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WORKING DRAFT OF NEW GUIDELINE ON THE SHORE VDES INFRASTRUCTURE

# Summary

Following discussions at the DTEC1 meeting, it was proposed that a new guideline for shore VDES service and infrastructure be developed to integrate the contents of Recommendation R0124 (The AIS Service) and the concurrent revision of Recommendation R1007 (The VHF Data Exchange System for Shore Infrastructure). ALLFORLAND Co., Ltd.(“A4L”) of the Republic of Korea and the correspondence group(including China MSA and Canada CG) have drafted the initial contents of the proposed guideline for further consideration at DTEC4.

## Purpose of the document

The purpose of this document is to propose a working draft of the contents of the new guideline on the Shore VDES Infrastructure and to request participation by DTEC4 WG3 members to discuss

## Related documents

1. R0124 Ed2.2, The AIS Service, December 2022
2. R1007 Ed3.0, The VHF Data Exchange System(VDES) for Shore Infrastructure, June 2017
3. G1029 Ed1.1, Universal Automatic Identification System(AIS) Technical Issues, December 2002

# Background

At DTEC1, it was proposed that a new guideline for VDES Infrastructure and other VDES guidelines be prepared for publication after DTEC7 in 2026. The proposed guideline on VDES Shore Infrastructure shall integrate and revise the contents of the Recommendation R0124 The AIS Service and simultaneous revision of the Recommendation R1007 The VHF Data Exchange System for Shore Infrastructure.

At the 10th session of the IMO NCSR in May 2023, NCSR10 established a correspondence group to finalize VDES performance standards. The new guideline on the VDES service and infrastructure shall take into account the subsequent conclusions made by the IMO NCSR correspondence group on the VDES ship and the shore service and infrastructure.

# Discussion

The Annex of this document provides the working draft of the new Guideline on the Shore VDES Infrastructure for the Committee's consideration.

# references

1. R0124 Ed2.2, The AIS Service, December 2022
2. R1007 Ed3.0, The VHF Data Exchange System(VDES) for Shore Infrastructure, June 2017
3. G1029 Ed1.1, Universal Automatic Identification System(AIS) Technical Issues, December 2002

# Action requested of the Committee

The Committee is requested to consider the annex of this document which provides the working draft of the Shore VDES Infrastructure Guideline, and

1. Review the working draft of the Shore VDES Infrastructure Guideline
2. Participate in a task group to develop the guideline with the coordinator of the Republic of Korea (Ms. Hwajin Claire Na, ALLFORLAND Co., Ltd.) for further development of the guideline;

**ANNEX**

**Preliminary draft**

**Guideline for The VDES Service and Infrastructure**

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# 1 BACKGROUND

The World Radiocommunication Conference 2015(WRC-15) allocated frequencies for VDE terrestrial (reception and transmission) ASM terrestrial (reception and transmission) and ASM satellite reception.

VDES communication shall follow ITU-R M.2092-1. IALA G1117 provides many possible usages of VDES. The VDES is an emerging communications system which is being coordinated by IALA in consultation with the International Telecommunication Union(ITU), the International Maritime Organization(IMO) and the International Electrotechnical Commission(IEC).

The distance of direct communication of VDES is limited due to the characteristics of VHF radio communication. Development of VDES systems (ship stations, land stations, satellites) has been started by different developers for various use cases. To realize such use cases and extend the communication distance and capability, it is expected that IALA national members and other appropriate authorities shall need to implement the following elements for optimal VDES operation:

1. Establishing a plan to upgrade existing AIS shore infrastructure to VDES shore infrastructure, thereby enhancing digital connectivity
2. Implementing VDES shore infrastructure in case of no existing AIS shore infrastructure
3. Using existing shore infrastructure as much as possible for VDES R-Mode
4. Implementing VDES data integrity monitoring at the VDES link level
5. Expansion of VDES application scope requiring coordination and resource sharing from multiple parties
6. Addressing network security issues

IALA initiated a new task “Develop a Guideline for VDES Shore Infrastructure and Operation”. The objective of the task is to develop a guideline that provides a framework for VDES shore infrastructure and operation to realize smooth and effective VDES communications on both official and private communications.

# 2 Purpose of the document

This document provides guidelines on the methodology of implementing VDES shore infrastructure, VDES frequency mode operation, and VDES data transfer network. This document does not provide a regulatory or obligatory framework for the operation of VDES.

# 3 Related documents

1. ITU-R M.2092-2, Technical Characteristics for a VHF Data Exchange System in the VHF Maritime Mobile Band, February 2026
2. ITU-R M.1371-6, Technical Characteristics for an Automatic Identification System using Time Division Multiple Access in the VHF Maritime Mobile Band, February 2026
3. IALA G1117, *VHF Data Exchange System (VDES) Overview, December 2022*
4. IALA R1007, *The VHF Data Exchange System(VDES) for Shore Infrastructure, June 2017*
5. IALA R0124, *The AIS Service, December 2012*

# 4 shore-based infrastructure for The VDES Service

This section describes the definition and scope of the terrestrial VDES service. The terrestrial VDES service may include some or all of the features and general requirements of the AIS service as described in IALA R0124, The AIS Service(December 2012) and its Appendix 0 to 19. The section also includes the functions and general requirements of ASM and terrestrial VDE services to enable higher data rates and a wider range of applications, leveraging the technical characteristics of ASM and VDE-TER as described in ITU-R M.2029-2, Technical characteristics for a VHF data exchange system in the VHF maritime mobile band(February 2026).

* + AIS Service Compatibility : Ensures interoperability with AIS services and/or their interoperability
  + Application Specific Messaging(ASM) Service : Messaging service for specific purposes between ships and shore
  + VHF Data Exchange(VDE) Service : Service for exchanging large volumes of data between ships and shore

Terrestrial VDES services are defined by the jurisdiction operating them based on geographical, economic and operational requirements, and in most cases cover a large portion of the coastline, or even the entire coastline, within 40 to 120 NM of the territorial sea and/or exclusive economic zone boundaries. The geographical topography of the coastline may vary.

Despite geographical and topological variations among terrestrial VDES service areas, functional similarities exist in service provision and criteria for selecting an appropriate configuration. The distribution model is essentially functional and generic, but it needs to be applied (‘tailored’) to the geography and topology by every administration. To this end, this document describes the components of a standard shore-based infrastructure applicable to most jurisdictions, along with methods for deriving appropriate infrastructure for some geographical and topological differences and the associated criteria.

# 4.1 functional definitions of the shore-BASED INFRASTRUCTURE

In order to describe the terrestrial VDES service, it is necessary to define the shore-based infrastructure required for service provision. A standard system architecture and its components are presented that include or interoperate with the conventional AIS service infrastructure and consider the scalability of ASM and terrestrial VDES services. Figure 1 shows the standard architecture of the shore-based infrastructure for terrestrial VDES service.

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Figure 1 Standard architecture of shore-based infrastructure for the terrestrial VDES service

The standard architecture of shore-based infrastructure consists of the following three functional layer components required to provide ASM/VDE services as well as ship-to-ship, ship-to-shore and shore-to-ship AIS information exchange within the VDES service area:

* + **Physical layer(VDES physical shore station or VDES**-PSS) : Consists of one or more VDES PSS controlling units and a fixed station (Note: The PSS includes not only the actual VDES base station, but also all the connections, antennas, cables, etc. (RF components) required for the base station to actually operate.
  + **Logical layer(VDES logical shore station or VDES-**LSS): Software that takes VDES data from one or more PSS(s) and delivers it in a usable format to the VDES service users. The VDES does not have to be located in the same location as the physical shore station(PSS).
  + Service Management Layer(VDES service control station or VDES-SCS): The top layer that controls the overall system. The VDES-SCS is connected to each base station or group of base stations (PSS) through a software system(LSS) and controls the shore-based VDES system. It is necessary to ensure a reliable means of data transmissions between all VDES physical shore stations. It acts as a central hub that manages communication resources within the service area and monitors the integrity of the data link.

Each layer of the VDES service requires a certain amount of processing capacity to ensure proper and timely interaction of the relevant components. The competent authority is responsible for providing the required processing capacity. The hierarchy of the VDES service does not explicitly specify whether data is transmitted locally or remotely. A transmission process called a ‘Functional Link’ is required between each layer. Functional links are defined as LAN(local), WAN feeder link(remote), and WAN backbone(remote). In the following chapters, the term ‘remote’ indicates, that either a WAN feeder link or a WAN backbone Functional Link will be required. Whenever the term ‘local’ appears, the LAN Functional Link would suffice.

# 4.1.1 vdes Physical shore station(VDES-PSS)

VDES-PSS is an abstract concept that encompasses several physical elements of a shore-based VDES service. Typically, all elements of a VDES-PSS are co-located at the same location, but there are notable exceptions where different elements of a VDES-PSS are located at different locations due to different external factors.

VDES-PSS is the most basic VDES-related entity that can exist on its own in a physical environment, unlike VDES-PCU(VDES PSS Controlling Unit) or VDES fixed station

A VDES-PSS consists of at least the following components.

* A VDES PSS Controlling Unit (VDES-PCU) responsible for controlling one or more VDES Fixed Stations;
* A VDES Fixed Station (base station, limited base station) that provides an interface to the VDL;
* An agent for a VDES Service Control Station (VDES-SCS) that provides configuration and monitoring functions for the VDES-PCU and VDES Fixed Stations;
* VDES RF Components (which may be shared with other services in the field);
* Supporting infrastructure (service owned or shared); and/or
* A legacy AIS service component configured separately from the above components.

Therefore, VDES-PSS does not necessarily need to be considered large physically.

The supported infrastructure in the above list of components represents the physical and functional elements required for designing a VDES service, such as shelter, power source, local network, data storage, cabling, etc. Some of these components may be shared with other co-located technical services or may be dedicated to the VDES service, in which case they are referred to as VDES service owned.

VDES-PSS usually has its own UTC source. This UTC source can be internal to the VDES Fixed Station, such as a GNSS receiver, or external to the VDES Fixed Station (part of the on-site infrastructure), such as a solid-state (crystal oscillator) clock, which can provide timing to the VDES Fixed Station via an appropriate timing interface. There are also cases where the VDES Fixed Station is set up using only the synchronization provided by the VDES VDL itself, i.e. UTC indirect or slot synchronization.

Figure 2 shows an example VDES-PSS site as described above. It includes all the components of VDES-PSS as described above.

* Functional components of a single VDES-PCU located at a different facility;
* Two VDES base stations located on site;
* Part of the functional components of the VDES-SCS responsible for monitoring and configuring the VDES-PCU;
* Infrastructure required for the PSS (routers, firewalls, VPNs, network switches, GPS, RF equipment, UPS, etc.); and
* Legacy AIS service components configured separately from the above components (AIS Data Network between the Remote site and Node, Control Station or Other location can be separated or integrated with the VDES Data Network).

The required infrastructure is highlighted in boxes, including RF equipment, GPS antennas, cables, UPS, local area network, local router, wide area network, VDES-PCU hardware, and some VDES-SCS hardware.

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Figure 2 Example of a VDES physical shore station for the VDES service

Note: Figure 2 should not be interpreted as normative or as the only recommended method for setting up a VDES physical shore station for VDES services. However, Figure 2 does claim to be accurate and consistent with the normative statements in this Recommendation with respect to what this guidance demonstrates. For example, the VDES-PCU hardware and software and/or PSS functional components of the VDES can be located at a remote site and should be located at a remote site when using a dependent mode base station. More information on slave mode is provided in §7.2.2.

The physical layer of the remote node is called VDES-PSS (Physical Shore Station), and the VDES-PCU, the highest layer of PSS, executes the configuration of the entire physical layer in the remote node. All VDES services are controlled and configured by VDES-SCS. In other words, VDES-PCU is the VDES service interface to VDL. Therefore, VDES-PCU is an essential part of the remote node and exists only in the remote node. VDES-PCU encapsulates the technology-dependent functions of VDES services and provides technology-independent VDES functions to VDES Logical Shore Station (VDES-LSS).

The VDES PSS Control Unit (VDES-PCU) performs the following main tasks:

* Control the VDES Fixed Station of the VDES-PSS according to the set configuration; and
* Preprocessing of VDES data in one or both directions (receiving and/or transmitting).

VDES-PCU is basically a software process running as an application program on a computer, a physical entity or as an integrated firmware of a dedicated device. It is responsible for configuring the VDES Fixed Station, scheduling transmissions and processing received information according to the PI (Presentation Interface) statements defined by IEC xxxxx.

Data communication with other e-Navigation services and clients takes place exclusively via the LSS, and data communication with the VHF Data Link (VDL) takes place exclusively via the VDES Fixed Station, the lowest layer of the shore-based VDES service.

The The VDES Fixed Station is the fundamental component of the VDES coastal infrastructure. Figure 3 shows the main components of the VDES Base Station.

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Figure 3 Block diagram of VDES fixed station

* GNSS receiver: The GNSS receiver provides the VDES station with a time reference (UTC) and synchronizes all transmissions to avoid collisions or overlapping that could degrade the information being transmitted.
* The internal (D)GNSS receiver can be used as a backup source for the determination of the vessel’s position, SOG and COG.
* VHF transmitter/receiver: There is one VHF transmitter for TDMA operation and a VHF receiver capable of simultaneously receiving AIS 1/2, ASM 1/2 and VDE upper leg/lower leg in a single receiving path. The VHF transceiver transmits and receives radio signals forming the data link (VHF data link or VDL) that interconnects the VDES stations. The individually allocated transmission time slots are short (26.6 ms). The VHF transmitter must have a very fast switching capability (0.41 ms) from zero to full output power and vice versa. In the block diagram (Fig. 3), the receiver is functionally represented as a radio receiving part, a binary modulation signal (GMSK of AIS) decoding part, and a multi-level modulation (ASM, pi/4-QPSK, 8-PSK, 16-QAM of VDE-TER) decoding part. In the same way, the transmitter consists of a binary modulation signal (GMSK of AIS) encoding part, a multi-level modulation (ASM, pi/4-QPSK, 8-PSK, 16-QAM of VDE-TER) encoding part, and a radio transmitting part.
* DSC VHF receiver: The DSC receiver is deprecated in VDES stations as per the revision of [2] ITU-R M.1371-6, Technical Characteristics for an Automatic Identification System using Time Division Multiple Access in the VHF Maritime Mobile Band, February 2026.
* Controller: The Control Unit manages the functions of all components of the VDES station. It manages the time slot selection process, the operation of the transmitter and receiver, the processing of the various input signals and the subsequent distribution of all output and input signals to the various interface plugs and sockets, and the processing of messages into the appropriate transmission packets.
* The Built-in Integrity-test (BIIT) continuously controls the integrity and operation.
* Power Supply
* Signal interface ports (Presentation Interface PI): There is also an interface for connecting to an external management and remote control system or for inputting and outputting VDES and application related messages.

The VDES Fixed Station converts the presentation interface sentences received from the VDES-PCU into actual VDES VDL messages for transmission over the VDES RF Component. This process is also performed in reverse for receiving VDES VDL messages.

There are different types of VDES Fixed Stations, such as VDES Base Station, Limited VDES Base Station. The differences between each type of VDES Fixed Station are as follows:

* VDES Base Stations are compatible with all VDES services and are typically deployed and operated by jurisdictions.
* Limited Base Stations (LBS) are compatible with some specific VDES services and are intended for jurisdictions that require limited VDES functionality without being able to manage VDLs. They are typically deployed by port authorities, ferry terminals or other such types of localised organizations.

# 4.1.2 vdes Logical Shore Station(VDES-LSS)

The VDES Logical Shore Station acts as a software router for VDES data sent to and from clients and VDES-PCUs. The VDES-LSS maintains a table of associated clients using VDL identifiers (MMSI) and maritime resource names (MRNs) and must be able to route appropriate data, particularly addressing messages, to clients. The VDES-LSS must also maintain a table of current VDES participants and the appropriate VDES-PCUs to use in routing messages addressed to clients to the target participants.

There are three main data processing functions:

* VDES data filtering;
* VDES data flow control;
* VDES data conversion.

The software process of VDES-LSS can be run on any appropriate computer at any appropriate location. The options for selecting the appropriate configuration for setting up an instance of VDES-LSS and the resulting results are described in §4.3.

An individual software process of VDES-LSS running on a separate computer is called an instance of VDES-LSS. Therefore, an instance of VDES-LSS is a software process that filters, controls, and transforms VDES data flows from one or more VDES Physical Shore Stations to produce a single VDES-related data flow associated with a single request service. The runtime configuration of a VDES-LSS instance is managed by VDES-SCS.

For each requesting service, the VDES service establishes one or more instances of VDES-LSS. The VDES-LSS instance of the VDES service communicates with one instance of the logical interface of the requesting service in a 1:1 relationship. The recommended protocol for exchanging VDES data between a VDES-LSS and a VDES service client system is described in §4.2.4.

There must be a reliable functional connection between all instances of a VDES-LSS and all associated VDES Physical Shore Stations.

# 4.1.3 vdes Service Control Station(VDES-SCS)

Since the VDES service of the jurisdiction is mostly composed of one or more VDES-LSS, VDES-PCU and VDES Fixed Station, a top layer is required to act as the control entity for the entire VDES service. As the top layer in the VDES service, the management role of the VDES Service Control Station is as follows:

* Acts as the management entity for the entire VDES service (in most cases consisting of two or more VDES-LSSs, VDES-PCUs and VDES Fixed Stations);
* Manages internal VDES services, including VDES VDL management (including data link integrity monitoring, resource allocation/transfer notification);
* Provides the last resort for system faults and maintenance. In particular, it performs the following tasks:

Calls, initializes, configures and terminates all instances of VDES-LSSs and VDES-PCUs at runtime.

* Determines the network communication relationships between the VDES-PCUs and their associated VDES-LSSs to be used during runtime.
* Determines the functional connection between the VDES-LSSs and the logical interfaces of clients requesting services associated with it. In other words, this top level acts as a 'switchboard' for data exchange relationships between different processes.
* Provides a Human Machine Interface for technical operations personnel to monitor the current state of the VDLs and configure them accordingly via VDL management. And
* Due to the distributed nature of the VDES service, VDES-SCS may consist of several distributed agents and one master function, all of which are typically software processes. The master function is often located in a central location.

# 4.1.4 nominal coverage PLAN

The actual number of VDES Physical Shore Stations (VDES-PSS) may be adjusted by the jurisdictional authority based on geographical, economic, and operational requirements, including the VDES VDL coverage area and shore traffic load, and the number of VDES Logical Shore Stations (VDES-LSS) in the area. In configuring the Shore-Based Infrastructure required to provide VDES services, it is essential to determine the nominal coverage for the functional components.

Nominal coverage provides the following benefits:

* + - * Management Decision Process: The nominal coverage area is precisely specified as one or more polygons of geographic coordinates. Therefore, the concept of nominal coverage area provides a clean-cut service statement of operational and management criteria to the authorities and the public, as it is independent of the variation of physical VHF range and the unpredictable time-varying nature of VDES VDLs.
      * Planning Phase: The nominal coverage area provides the most important criteria for determining the location and number of VDES-PSSs required to achieve the desired quality of the VDES service under consideration, taking into account factors such as nominal VHF range, antenna height, etc. It is usually defined as always smaller than the physical VHF range that can theoretically be achieved by VHF range calculations.
* Functional definition of VDES service components: The nominal coverage area is a means to support computerized algorithms related to message reception evaluation and message transmission routing within the VDES service, and provides a convenient means to exchange coverage area designations between stakeholders (human and/or organizational and/or machine) of the service.
* The basic framework for planning and/or runtime calculations of VDES service quality features such as service reliability and continuity.
* Integration of VDES services into shore-based e-Navigation systems during planning and operations: The level of abstraction provided by the nominal coverage effectively hides the complexity of the VDES VHF data link, such as the science of VDES, from other services of the shore-based e-Navigation system. Thus, the nominal coverage area supports the encapsulation principle of the shore-based e-Navigation system architecture.
* The regulatory and legal framework for all aspects of the VDES service related to its geographical scope, including mutual agreements between adjacent jurisdictions in different countries.

Nominal scope can be defined for the entire VDES service and all of its functional components.

Figure 4 shows the nominal coverage area occupied by the Terrestrial VDES service components of the Shore-Based Infrastructure.

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Figure 4 Graphical representation of nominal coverage definitions

* The VDES sector coverage area is the conservative theoretical coverage area of ​​the RF equipment of a VDES fixed station. It is the nominal coverage area that can be achieved by antenna configuration and is usually based on VHF range calculations and/or VHF range predictions. The VDES sector coverage area is the most basic nominal coverage area.
* A VDES-PCU coverage area is the nominal coverage area of ​​a single VDES-PSS. The size of a VDES-PCU coverage area is the sum of all VDES sector coverage areas of the VDES-PSS controlled by the VDES-PCU. A VDES-PCU coverage area can also be defined as an area smaller than the sum of the VDES sector coverage areas.
* VDES-LSS service area is the nominal service area of ​​a VDES Logical Shore Station (VDES-LSS) instance. This is the area where a shore-based e-Navigation system's requesting service constructs the requested basic VDES service, and this is the area where the VDES service provides the basic VDES service to the requesting service. For a particular VDES-LSS, the VDES-LSS coverage area may be a subset of the VDES service coverage area or may be identical to the VDES service coverage area.

The VDES service can function as a client (receiving) or a server (transmitting). To ensure optimal use of VDES VDL, the nominal coverage areas for receive and transmit can be different. To allow optimal use of VDES VDL, the nominal coverage area should be conceptually subdivided into a receive (Rx) nominal coverage area and a transmit (Tx) nominal coverage area. Details on the nominal coverage area of ​​AIS service are described in IALA Recommendation 0124, Appendix 3.

# 4.1.5 SErvice DISTRIBUTION CONFIGURATION

To derive the appropriate infrastructure for some geographic and topological differences, the following three VDES service deployment configurations can be tailored by the jurisdiction: If the terrestrial VDES service area is in a geographically isolated area, it can be reduced to a ‘one-spot VDES service’.

Criteria and recommendations for selecting an appropriate VDES service distribution are provided in Table 1.

* + Multi-node VDES service distribution configuration: The topology of a multi-node VDES service distribution configuration features at least two node sites and at least two remote sites. All VDES Physical Shore Stations (VDES-PSS) for the VDES service are located at the remote sites and are connected to the node sites used by the VDES service by WAN feeder links (multi-star configuration). Additionally, all node sites used by the VDES service are connected to WAN backbone links. This is required for master control and data replication of the VDES service. It is recommended that every node used by the VDES service be connected to every other node used by every other VDES service.

Typically, only 2-3 nodes are required, even in geographically large multi-node VDES service deployment configurations.

Multi-node VDES service distribution configurations are best suited for jurisdictions that:

1. When the area of ​​responsibility and/or interest is geographically large
2. When a concave coastal topology requires multiple nodes, especially when considering the costs associated with WAN feeder links rather than WAN backbone links
3. When it is not desirable to centralize all geographically variable functions into a single node, regardless of the additional costs associated with such redundancy

NOTE: In a multi-node distribution model, there is an option to replicate the VDES Service Management (VDES-SCS) master functionality to two or more nodes, for reasons such as unnecessary redundancy. However, in this case, only one VDES-SCS master should be active at any time.

* + Single-node VDES service distribution configuration: A single-node VDES service distribution configuration is topologically characterized by one node site and one or more remote sites. All VDES-PSSs of the VDES service at the remote sites are connected to a single node by WAN feeder links (logical star configuration)

A single node VDES service distribution configuration is best suited for jurisdictions with the following characteristics:

1. Where responsibility and/or area of ​​interest is limited to a geographic area
2. Where single node VDES service distribution is the most economical solution considering the costs associated with WAN feeder links due to concave coastal topography
3. Where all geographically distributed functions are to be centralized to a single node regardless of coastal topography
   * One-Spot VDES Service Distribution Configuration: The One-Spot VDES Service distribution Configuration is the simplest VDES Service deployment configuration. The functionality of the VDES-PSS, VDES-LSS, and VDES-SCS are co-located in one location. Therefore, all technical operations, maintenance, and further development are performed at this location. The One-Spot VDES Service deployment configuration is best suited for administrators whose responsibilities and/or areas of interest are limited to a single geographic area. Administrators can install multiple One-Spot VDES Services in several geographically separated locations, each of which constitutes an independent VDES Service. Therefore, the One-Spot VDES Service deployment configuration can serve administrators in large geographical countries with only one or a few geographically distinct ports.

Key application cases of One-Spot VDES service distribution include:

1. Case 1: National authorities with an interest in a limited geographical coverage area within a wider geographical topology; and
2. Case 2: Local authorities operating (limited) base stations delegated by the national authorities.

Table 1 Criteria and recommendations for selecting an appropriate VDES service distribution

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Recommendation | Criteria related to | | | | |
| Coverage Area Characteristics | VDES VHF Data Link Loading | | | Site diversity required for Node site (Node site redundancy) |
| VDES VDL traffic intensity(1)/ garbling mitigation | Site separation for Rs and Tx | Coverage redundancy beyond garbling mitigation |
| Multiple VDES Service Distribution | Very large or distinct and separate areas to be covered | Capable of  - high VDES VDL traffic intensity  - garbling mitigation by smaller cells  - dual coverage | Capable/Possible | Capable/Possible | Possible |
| One-Node VDES Service Distribution | Intermediate to large, or contiguous area to be covered | Capable of  - high VDES VDL traffic intensity  - garbling mitigation by smaller cells  - dual coverage | Capable/Possible | Capable/Possible | Not Possible |
| One-Spot VDES Service Distribution | Small, contained area to be covered | Capable of only low VDES VDL traffic intensity and suitable only for situations where garbling is unlikely | Not Possible | Not Possible | Not Possible |

It should be noted that the VDES service may be a sub-service of a larger deployment configuration such as a VTS service or e-Navigation. Details on a common maritime-based system architecture for e-Navigation are described in IALA Guideline 1114.

# 4.2 Shore-based VDES SERvice

This section describes the shore-based VDES service in relation to ASM and terrestrial VDE service functions. The purpose of the shore-based VDES service is to allow clients to interface with a variety of VDES stations available to mariners or marine managers over a VHF data link (VDL). VDL is defined as the medium used by VDES stations to exchange information.

Customers of shore-based VDES services may include:

* + Other systems of the maritime administration that operate land-based AIS/VDES services, such as viewing clients;
  + Systems of other agencies outside the maritime administration (e.g. other government departments or other governments);
  + Other shore-based services.

The various VDES stations that shore-based VDES services can interface with include, but are not limited to:

* + AIS/VDES Base stations of other competent authority
  + Limited AIS/VDES Base stations of other competent entities
  + Class A mobile AIS/VDES stations
  + Class B mobile AIS/VDES stations
  + SAR AIS/VDES stations
  + AtoN AIS/VDES stations
  + AIS/VDES-SART stations
  + AIS/VDES-EPIRB stations
  + AMRD Group A (mobile AtoN, AIS MOB) stations.

Shore-based VDES services are designed, operated, and maintained as described in the CSSA's general service engineering model.

Although the functionality of the AIS service can be combined with that of the ASM and terrestrial VDE services, this increases the data volume and processing complexity, but in most cases the unique service categories and associated data objects are independent of AIS, ASM and terrestrial VDE, other than the message routing functionality provided by VDES-LSS. Further details on the AIS Service Model are given in [5] IALA R0124, The AIS Service, December 2012 and its dependent documents Appendix 0 to 19.

# 4.2.1 Category Classification

Depending on the data flow interaction between components of the shore-based infrastructure, they are divided into internal VDES services and external VDES services. Internal VDES services are defined as services that manage VDES data links or manage resources required for the technical operation of VDES VDL and/or VDES services, and collect/process/analyze/display information about external mobile stations. External VDES services are defined as services that exchange service data from an application perspective between ships and shores, shores and ships (and other traffic systems) through Shore-Based Infrastructure.

Figure 5 shows an overview of the entire VDES service, including individual AIS/ASM/Terrestrial VDE services, and Table 2 explains the category classification of VDES services.

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Figure 5 Overview of the whole VDES Service

Table 2 Category classification of the whole VDES Service

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Sort | Interna  /External | Category | Service | Transmission/Reception | Description |
| AIS  Service | Internal | (A)I-1 | AIS Service categories are described in detail in IALA Recommendation 0124, Appendix 1. To clearly distinguish between ASM Service and Terrestrial VDE Service, an (A) is added in front of the AIS Service category names. | | |
| (A)I-2 |
| (A)I-3 |
| (A)I-4 |
| (A)I-5 |
| (A)I-6 |
| (A)I-7 |
| External | (A)E-1 |
| (A)E-2 |
| (A)E-3 |
| (A)E-4 |
| ASM Service | Internal | SI-1 |  |  |  |
| SI-x |  |  |  |
| SI-x |  |  |  |
| SI-x |  |  |  |
| SI-x |  |  |  |
| External | SE-1 |  |  |  |
| SE-2 |  |  |  |
| SE-3 |  |  |  |
| SE-x |  |  |  |
| SE-x |  |  |  |
| Terrestrial VDE Service | Internal | TI-1 |  |  |  |
| TI-x |  |  |  |
| TI-x |  |  |  |
| TI-x |  |  |  |
| TI-x |  |  |  |
| External | TE-1 |  |  |  |
| TE-2 |  |  |  |
| TE-x |  |  |  |
| TE-x |  |  |  |
| TE-x |  |  |  |

* ASM Services: ASM services are divided into the following four categories (categories) based on data flow characteristics (see Figure 6):

1. Internal ASM Service Category 1 (SI-1): Transmits ASM VDL monitoring information and data integrity monitoring information upon request.
2. External ASM Service Category 1 (SE-1): Initiated by an external ASM mobile station, data is transmitted from the external ASM mobile station to the corresponding ASM service.
3. External ASM Service Category 2 (SE-2): Transmits data from the shore service to an external ASM mobile station upon request.
4. External ASM Service Category 3 (SE-3): Transmits navigation assistance data to an external ASM mobile station within a specified time upon request or configures transmission parameters (parameters) of an external AIS mobile station in the VDL.

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Figure 6 ASM Service Category Classification

* Terrestrial VDE services: divided into three categories (categories) based on service characteristics (see Figure 7):

1. Internal VDE Service Category 1 (TI-1): Transmits VDE VDL monitoring information and data integrity monitoring information upon request.
2. External VDE Service Category 1 (TE-1): Shore-based service that configures the transmission access parameters (parameters) of external VDE mobile stations in the VDL
3. External VDE Service Category 2 (TE-2): Shore-based service initiated by external VDE mobile stations or shore clients that enables interaction between VDE mobile stations or between VDE mobile stations and shore clients.

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Figure 7 Terrestrial VDE Service Category Classification

# 4.2.2 Interaction model

The physical layer of the VDES service is configured and controlled by the VDES Service Control Station (VDES-SCS), but the VDES-SCS has no direct access to the VDES Fixed Station and relies on the VDES-PCU for internal interactions or on the VDES-LSS for external interactions to configure and communicate data with the VDES Fixed Station.

Figures 8 and 9 illustrate the interactions between other components of the shore-based infrastructure and the VDES Physical Controlling Unit (VDES-PCU), respectively.

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Figure 8 Interactions between VDES-PCU and VDES-LSS

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Figure 9 Interactions between VDES-PCU and VDES-SCS

The purpose of the VDES Logical Shore Station is to facilitate interaction with the VDES service. For client systems, the VDES-LSS represents a single interface point to the VDES service. It merges the different data streams of all the relevant VDES-PSSs. In a sense, the VDES-LSS hides all the complexities of the VDES service from the client.

Figure 10 shows the interaction between other components of the shore-based infrastructure and the VDES Logical Shore Station (VDES-LSS).

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Figure 10 Interactions between VDES-LSS and other components of shore-based infrastructure

Figure 10 shows that only one VDES-SCS can interface to any VDES-LSS, but multiple can interface to clients, VDES-LSSs, and VDES-PCUs.

VDES-SCS controls the overall data flow of the system and manages VDES services by configuring various entities to meet service requirements. Figure 11 shows the interaction between other components of the Shore-Based Infrastructure and a single VDES Service Control Station (VDES-SCS).

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Figure 11 Interactions between VDES-SCS and other components of shore-based infrastructure

Figure 11 shows that multiple technology interfaces, VDES-LSS and VDES-PCU, can be interfaced to one VDES-SCS.

# 4.2.3 Data flow model

Functional components that match the service category classification can be grouped if there is a model for interaction and data flow between them, and the way the interaction and data flow are generated is similar. Interaction and data flow are performed through functional interfaces.

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• Interaction and data flow for SI-1

Figure 12 Template for internal ASM Service-1 data flow model

* Interaction and data flow for SI-x

Figure x Template for internal ASM Service-2 data flow model

* Interaction and data flow for SI-x

Figure x Template for internal ASM Service-3 data flow model

* Interaction and data flow for SI-x

Figure x Template for internal ASM Service-x data flow model

* Interaction and data flow for SI-x

Figure x Template for internal ASM Service-x data flow model

* Interaction and data flow for SE-1

Figure x Template for external ASM Service-1 data flow model

* Interaction and data flow for SE-2

Figure x Template for external ASM Service-2 data flow model

* Interaction and data flow for SE-3

Figure x Template for external ASM Service-3 data flow model

* Interaction and data flow for SE-x

Figure x Template for external ASM Service-x data flow model

* Interaction and data flow for SE-x

Figure x Template for external ASM Service-x data flow model

# 4.2.4 data model

The data model of the VDES service is intended to describe what data is used, received and transmitted by the VDES service. That is, it identifies the data that the VDES service can provide to shore-based systems for VDES-equipped traffic objects (in particular ships), and the data objects that shore-based systems can send to the VDES Stations on board these traffic objects.

It is important to understand that the data objects used by the VDES service are derived from an important data model called the IALA Universal Maritime Data Model (UMDM). The data model provides a well-structured and abstract (functional) description of the data that the VDES service exchanges with the client's request service through a functional interface, with data properties based on appropriate data type definitions, described in one place.

* List of data objects in the internal ASM service

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* List of data objects in the external ASM service



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* List of data objects of the internal Terrestrial VDE service

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* List of data objects of the external Terrestrial VDE service



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The data model provides engineers of the requesting service and/or application with precise information about the data that the VDES service can provide (receive) or expect (transmit) without needing to know, for example, the encoding details of the VDL. Thus, the data model helps encapsulate the 'science of VDES' and confine it to the VDES service on behalf of the entire shore-based system. The data model does not contain any encoding information, but encoding is required at the application level.

# 4.2.5 Interface model

It is necessary to recommend the minimum interfaces required for a VDES service. Specific implementations may use or provide additional interfaces to meet specific user requirements. The interface model for the VDES service describes:

* Relationship between VDES service and client (called external interface)
* Interface between Terrestrial VDES service components of Shore-Based Infrastructure (called internal interface)
* Encoding used for all identified interfaces

The internal and/or external interfaces of the VDES service must correspond to the internal and/or external VDES service interactions, respectively, as described in §4.4.2.

Based on Figure x, Table 3 specifically identifies all interfaces of the VDES service. It includes both internal and external, machine-to-machine and human-to-machine interfaces.

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Figure x Identification of the functional interfaces in relationship to the functional component’s tasks they connect

Table 3 Complete identification of functional interfaces of the VDES Service

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Interface Name | Interface Type | Interface Actors | | Recommended Interface |
| Actor A | Actor B |
| Clients | External - MMI | VDES-LSS | All VDES Service clients | MDEF sentences |
| Technical Operational Personnel | External - MMI | VDES-SCS | Technical Operational Personnel | None |
| VDES-SCS | Internal - MMI | VDES-SCS | VDES-PCU  & VDES-LSS | MDEF sentences |
| VDES-LSS | Internal - MMI | VDES-LSS | VDES-LSS | MDEF sentences |
| VDES-PCU | Internal - MMI | VDES-PCU | VDES-LSS | MDEF sentences |
| VDES Fixed Station | Internal - MMI | VDES Fixed Station | VDES-PCU | PI sentences  IEC 61162  IEC 62320  IEC xxxxx |
| VDL | Internal - MMI | VDES Fixed Station | Other VDES stations on VDL | ITU-R M.1371  ITU-R M.2092 |

The exchange of data by VDES services through internal and/or external interfaces is performed by means of ‘sentences’, which are sets of data objects arranged in a meaningful order (‘semantics’). These ‘sentences’ are part of the IALA Maritime Data Exchange Format (MDEF). It should be noted that MDEF sentences are abstract representations of the data objects that are exchanged between VDES actors. The PI sentences defined in IEC 61162-1 and IEC 62320-1, IEC 6xxxx are recommended for encoding MDEF sentences. All Terrestrial VDES service components in a Shore-Based Infrastructure shall support the standard PI sentences for data exchange by default.

It is possible to define a set of unique sentences that complement the existing MDEF sentences to provide additional functionality or additional VDES services. It is recommended to reuse these interfaces where possible to support both MDEF and unique sentences in the same interface, but it is also possible to define new interfaces to exchange unique sentences.

All Terrestrial VDES service components in the shore VDES Infrastructure must always be compatible with MDEF statements and standard interfaces. It is also not recommended to duplicate information already available in the rest of the protocol stack within MDEF statements or proprietary statements. If such information is required, the appropriate MDEF statement or protocol stack parameters should be used.

The TCP/IP Socket client-server protocol is the recommended protocol stack for the Machine-to-Machine Interface (MMI) of VDES networks, with TLS/SSL recommended for secure connections. Additional standard protocol stacks may be supported in various environments for various interfaces, such as serial RS-232 and RS-422, but are not recommended for VDES networks.

When the Terrestrial VDES service component of the shore VDES infrastructure is implemented as an integrated component consisting of hardware and firmware, there must additionally be an appropriate 'HMI Direct' and/or 'Local HMI'.

* HMI Direct: Consists of all signals, displays and input devices (e.g. on/off switches, reset keys, LED indicators, etc.) that are mounted on the machine and form an integral part of the machine. The 'HMI Direct' is always located where the machine is, i.e. at the remote and node sites. These interfaces are usually intended for quick access to the most important information about the current status of the machine, but are not used for convenient technical operation.
* Local HMI: Similar to ‘HMI Direct’, but consists of all individual signals, displays and input devices whose functionality is entirely dependent on the machine. Examples include computer peripherals such as the mouse, keyboard and display.
* Field-deployed HMI: A human interaction (HI) device located at a remote or node site, connected to a machine via a LAN (i.e., in the same building or location as the machine to which it is connected), operates independently of the machine for basic HI functions, but relies on the machine for information.
* Remote HMI: A Human Interface (HI) device located at the technical operator’s work site (either a fixed or mobile work site) and connected to the machine via a WAN. That is, it is not located in the same building or location as the connected machine, and operates independently of the machine for basic HI functions, but relies on the machine for information. The provision of a remote HMI alone allows for the operation of a centralized Technical Operation Personnel location.

# 4.3 vdes dATA TRANSFER NETWORK

This section presents the basic concepts and requirements for forming the framework of a VDES data transmission network. At some level of the decision-making process within the competent authority, it may help to formalize macro-level decisions on network configuration.

# 4.3.1 ELEmentary concepts and Requirements

Figure x shows the most basic VDES data network. The "cloud" can be a wired or complex wide area network, but the VDES network requirements are greatly simplified. In the simplest configuration, a layer can consist of a single entity, such as a physical device or a software module running on a computer.

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Figure x Basic VDES data network (including integrated or separate AIS data network)

* TCP/IP: Entities of the VDES service shall use the TCP/IP protocol for VDES data transmission to the greatest extent possible. TCP/IP packets containing AIS service and safety-related data shall be assigned the highest priority and shall be prioritized for transmission.
* Security: The network must provide adequate protection against unauthorized use of information and the network. By establishing the concept of user rights and authorization, unauthorized users can prevent unauthorized users from changing or obtaining unauthorized information. Likewise, unauthorized transmission of data over the network must be prevented.
* Other application capacity: In a comprehensive view of the shore-side network, if properly designed for both ship and land users, it should be able to accommodate commercial requirements other than those aimed at public interest, such as maritime safety and traffic management.

# 4.3.2 Progression concepts and Requirements

As the complexity of VDES service categories increases, the configuration and capacity of the connected network configurations also increase, so it is recommended to apply a layered architecture. The following shows the degree of complexity inherent in VDES services and how a layered architecture can effectively address these requirements.

* Geographic Coverage Requirements: The requirement to provide coverage of the VDES coastal infrastructure over a larger area has several important implications. In areas with high traffic volumes, it may be necessary to subdivide the coverage area of ​​a single VDES coastal station into sectors using directional diversity of the antennas to ensure unbroken VDES messages are received by all surrounding mobile VDES stations. To utilize directional diversity, a VDES coastal station has multiple VDES base stations, which are connected to other antennas whose antenna sectors should not overlap each other as much as possible. Simply to cover a larger geographic area, and especially to address the garbling problem in a larger geographic area, multiple VDES coastal stations may be required, each of which may consist of multiple VDES base stations.
* Complexity Processing: VDES itself and proper handling of VDES data represent high complexity. To address this complexity, the overall functionality of VDES must be subdivided into appropriate sections. Since the geographical coverage requirement implies a hierarchical structure, the functional layer can be considered as the first step. The functional layers can be further subdivided into entities on the same functional layer.
* Encapsulation: Encapsulation principles must be followed to ensure that design and configuration details that apply only to one specific layer or to some entities within a layer are not inappropriately distributed across the VDES service or across application layers.
* Modularity/open system requirements: The layered approach meets the general requirements for open systems, which outline more detailed requirements from the competent authorities.

1. the desire to use "plug and play" components for easy installation,
2. the flexibility requirement (designing a system that can be easily changed during its life cycle due to partial maintenance considerations or changes in maintenance considerations without affecting the entire system);
3. the "second source" requirement (to have at least one second vendor for spare parts);
4. the timing requirement, i.e. allowing some parallelization of processing in different tiers and different entities;

e) the cost requirement (achievement of a reasonable market price through competition).

# 5 vdES mode operation

To be written.

# 5.1 functional Definitions of MODE OPERATION

To be written.

# 5.2 Frequency MODE OPERATION

To be written.

# 5.2.1 SIMPLEX MODE OPERATION

To be written

* + - 1. Shore to Ship Operation
      2. Ship to Shore Operation
      3. Ship to Ship Operation

# 5.2.2 DUPLEX MODE OPERATION

To be written

* + - 1. Shore to Ship Operation
      2. Ship to Shore Operation
      3. Ship to Ship Operation

# 5.3 RANGE MODE OPERATION

To be written.

# 6 vHF Data Link Integrity monitoring

To be written.

# 6.1 functional Definitions of vdl integrity

To be written.

# 6.2 Big data analytics model

To be written.

# 6.3 Detection and investigation

To be written

# 6.4 report and inform method

To be written

# 7 RESOURCE SHARING management AND COORDINATION

Terrestrial VDES services are in most cases limited to a service area extending 40 to 120 NM inside the territorial sea and/or exclusive economic zone boundaries, but may overlap service coverage areas depending on the geographical features of borders and coastlines of adjacent countries. Thus, there is a need for appropriate sharing and coordination of resources required for data transmission, such as frequency, bandwidth, initial contact time, and transmission frequency, between VDES base stations in adjacent countries. In addition, communication priorities should be considered according to the technical characteristics of ASM and VDE-TER as described in [1] ITU-R M.2092-2, Technical Characteristics for a VHF Data Exchange System in the VHF Maritime Mobile Band, February 2026. There are 2 types of coordination to be considered in shore-based infrastructure by competent authority.

* Coordination with other VDES base stations, within the same organization and between different organizations
* Coordination with own AIS / ASM / VDE-TER transmissions

# 7.1 functional Definitions of VDES resource sharing

To be written

# 7.2 Coordination with other VDES station

To be written.

# 7.2.1 Coordination for ASM base stations

To be written

# 7.2.2 Coordination for VDE-TER base stations

To be written

# 7.3 Coordination with own AIS / ASM / VDE-TER transmissions

To be written

# 7.4 Examples of Resource sharing management and coordination scheme

# 7.4.1 Over the Air (OTA) coordination

To be written

# 7.4.2 Frequency domain sharing

To be written

# 7.4.3 time domain sharing

To be written

# 8 installation, implementation and maintenance

To be written

# 8.1 installation

To be written.

# 8.1.1 vdes shore station installation

To be written. Includes both cases for AIS + VDES, AIS-VDES separation.

# 8.1.2 vdes antenna(s) installation

To be written. Refers to SN/Circ.227(page 6)

# 8.1.3 gnss antenna installation

To be written. Refers to SN/Circ.227(page 6)

# 8.1.4 power source

To be written.

# 8.2 implementation and maintenance

To be written.

# 8.2.1 role of authorities

To be written.

# 8.2.2 operator

To be written.

# 8.2.3 protection and security

To be written.

# 8.2.4 failure warning and indication

To be written.

1. [↑](#footnote-ref-1)