be added to the bulletin board with the bulletin board announcing which traffic can be presented at any particular time. This could be priority based (e.g. priority 1 to 32 essential services and 33 to 64 for non-essential services) or simple essential versus non-essential services based]**

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. Data transfers are recommended to be limited to messages that can be transferred within 1(?) second within the system being used (channel bandwidth, modulation type and base station design dependent).

# VDES SHORE INFRASTRUCTURE CONSIDERATIONS (PHYSICAL/LOGICAL)

The VDES shore side infrastructure considers the following:

1. OSI 7 layer implementation
2. System Topology Concept
3. Radio frequency performance
4. ASM and VDE packet format
5. VDES base station connection
6. The Terrestrial Bulletin Board (TBB)

These are covered in more detail below.

## OSI 7 layer implementation

The VDES base station ends at the OSI level 5 of the OSI 7 layer model illustrated below.

The VDES architecture should utilize the open systems interconnection layers 1 to 4 (physical layer, link layer, network layer, transport layer) as illustrated below in Table 2.

|  |  |
| --- | --- |
| Layer | Description |
| 1 | Application layer |
| 2 | Presentation layer |
| 3 | Session layer |
| 4 | Transport layer |
| 5 | Network layer |
| 6 | Link layer |
| 7 | Physical layer |

Table 2 - Seven layer OSI model

Responsibilities of the OSI layers for preparing VDES data for transmission:

### Application layer

The application layer is the application that collects, stores and processes the VDES data on the shore side.

### Presentation layer

The presentation layer is the interface between the application layer and the transport layer and is defined by IEC61162. For VDES transceivers:

1. Data may be input via the presentation interface to be transmitted by the VDES station;
2. Data received by the VDES station should be output through the presentation interface.

### Transport layer

This layer ensures reliable transmission of the data segments between ships, ship and shore, and ship and satellite, including segmentation, acknowledgement and multiplexing.

### Network layer

This layer is responsible for the management of priority assignments of messages, distribution of transmission packets between channels and data link congestion resolution.

### Link layer

This layer ensures reliable transmission of data frames between ships, ship and shore, and ship and satellite. The link layer is divided into three sub-layers with the following tasks:

#### Link management entity

Assemble unique word, format header, Physical Layer Frame (PL-Frame) headers, pilot tones (satellite) and VDES message bits into packets.

#### Data link services

Calculates and adds CRC check sum and completes the PL-Frame/packet.

#### Media Access Control

Provides methods for granting data transfer access.

### Physical layer

This layer provides transmission and reception of raw bit streams over a physical medium including signal modulation, filtering/shaping upon transmission, and amplification, filtering, time and frequency synchronization, demodulation, and decoding upon reception.

## System topology concept

The VDES is conceptually connected as illustrated in Figure

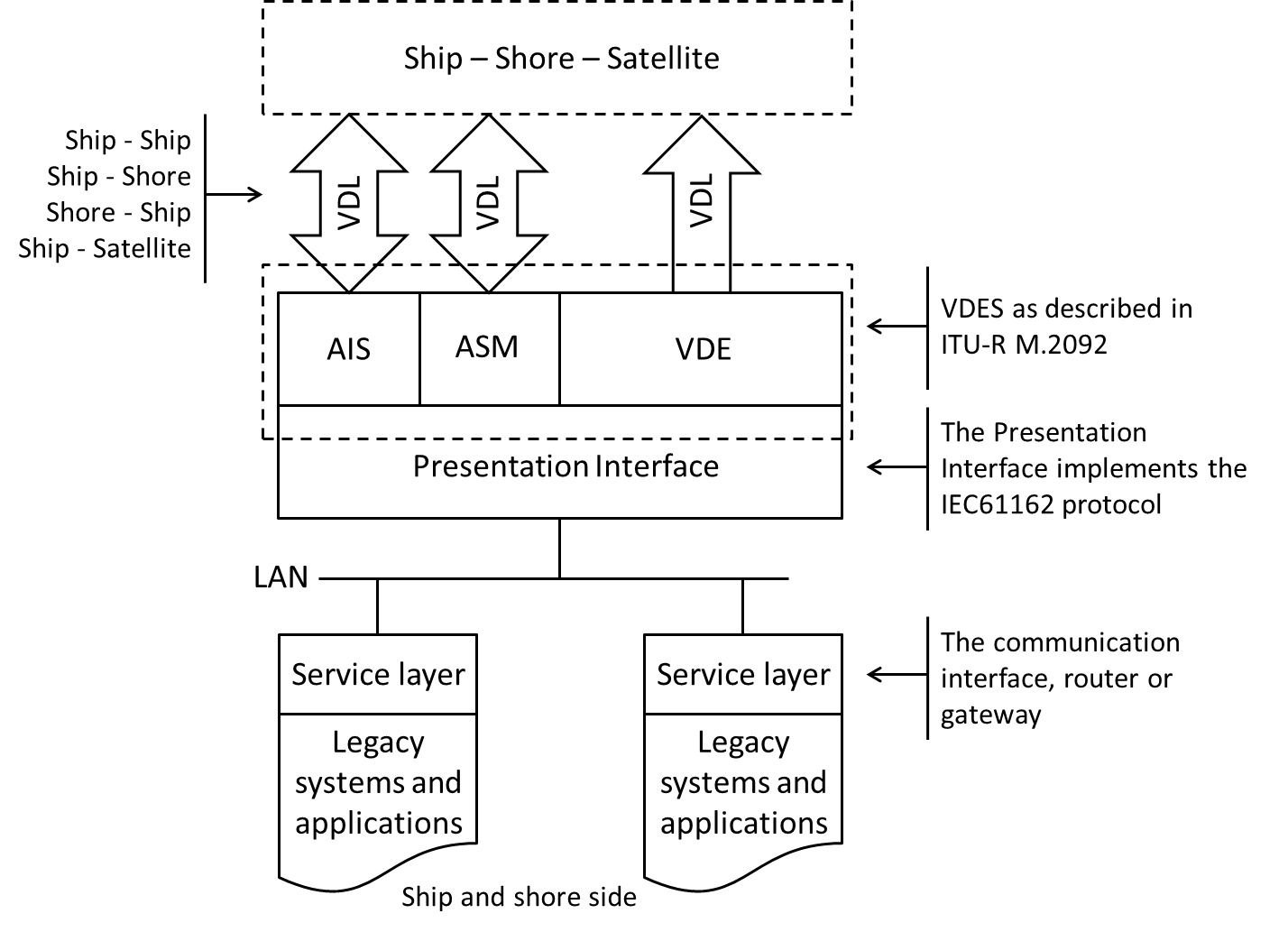


Figure 3 - VDES conceptual topology

## Radio frequency performance

The frequencies that are allocated to ASM and VDE services along with the bandwidth are illustrated in Table below.

|  |  |  |  |
| --- | --- | --- | --- |
| RR Appendix 18 channel number | | Transmitting frequencies (MHz) | |
|  | | Ship stations (ship-to-shore) (long range AIS) Ship stations (ship-to-satellite) | Coast stations Ship stations (ship-to-ship) Satellite-to-ship |
| AIS 1 | | 161.975 | 161.975 |
| AIS 2 | | 162.025 | 162.025 |
| 75 (long range AIS) | | 156.775 (ships are Tx only) | N/A |
| 76 (long range AIS) | | 156.825 (ships are Tx only) | N/A |
| 2027 (ASM 1) | | 161.950 (2027) | 161.950 (2027) |
| 2028 (ASM 2) | | 162.000 (2028) | 162.000 (2028) |
| 24/84/25/85 (VDE 1)    24  84  25  85 | 24/84/25/85/26/86 (Ship-to-satellite, satellite-to-ship)  24  84  25  85  26  86 | 100/150 kHz channel  (24/84/25/85, lower legs (VDE1‑A) merged) Ship-to-shore  (24/84/25/85/26/86) Ship-to-satellite | 100/150 kHz channel  (24/84/25/85, upper legs (VDE1‑B) merged) Ship-to-ship, Shore-to-ship (24/84/25/85/26/86) Satellite-to-ship |
| 157.200 (1024) | 161.800 (2024) |
| 157.225 (1084) | 161.825 (2084) |
| 157.250 (1025) | 161.850 (2025) |
| 157.275 (1085) | 161.875 (2085) |
| 157.300 (1026) | 161.900 (2026) |
| 157.325 (1086) | 161.925 (2086) |

Table 3 - ASM and VDE frequencies of operation and bandwidth allocations

The modulation and coding options and raw channel throughput rates are provided for a range of ASM and VDE bandwidths and modulation and coding schemes (MCS).

Table 3 below illustrates the symbol rate versus radio frequency channel band with in kilo symbols per second.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ASM-25kHz | VDE-25kHz | VDE-50kHz | VDE-100kHz |
| Symbol Rate | 9.6 | 19.2 | 38.4 | 76.8 |

Table 4 - Channel bandwidth versus symbol rate (kS/s)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ASM-25kHz | VDE-25kHz | VDE-50kHz | VDE-100kHz |
| MCS-0 (π/4 QPSK, no coding) | 19.2 | - | - | - |
| MCS-1 (π/4 QPSK, CR = 1/2) | - | 38.4 | 76.8 | 153.6 |
| MCS-3 (8PSK, CR = 3/4) | - | 57.6 | 115.2 | 230.4 |
| MCS-5 (16QAM, CR = 3/4) | - | 76.8 | 153.6 | 307.2 |

Table 5 - Channel bandwidth (kb/s) versus Data throughput and Modulation and Coding Schemes

VDE uses Forward Error Correction (FCE). Modulation and Coding Schemes (MCS), MCS-1, MCS-3 and MCS-5 use various coding rates. The code rate of the FEC code is the proportion of the data-stream that is useful (non-redundant). That is, if the code rate is k/n, for every ‘k’ bits of useful information, the coder generates ‘n’ bits in total of data, of which ‘n-k’ are redundant.

VDES uses several channels to carry data. These channels are separated into Physical and Logical channels. Shore-based stations should transmit a channel terrestrial bulletin board (TBB) message that defines the configuration of the VDE channels.

Lacking bulletin board information, ship borne stations should employ a default channel configuration of 50 kHz channels on the terrestrial VDES (channel 2024, and 2084 combined) operating in a simplex ad-hoc access scheme. The simplex ad-hoc access scheme for ship-to-ship communications should be ITDMA (when possible) or RATDMA.

### Physical channels

The physical channels (PC) are determined by the centre frequency and bandwidth.

### Logical channels

The logical channels (LC) are divided into signalling and traffic channels. Logical channel definitions can be defined based on the physical channel and message time information (frame hierarchy, start time, etc.).

## ASM and VDE packet format

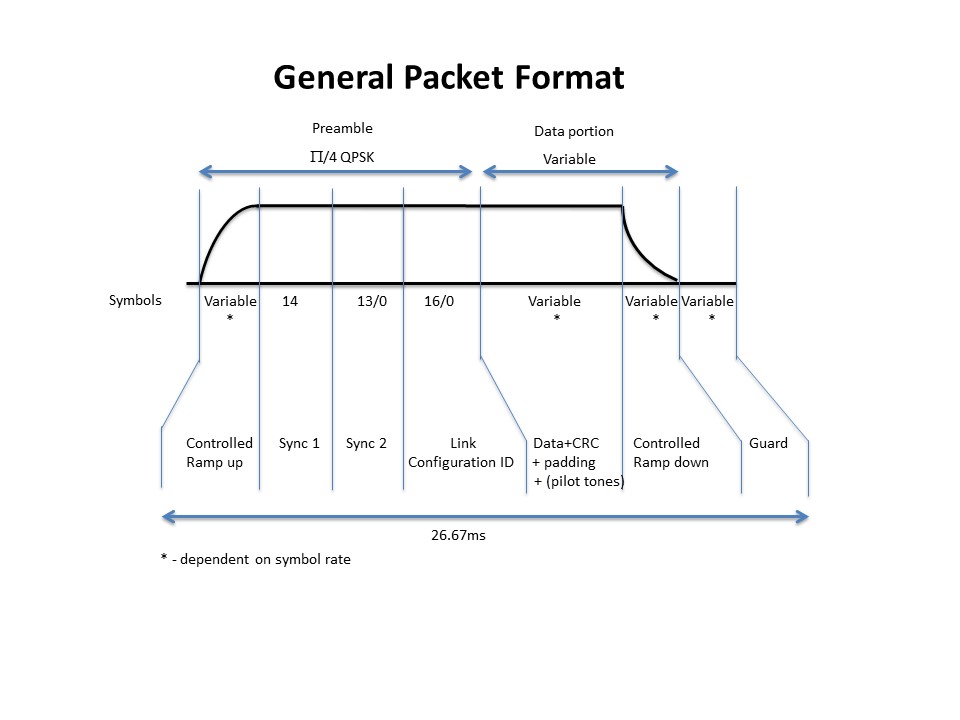
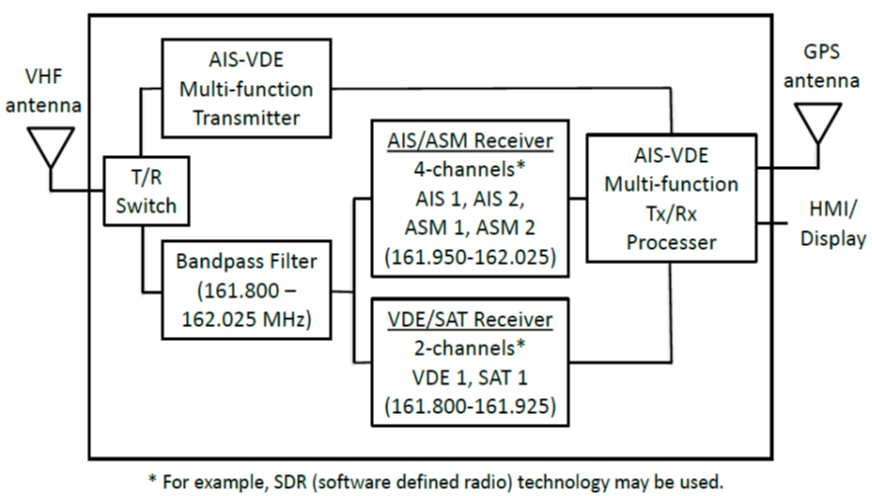
The AIS, ASM and VDE slot time remains at 26.67ms. Due to the higher bit rate, the number of bits in each slot changes. This is illustrated in in Figure 1.

Figure 4 - General ASM and VDE Packet Format

## VDES base station

The VDES base station construction is illustrated in Figure 5. The VDES base station has a number of components that are all operational concurrently.

Figure 5 - VDES base station components

## VDES base station connection

The VDES base station connects to a Base Station Controller (BSC), a VHF antenna system and a timing source (GNSS or other timing source of similar or better accuracy). The VDES base station will connect via a BSC to a system that could follow the Common Shore-based System Architecture (CSSA) structure as described in IALA Guideline 1114 on a Technical Specification for the Common Shore-based System Architecture (CSSA).

The AIS, ASM and VDE could be separate physical units or could be combined into a single physical unit in any one of the following five combinations:

1. AIS
2. AIS plus ASM
3. AIS plus VDE
4. AIS plus ASM and VDE
5. ASM plus VDE

One or more VDES base stations comprising of an integrated base station or a number of separate but connected units can be connected to any one BSC.

AIS

ASM

VDE

BSC

CSSA

AIS

ASM

VDE

External services and applications

Figure 6 - Multiple VDES base station connection

The interface between the VDES base station and the BSC will be compliant with IEC 61162-450. The application will route messages to the respective AIS, ASM and/or VDE transmitters based on the communications capability of the vessel as declared by the vessel from time to time. The current AIS Application Specific Messages are described in IMO Circular S/N 289. These Messages, ITU-R M.1371 International Function Messages, and other regional Application Specific Messages are catalogued on the IALA website as Application Specific Message (ASM)(International and Regional).

VDES Application Specific Messages shall be treated the same way as AIS Application Specific Messages.

The timing source, although normally a local GNSS system, can be any timing source that has the required accuracy to maintaining the required slot timing accuracy (11µS (?)). If the timing source is lost to the VDES base station, a local timing source could be used provided that the drift of this timing source ensures that the slot timing accuracy with reference to GNSS time is maintained within the specified limits.

When constructing the VDES base station site, the location of the VHF antenna should be accurately known and used for all location based references to that VDES base station.

The VDES BSC is connected to a CSSA system as described in IALA Guideline 1114. The CSSA model is illustrated in Figure 5.

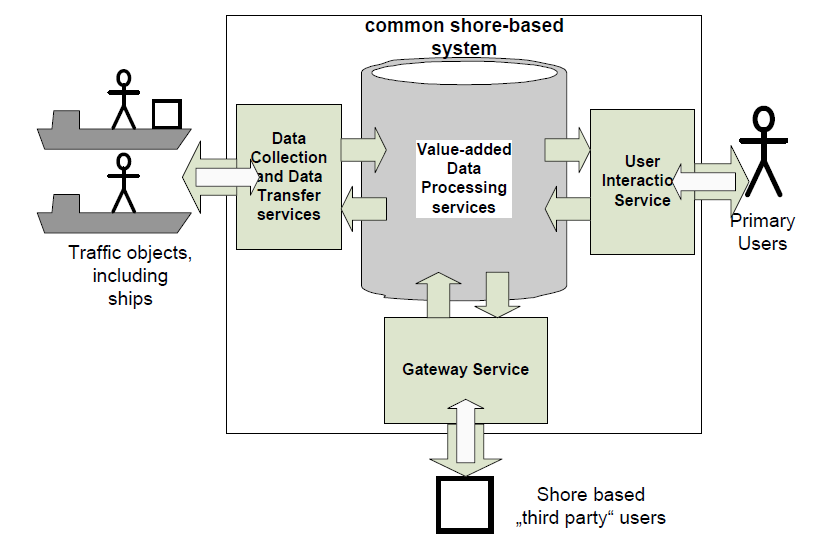


Figure 7 - The CSSA model

The primary users are the users of essential services. The third party users are lower priority user and / or commercial users.

# The TERrestrial Bulliten Board (TBB)

Both the ship and shore need to have a common record of the communications capability of each side to enable the most effective communications method to be used. This is achieved by the shore side systems publishing its capabilities from time to time using the bulletin board.

The authority implementing the VDES base station will need to keep the shore station VDES Bulletin board updated as to services available and offered by the shore side VDES infrastructure. The bulletin board updates could either be by automatic or manual methods.

Each VDE shore station employs a fixed logical channel for the TBB.

The TBB defines the network configuration parameters such as signalling channels (control channels) and data channel(s), protocol versions and future network configuration. The TBB takes precedence in the allocation of spectrum (logical channel) resources.

The VDE terrestrial channel usage for the service area of VDE shore station is defined by the TBB. The TBB information includes the area of applicability. The TBB does not change often and should be transmitted at regular intervals.

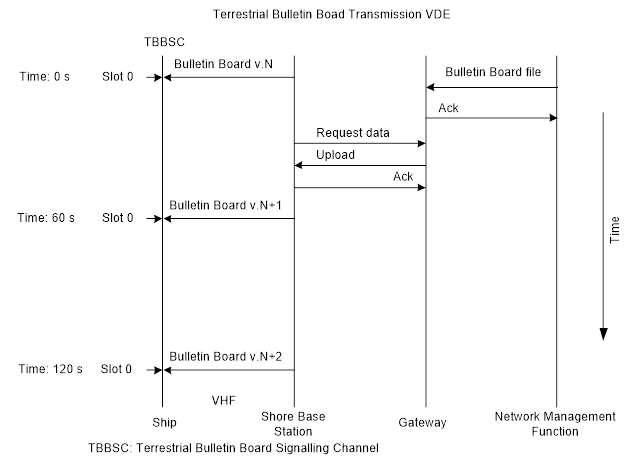


Figure 8 - Terrestrial Bulletin Board

**[Detail to complete the Terrestrial Bulletin Board was presented at the Cape Town WG3 intersessional and covers the following**:

1. **rule set for conflicts e.g. terrestrial and satellite**
2. **set time slot aside for bulletin board**
3. **bulletin boards Tx planning (similar to FATDMA planning, 120 NM rule, RF coverage in the bulletin board)**
4. **bulletin board has to be decoded by the VDES station, not only by application, as there is information for the VDES station in the bulletin board**
5. **how many bulletin boards stored and act upon (6 or 18 or 32) at the receiving station?**
6. **how long is bulletin board valid?**
7. **how long is bulletin board data wise?**
8. **default bulletin board for outside the shore station service area: defines default random access slots**
9. **bulletin board Tx once per minute (max) or less in low traffic area?**
10. **not all information may be included in all bulletin board messages (e.g. geographical area)**
11. **system bulletin board document for terrestrial and satellite published by IALA ]**

# Terrestrial Link Layer

The Terrestrial Link Layer (TLL) control access to the ASM and VDE channels.

The ASM and VDE link layers are different with ASM closely aligned with the existing AIS Link Layer and the VDE Link Layer optimised for the greater capacity of the VDE channels.

**[The ASM and VDE link layers were discussed at the Cape Town WG3 intersessional and are currently being reviewed for inclusion in this guide]**

# Message addressing

VDES messages are sent ship to ship, ship to shore and shore to ship. All addressed messages to ships are directed to a particular ship using that ships MMSI. All broadcast messages for a particular service area are addressed to one or more VDES base station MMSIs.

When messages are sent from the ship to the shore and where the shore side service has an MMSI (refer dynamic MMSI in AIS services), the message will be delivered to the service identified with that MMSI. These are normally primary users (e.g. national coast guard).

Where the shore side service does not have an allocated MMSI, the message will be delivered to the VDES gateway using a global VDES Gateway MMSI and the VDES Gateway will extract from the message the identity of the service that is to consume the message from the ship.

**[The VDES Gateway MMSI is to be agreed and published]**

**[The method of including the identity of the service that is to consume a message is directed through the VDES Gateway service needs to be determined. One method could use X (9?) alpha numeric characters as a ID and this ID would be globally unique and would allow the URL of this service to be looked up on a local Dynamic Naming Service (DNS) (e.g. Gateway\_MMSI.Service\_ID = 123456789.abcdefhij). This requirement needs to be referred to / discussed with the IALA working group dealing with this matter.]**

AIS

ASM

VDE

BSC

CSSA

AIS

ASM

VDE

VLR

DNS

External services and applications

Figure 9 - ASM and VDE Dynamic Naming Service integration

# Local, national regional and international networks

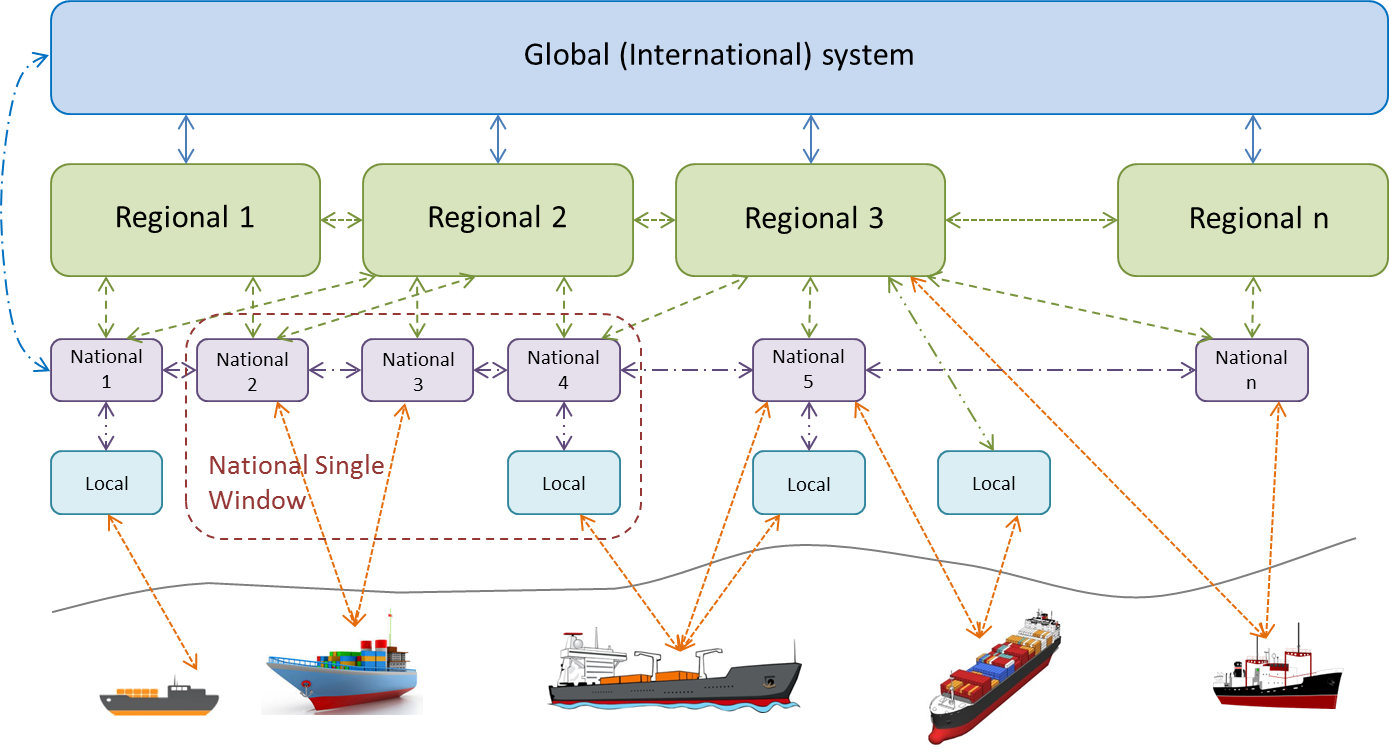
The CSSA model described in IALA Guideline 1113 describes the CSSA being a network that caters for local, national, regional and international CSSA networks. It is within this topology that VDES systems are connected. The CSSA topology with the described range of topologies is illustrated below.

Figure 10 - CSSA model

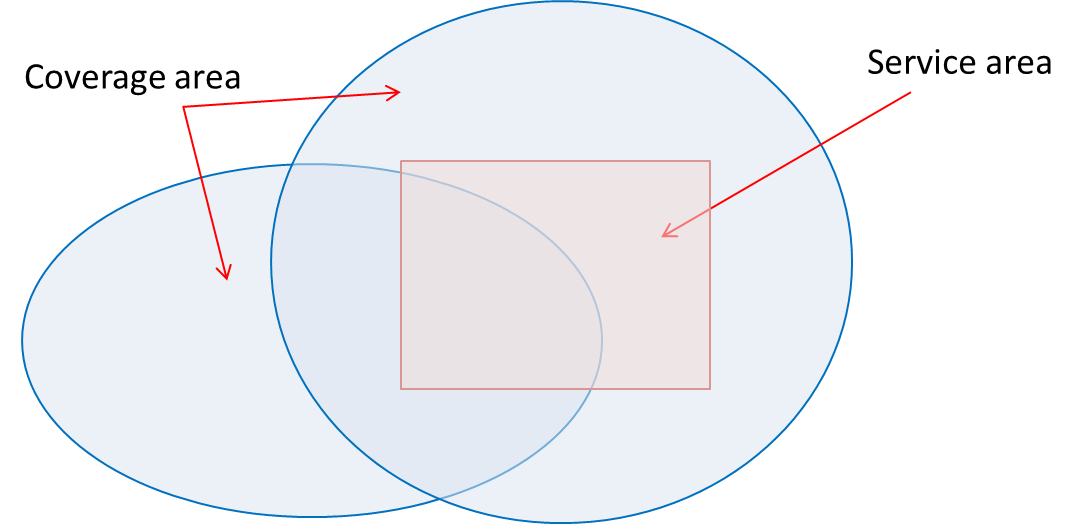
Each of the VDES Shore Station (VSS) that connect to the CSSA has both a coverage and service area. The Coverage Area is defined by the coverage of the VSS and the Service Area is a defined area that can exist within the coverage of a single VSS or the combined and overlapping area of two or more VSS. This is illustrated below.

Figure 11 - Coverage and Service areas

A local VDES network can consist of one or more VSS as illustrated below.

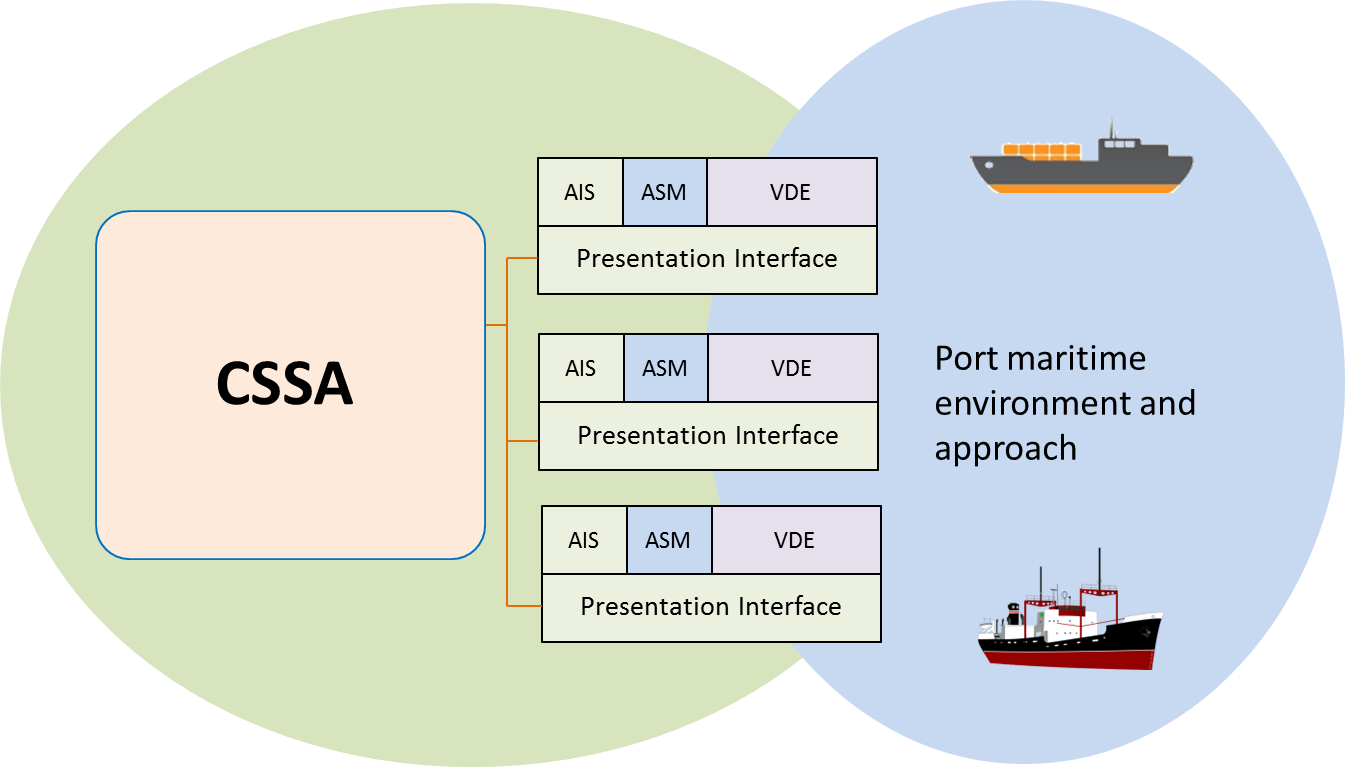


Figure 12- Local VDES network

A national network can consist of one or more local networks as illustrated below.

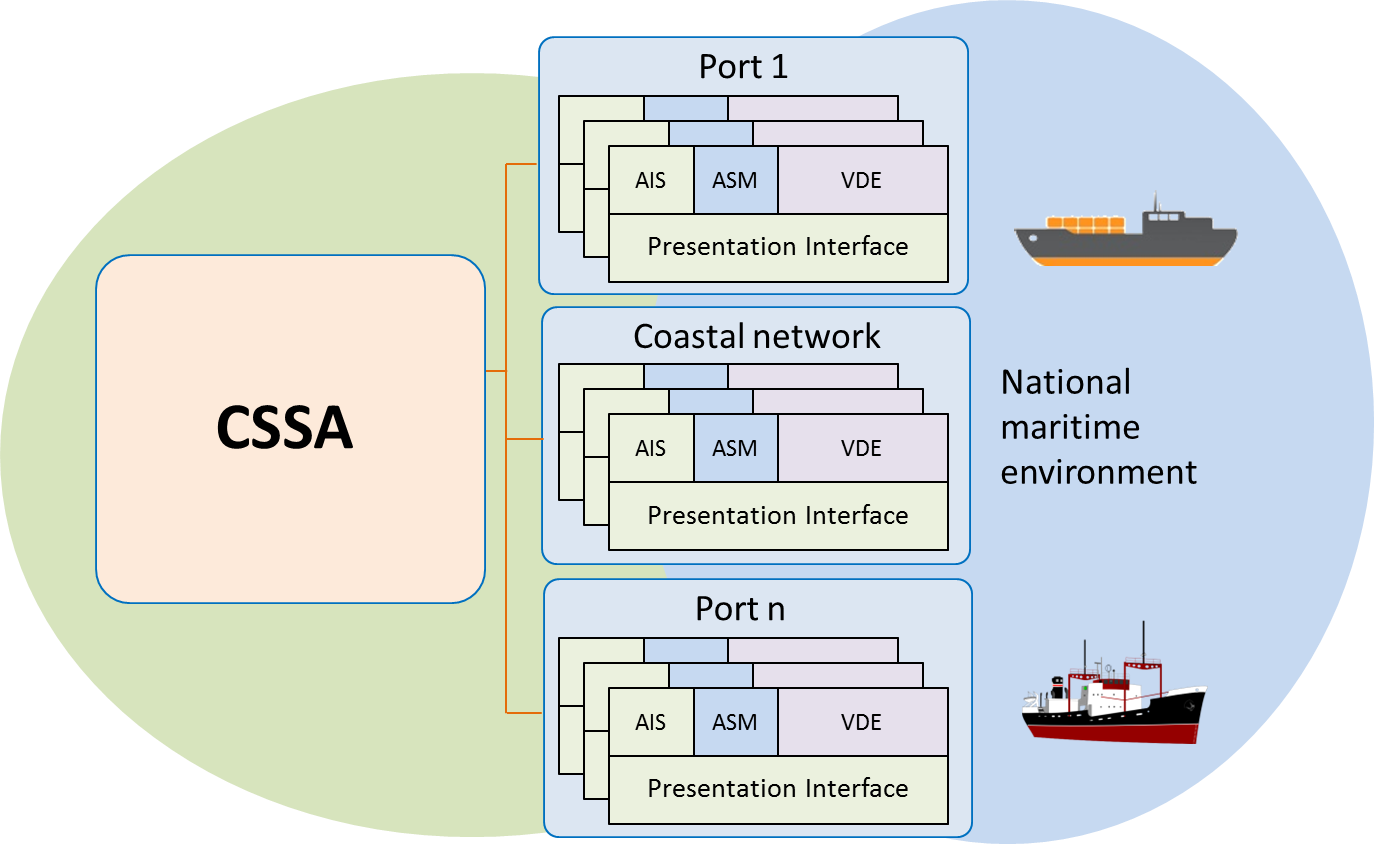


Figure 13 - National VDES network

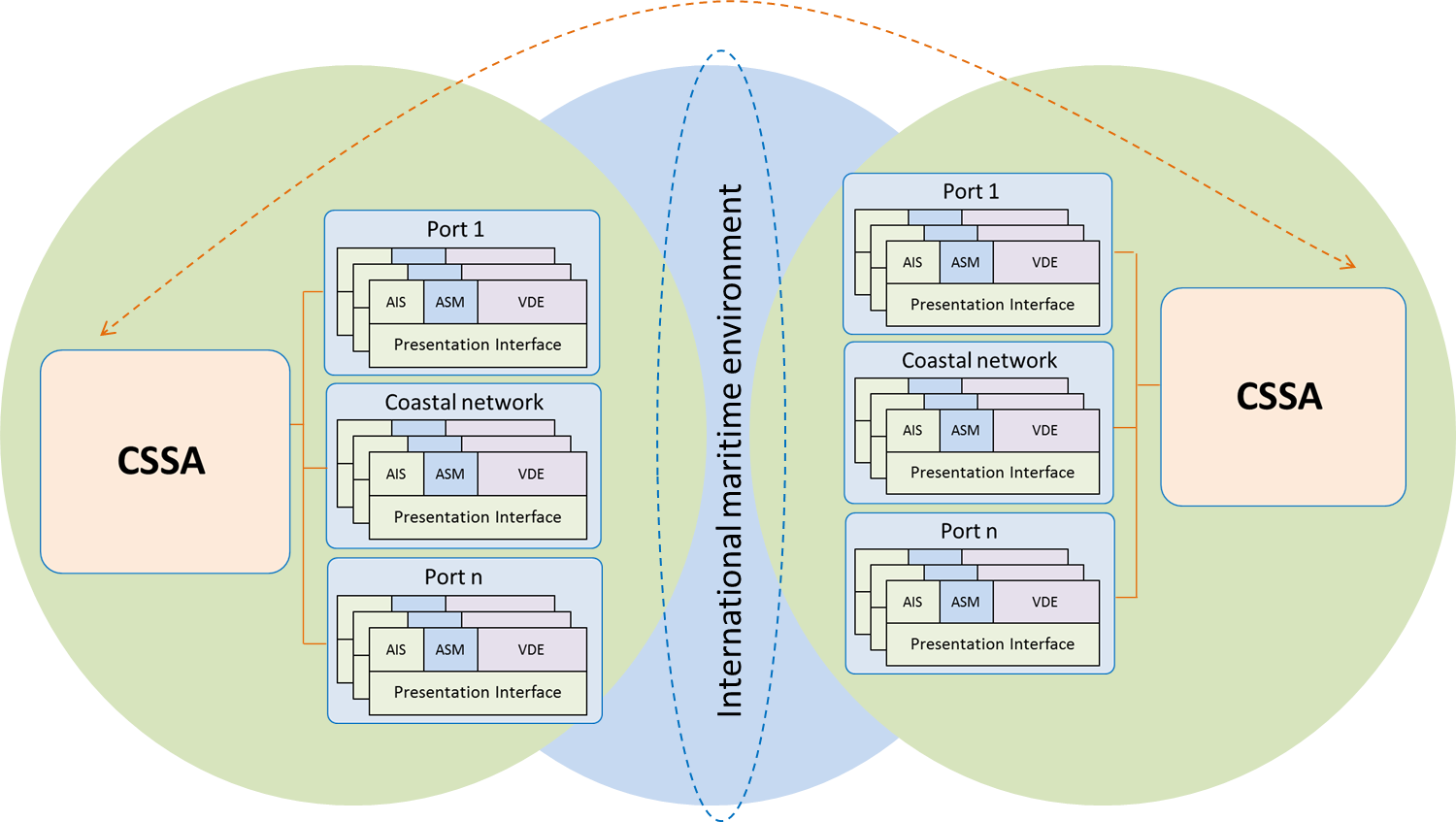
An international network will consist of two or more national networks as illustrated below.

Figure 14 - International VDES network

The international environment introduces the need for the two or more national operators to share planning and dynamic slot allocation information on an ongoing basis and within the time constraints of slots being allocated for both normal and priority messages.

# INTEGRITY MONITORING AND AUTHENTICATION

The integrity monitoring of the ASM and VDE systems are monitored by including an authorisation field in the TBB ensuring that:

1. The TBB is current and not a copy of an earlier version
2. The authentication components is constructed using the agreed method

**[Detail of the TBB integrity monitoring was submitted to the Cape Town WG3 intersessional meeting and a final proposal is being constructed.]**

# Message Priority

The message priority is contained in the Service Layer and is inserted into the ASM and /or VDE transmitter queue as and when it is required to be transmitted along with the slot in which the message is to be transmitted taking into account any slots allocated to Logical Channels and slots reserved for local or remote allocations.

Once the message is transmitted, the result of this transmission should be available in the VDES Presentation Interface.

# Service Layer

The Service Layer interfaces with the VDES PI using IEC61162 messages and the various applications that are required on the shore side and could include the following:

1. Bulletin Board maintenance including validation components
2. Message priority with dynamic queue management and message scheduling
3. Message Automatic Repeat Request (ARQ) and scheduling where required
4. Message broadcast and repeat state machines where these exist
5. VHF Data Link (VDL) layer slot management, reservation and allocation
6. PI health monitoring
7. Terrestrial message routing in multi-VDES unit environments
8. Local message storage and TCP/IP data link management
9. Virtual Private Network (VPN) connection for monitoring and support.

# DEFINITIONS AND ACRONYMS

ACCSEAS Accessibility for Shipping, Efficiency, Advantages and Sustainability

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)

ASM Application Specific 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

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)

IS Information Service

ISPS International Ship and Port Facility Security Code

ITU International Telecommunication Union

ITU-R International Telecommunication Union-Radiocommunication Sector

LPS Local Port Service

MARPOL International Convention for the prevention of pollution from ships (1973) (as amended)

MAS Maritime Assistance Service

MEDEVAC Medical evacuation

METAREA Geographical sea regions 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)

OSC On-scene commander

NAS Navigation Assistance Service

NAVAREA Geographic areas in which various governments are responsible for navigation and weather warnings

NAVTEX Navigational Telex (service

NCSR National Centre for Sensor Research

RCC Rescue Co-ordination Centre

RTCM Radio Technical Commission for Maritime Service

SAR Search and Rescue

SART Search and Rescue Transponder

SAT Satellite

SIP Strategic Implementation Plan

SOLAS International Convention for the Safety of Life at Sea, (IMO)

SRU Search and Rescue Unit

TDMA Time-division multiple access

TMAS Telemedical Maritime Assistance Service

TOS Traffic Organization Service

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

VSS VDES Shore Station

VTS Vessel Traffic Information Service

WRC World Radio Conference

WWRNS World-wide Radionavigation System

1. Recommendation ITU-R M.493 [↑](#footnote-ref-1)
2. Recommendation ITU-R M.1371 [↑](#footnote-ref-2)
3. Recommendation ITU-R M.1842 [↑](#footnote-ref-3)
4. More information on VDL loading is available in Report ITU-R M.2287-0 [↑](#footnote-ref-4)