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Key Points of the Modernized GMDSS System

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ABSTRACT: The article presents the reasons and the entire process of work on the modernization of the GMDSS system. The main legal and technical aspects of the modernization of the GMDSS system were discussed as well. New devices and systems of the modernized GMDSS system were described. On the basis of the key points of the modernized GMDSS, an attempt was made to evaluate the entire project.

1 INTRODUCTION

Technological progress in electronics, radio communications and information technology results in the constant emergence of new proposals for modifications to the equipment and systems used on sea-going vessels. The principles and scope of equipment for these vessels, related to ensuring their safety, are strictly regulated by the International Maritime Organization (IMO), with merit-related support by its committees and sub-committees. In 2006, several countries submitted a proposal to the IMO Maritime Safety Committee (MSC) for preparing a broad strategy for the inclusion of new technologies in a comprehensive manner, to ensure their compatibility with existing navigation and communication technologies and services [1]. In response to this proposal, the MSC took the decision to initiate work on the "e-navigation" project through two IMO technical sub-committees: Sub-Committee on Safety of Navigation (NAV) and Sub-Committee on Radiocommunications, Search and Rescue (COMSAR). The project coordinator became the NAV Sub-Committee [1]. The International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), International Hydrographic Organisation (IHO) and International Federation of Shipmasters' Associations (IFSMA) were also invited to participate in the project. As a result of the organisational changes in the IMO sub-committees in 2013 coordination over the e-navigation project was entrusted to a new sub-committee formed by merging the NAV and COMSAR sub-committees, i.e. Sub-Committee on Safety of Navigation, Communication and Search and Rescue (NCSR).

Doubtlessly, one of the key elements of e-navigation will be a radio communication data transmission network based on new systems and those already used in maritime communications. The above led the IMO to undertaking work in 2012 on reviewing and modernising the Global Maritime Distress and Safety System (GMDSS) used in maritime radio communications. The first phase of this project concerned a "High-Level Review", where fundamental elements of the GMDSS were analysed. During phase two, in 2013–2016, a "Detailed Review" of the GMDSS was performed. Another phase, completed in 2017, concerned the preparation of a "GMDSS Modernization Plan". According to this plan, all works carried out by the NCSR subcommittee on the modernization of the system

were to be completed in 2021. So, the NCSR Sub-Committee during 8 session has completed its review of the Global Maritime Distress and Safety System (GMDSS) requirements, agreeing draft amendments to the International Convention for the Safety of Life at Sea (SOLAS), 1974 and other existing instruments. These amendments are intended to enable the use of modern communication systems in the GMDSS whilst removing requirements to carry obsolete ones.

Finally draft amendments to the SOLAS Convention were presented at the 104th Session of the Maritime Safety Committee (MSC), with a view to approval and subsequent adoption into MSC 105 in 2022, so that they can enter into force on 1 January 2024.

The work on the GMDSS modernization project can be broken down into tasks concerning the legal and technical aspects related to implementation of new maritime radio communication systems and modification of existing ones [2].

The article presents the main results of work on the GMDSS modernization project, carried out by the NCSR Sub-committee, the IMO Correspondence Group on the Review of the GMDSS and the Joint IMO/ITU Experts Group, in which the author of the article participated.

2 LEGAL ASPECTS OF THE GMDSS MODERNIZATION

The legal aspects of the GMDSS modernization concern mainly the regulations issued by the IMO and also issued by the ITU (International Telecommunications Union).

2.1 *IMO regulations*

IMO legal aspects of the GMDSS modernization mainly concern amendments to the Safety Of Life At Sea (SOLAS) Convention and its related documents. The SOLAS Convention defines uniform rules and regulations for the minimum required equipment of marine vessels, with section 4 devoted to the radiocommunication.

As a result of the work on the modernization of GMDSS, Search and Rescue Locating Devices - SARLD regulations, i.e. SART (Search And Rescue Transponder) and AIS-SART (Automatic Identification System - Search and Rescue Transmitter), have been transferred from Chapter III (LIFE-SAVING APPLIANCES AND ARRANGEMENTS) to Chapter IV (RADIOCOMMUNICATIONS) of the SOLAS Convention [3].

A very important change in the SOLAS Convention concerns the definition of sea area A3. After discussion, the following definition was adopted [3]:
"Sea area A3 means an area, excluding sea areas A1 and A2, within the coverage of a recognized mobile satellite service supported by the ship earth station carried on board, in which continuous alerting is available."

In the above definition "recognized mobile satellite service" means any service which operates through a satellite system and is recognized by the IMO, for use in GMDSS.

Another significant change in the SOLAS Convention concerns the Functional requirements of the ship's radio station. According to the changes introduced to the Convention every ship, while at sea, shall be capable of [3]:

1. performing the GMDSS functions, which are as follows:
    1. transmitting ship-to-shore distress alerts by at least two separate and independent means, each using a different radiocommunication service;
    2. receiving shore-to-ship distress alert relays;
    3. transmitting and receiving ship-to-ship distress alerts;
    4. transmitting and receiving search and rescue coordinating communications;
    5. transmitting and receiving on-scene communications;
    6. transmitting and receiving signals for locating;
    7. receiving MSI;
    8. transmitting and receiving urgency and safety communications; and
    9. transmitting and receiving bridge-to-bridge communications; and
2. transmitting and receiving general radiocommunications.

In the above functional requirements [3]:

- Locating means the finding of ships, aircraft, survival craft or persons in distress;
- Maritime Safety Information (MSI) means navigational and meteorological warnings, meteorological forecasts and other urgent safety-related messages broadcast to ships;
- Bridge-to-bridge communications means safety radiocommunications between ships from the position from which the ships are normally navigated;
- General radiocommunications means communications other than distress, urgency and safety communications.

It should be noted that the above functional requirements clearly separate the functions related to GMDSS (distress, urgency and safety communications) from the functions related to general communications. Definitions of sea areas A1 and A2 was left unchanged. Sea area A4 was not redefined, but as it is the area outside sea areas A1, A2 and A3, it will vary for ships using different mobile satellite communication providers.

Taking into account the changes presented above, the Ship requirements contained in Part C of Chapter IV of the SOLAS Convention have been changed accordingly.

All equipment to which the Chapter IV of the SOLAS Convention applies shall be of a type approved by the Administration. Such equipment shall conform to appropriate performance standards not inferior to those adopted by the IMO. The resolutions adopted in the above scope by the IMO have been collected in one Regulation (Regulation 14 – Performance standards) and ordered with regard to [3]:

– General requirements,
– VHF equipment,
– MF and HF equipment,
– Ship earth stations and enhanced group call (EGC) equipment,
– Integrated radiocommunication systems,
– Emergency position-indicating radio beacons, and
– Search and rescue transmitters and transponders.

In addition, as a result of work on the modernization of GMDSS certain regulations of Chapter IV were modified, as they were simply outdated or incorrect.

Other major work has been done with regard to documents relating to the SOLAS Convention. Following a comprehensive review of the Global Maritime Distress and Safety System (GMDSS) by the Sub-Committee on Navigation, Communications and Search and Rescue (NCSR), the MSC 104 in 2021 approved a set of associated amendments and revisions to existing related instruments. The aim of all amendments is to enable the use of modern communication systems in the GMDSS whilst removing requirements to carry obsolete systems.

It should be emphasized that the revision of the relevant regulations in SOLAS chapters IV and preparation of related and consequential amendments to other existing instruments is the result of a decade of detail-oriented work by IMO, in particular by the NCSR Sub-Committee.

2.2 *ITU regulations*

As mentioned earlier the legal aspects of the GMDSS modernization concern the regulations issued by the ITU (International Telecommunications Union), as well. These regulations mainly concern the provisions of the Radio Regulations and the revision of the relevant ITU Resolutions and Recommendations adopted at the World Radiocommunication Conferences (WRCs). Since the beginning of work on the review and modernization of the GMDSS, two World Radiocommunication Conferences have been held i.e. in 2015 (WRC-15) and in 2019 (WRC-19).

During WRC-15, there was no agenda item directly related to the modernization of the GMDSS system. The only item on the agenda of this Conference was item 1.16:
"1.16 to consider regulatory provisions and spectrum allocations to enable possible new Automatic Identification System (AIS) technology applications and possible new applications to improve maritime radiocommunication in accordance with Resolution 360 (WRC-12)".

Resolution 360 (WRC-12) concerned: Consideration of regulatory provisions and spectrum allocations for enhanced Automatic Identification System technology applications and for enhanced maritime radiocommunication.

During the next World Radiocommunication Conference in 2019 (WRC-19), two points were directly related to the modernization of the GMDSS system:
"1.8 to consider possible regulatory actions to support Global Maritime Distress Safety Systems (GMDSS) modernization and to support the introduction of additional satellite systems into the GMDSS, in accordance with Resolution 359 (Rev.WRC 15); and
1.9.2 modifications of the Radio Regulations, including new spectrum allocations to the maritime mobile-satellite service (Earth to space and space-to-Earth), preferably within the frequency bands 156.0125-157.4375 MHz and 160.6125-162.0375 MHz of Appendix 18, to enable a new VHF data exchange system (VDES) satellite component, while ensuring that this component will not degrade the current terrestrial VDES components, applications specific messages (ASM) and AIS operations and not impose any additional constraints on existing services in these and adjacent frequency bands as stated in recognizing d) and e) of Resolution 360 (Rev.WRC 15) - Consideration of regulatory provisions for updating and modernization of the Global Maritime Distress and Safety System".

Resolution 359 (Rev.WRC 15) concerned: Consideration of regulatory provisions for updating and modernization of the Global Maritime Distress and Safety System, and Resolution 360 (Rev.WRC 15) concerned: Consideration of regulatory provisions and spectrum allocations to the maritime mobile-satellite service to enable the satellite component of the VHF Data Exchange System and enhanced maritime radiocommunication.

The World Radiocommunication Conferences 2015 and 2019 revised Appendix 18 of the Radio Regulations, the VHF maritime radio frequency band, to designate frequency channels to be used for VDES in accordance with the most recent version of Recommendation ITU-R M.2092 - Technical characteristics for a VHF data exchange system in the VHF maritime mobile band. These VDES channels were duplex channels with two bands separated by 4.6 MHz, where both bands are used to facilitate VDES communications between ships, shore stations, and satellites. Since 2024 all the VDES VHF channels shall only be used for the VDES (MSC.1/Circ.1460/Rev.2) globally (Fig. 1) [4].

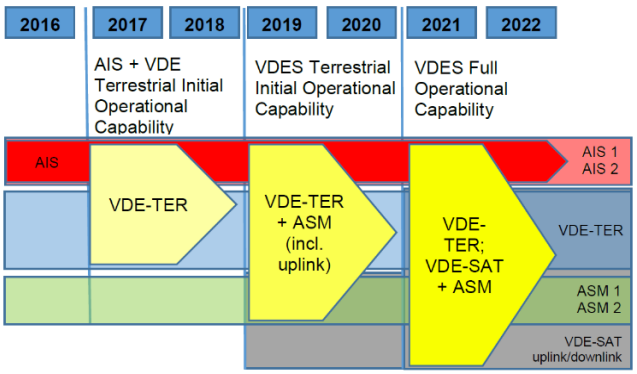

Figure 1. International availability of VDES spectrum (as App.18 of ITU Radio Regulations) [4]

In 2022 ITU has published latest version of ITU-R M.2092-1 incorporating changes to add VDES Satellite functionality and updates consequential to feasibility tests [5].

It should be mentioned that the World Radio Conference 2012 approved the worldwide exclusive usage of the frequency band 495 - 505 kHz for the maritime mobile service for the exclusive use of NAVDAT. In 2011 the ITU-R Study Group 5 adopted the Recommendation ITU-R-M.2010 which will be

published in 2012 “Characteristics of a digital system, named Navigational Data for broadcasting maritime safety and security related information” [6]. In 2014, Recommendation ITU-R M.2058 “Characteristics of a digital system, referred to as navigational data for broadcasting maritime safety and security related information from shore-to-ship in the maritime HF frequency band” [7] was adopted. The adopted frequency bands for NAVDAT HF are given in Table 1 (frequencies of RR Appendix 17).

Table 1. Frequencies for NAVDAT HF system [7]

Central frequency (kHz)	Limits (kHz)
4 226	4 221 to 4 231
6 337.5	6 332.5 to 6 342.5
8 443	8 438 to 8 448
12 663.5	12 658.5 to 12 668.5
16 909.5	16 904.5 to 16 914.5
22 450.5	22 445.5 to 22 455.5

Wherein, the main international NAVDAT HF frequency is 4 226 kHz.

As a result of further work on NAVDAT, ITU published Report ITU-R M.2443-0 "NAVDAT Guidelines" in 2022, and updated versions of the recommendations ITU-R-M.2010 and Recommendation ITU-R M.2058 in 2023.

In addition to the above-mentioned main regulations regarding the modernization of GMDSS, ITU also introduced a number of changes to improve or update the existing provisions.

2.3 *Upcoming regulations*

In order to complete the process of GMDSS modernization, further work is being carried out by the IMO and ITU. The expression of these works are the following items on the agenda of the NCSR Sub-Committee planned for discussion in 2023 during its 10 sessions:

1. Development of amendments to SOLAS chapters IV and V and performance standards and guidelines to introduce VHF data exchange system (VDES),
2. Development of performance standards for a digital navigational data system (NAVDAT),
3. Developments in GMDSS services, including guidelines on maritime safety information (MSI),
4. Revision of the Criteria for the provision of mobile satellite communication services in the Global Maritime Distress and Safety System (GMDSS) (resolution A.1001(25)), and
5. Response to matters related to the ITU-R Study Groups and ITU World Radiocommunication Conference.

The upcoming World Radiocommunication Conference (WRC-23), which will take place from 20 November to 15 December 2023, will deal with the following agenda item directly related to the modernization of the GMDSS too:
“1.11 to consider possible regulatory actions to support the modernization of the Global Maritime Distress and Safety System and the implementation of e-navigation, in accordance with Resolution 361 (Rev.WRC-19)”.

In accordance with Resolution 361 (Rev.WRC 19), this agenda item consists of three different issues which should be treated separately:

1. to consider possible regulatory actions, based on the ITU Radiocommunication Sector (ITU R) studies, taking into consideration the activities of IMO, as well as information and requirements provided by IMO, to support GMDSS modernization;
2. to consider possible regulatory actions, including spectrum allocations based on the ITU Radiocommunication Sector (ITU R) studies, for the maritime mobile service, supporting e navigation;
3. to consider regulatory provisions, if any, based on the results of ITU R studies, referred to in invites the ITU Radiocommunication Sector below, to support the introduction of additional satellite systems into the GMDSS.

Under point 1) the following issues will be considered:

– removal of the obsolete Narrow Band Direct Printing (NDBP) telegraphy system from the GMDSS in all associated MF and HF bands (amendments to Appendices 15 and 17 RR);
– introduction of a new ACS (Automatic Connection System) system to the RR, which would use the marine MF and HF bands;
– including the NAVDAT system frequencies in the HF and MF bands in Annex 15 RR and making appropriate changes to Art. 5, 32, 33 and 52 RR;
– ensuring protection in RR for frequencies used by AIS-SART (Automatic Identification System - Search And Rescue Transmitter);
– regulatory actions in response to IMO's decision to remove EPIRBs using frequencies other than 406 MHz ("non-406 MHz EPIRBs") from the GMDSS.

3 TECHNICAL ASPECTS OF GMDSS MODERNIZATION

The most important proposals for introducing new or modifying existing marine radio communication systems are presented below.

3.1 *New satellite operators*

According to the current regulations, in order for a satellite system (operator) to be considered as meeting the requirements of the SOLAS Convention (GMDSS), it has to meet the requirements specified in IMO Resolution A.1001(25) “Criteria for the provision of mobile satellite communication systems in a global maritime distress and safety system (GMDSS)” [8]. Current provisions of the SOLAS Convention and the above Resolution are very strict, e.g. they require global coverage for operations [8]. In order to change this, SOLAS Chapter 4 was modified to ensure actual access to the GMDSS for other satellite service providers (see point 2.1). In the above context, the issue of frequency availability for new GMDSS operators was considered in point 1.8 of the WRC-19 and will be considered in point 1.11 of the WRC-23.

During the work on the modernization of GMDSS, all IMO documents applicable to Inmarsat were reviewed to adapt them to new GMDSS satellite service providers. In 2018 the MSC 99 agreed that Iridium Satellite LLC had satisfied the established criteria to receive recognition as a mobile satellite communication service provider in the Global Maritime Distress and Safety System (GMDSS) and adopted a Statement of Recognition of the Maritime Mobile Satellite Services provided by Iridium Satellite LLC, which recognizes the services provided by the Iridium Safety Voice, Short-Burst Data and enhanced group calling services, for use in the GMDSS. The Iridium constellation connects 66 cross-linked satellites in Low-Earth Orbit, providing reliable coverage even in adverse weather around the entire globe, including over the Arctic and Antarctic waters in Sea Area A4 (Fig. 2) [9].

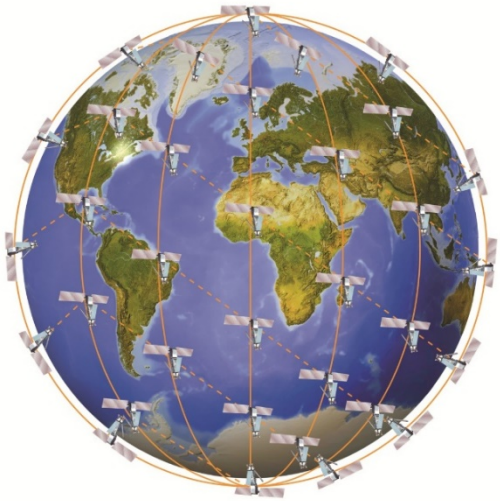

Figure 2. Iridium constellation showing the six orbital planes [9]

At the same session the MSC also adopted a Statement of Recognition of Maritime Satellite Services provided by Inmarsat Global Ltd, for use in the GMDSS. The statement recognizes services provided by the Inmarsat Fleet Safety service, in the coverage area under the Inmarsat-4 Middle East and Asia (MEAS) region satellite. Approved by the IMO Inmarsat Fleet Safety is a maritime data service that supports GMDSS compliance for voice and data distress, and urgency and safety communications. Combining a Maritime Safety Terminal (MST) with existing FleetBroadband or Fleet One data services, Fleet Safety is the significant advance in maritime safety. Fleet Safety offers a full suite of GMDSS applications such as Distress Alerting, Priority Messaging, reception of Maritime Safety Information, priority Short Access Codes such as 38-Medical Assistance. New innovative safety features are also included such as Distress Chat with MRCCs and retrieval of historic Maritime Safety Information.

Following the assessment and evaluation of an application by China Transport Telecommunication Information Group Co. Ltd. (CTTIC) to recognize the BeiDou Message Service System (BDMSS) for use in the GMDSS, in November 2022the, MSC 106 adopted an MSC resolution on Statement of recognition of the maritime mobile satellite services provided by CTTIC through BDMSS. The recognition is currently limited to a coverage area within 75°E to 135°E longitude and 10°N to 55°N latitude. IMSO will continue to monitor the implementation of BDMSS and will report to the Committee when the Public Services Agreement with CTTIC has been concluded and the Letter of Compliance has been issued to mark the commencement of services.

3.2 *Terrestial radio communication*

Without a doubt, VHF radiotelephones will remain a highly useful component of maritime radio communications. HF radio communications will remain a required communication system for sea area A4. It is well known that HF communication is highly varied and difficult due to variable ionospheric propagation. A solution to this problem is the use of ACS (Automatic Connection System). An example of such a system is automatic frequency scanning and automatic link establishment (ALE) systems, improving the success of using HF communication.

Automatic link establishment (ALE) equipment transmits signals to other stations on a network on one or more of a pre-arranged list of frequencies. Link assessment data is stored in an internal database and used to establish communications on the frequency most suited to the propagation environment. The ALE system requires the prior assignment of a suite of frequencies. These frequencies vary in number but, in the interests of establishing the link as rapidly as possible, the number is kept reasonably small (e.g. four to seven). The ideal adaptive system uses real-time ionospheric information to modify the suite of frequencies being evaluated.

Another analysed issue was the use of NBDP in sea areas A3 and A4. It was found that reception of maritime safety information (MSI) in the HF band remains necessary, but it can be acquired by means other than NBDP, and that this technology will not be required to fulfil any other GMDSS function. However, existing NBDP devices can be left to receive MSI if the ship is not equipped with other devices fulfilling this function.

To summarise, the application of the proposed technological progress may lead to easier and more effective use of the MF/HF bands.

3.3 *New communication technologies*

The detailed GMDSS review clearly indicates the need to use new technologies. The main examples of such new technology are systems NAVDAT and VDES.

Navigational Data (NAVDAT) is the radio system, for use in the maritime mobile service, operating in the MF (500 kHz) and HF bands for digital broadcasting of maritime safety and security related information from shore-to-ship [6, 7]. The NAVDAT system uses a time-slot allocation similar to the NAVTEX system which could be coordinated by IMO in the same manner. That system can also work on Single Frequency Network (SFN). In this case transmitters are frequency synchronized and the transmit data must be the same for all transmitter. The

NAVDAT digital system offers a broadcast transmission of any kind of message from shore to ships with possibility of encryption. Any broadcasting message should be provided by a secure and controlled source.

Message types broadcast can include, but are not limited to, the following:
- safety of navigation;
- security;
- piracy;
- search and rescue;
- meteorological messages;
- piloting or harbour messages;
- vessel traffic system files transfer.

These messages are broadcasted for the attention of all ships, a group of ships or in a specific navigation area. These messages can be addressed to one ship, using the maritime mobile service identity (MMSI) as well. The NAVDAT system is organized upon five vectors performing the following functions [6, 7]:
1. System of information and management (SIM):
   - collects and controls all kinds of information;
   - creates message files to be transmitted;
   - creates transmitting programme according to message files priority and need of repetition.
2. Shore network:
   - assures the transportation of the message files from sources to the transmitters.
3. Shore transmitter:
   - receives the message files from SIM;
   - translates message files to orthogonal frequency division multiplexing (OFDM) signal;
   - transmits RF signal to the antenna for broadcast to ships.
4. Transmission channel:
   - transports the RF signal.
5. Ship receiver:
   - demodulates the RF OFDM signal;
   - reconstructs the message files;
   - sorts and makes the message files available for the dedicated equipment according to the message files applications.

Figure 4 shows the diagram of the NAVDAT broadcast chain [10].

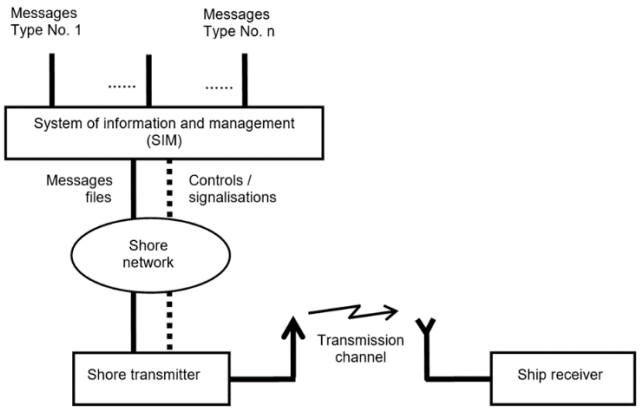

Figure 4. The diagram of the NAVDAT broadcast chain [10]

The SIM term includes:
- all the sources that deliver file messages (e.g. meteorological office, safety and security organizations, etc.);
- the file multiplexer which is an application running on a server;
- the file multiplexer manager;
- the shore transmitter manager.

All the sources are connected to the file multiplexer through a network. The shore network can use a broadband link, a low data rate link or a local file sharing.

A coastal transmitting station consists of this minimum configuration:
- one local server connected to a protected access;
- one OFDM modulator;
- one RF amplifier;
- one transmit antenna with matching unit;
- one GNSS receiver or atomic clock for synchronization;
- one monitoring receiver with its antenna.

A typical NAVDAT digital receiver is composed of several basic blocks:
- reception antenna and GNSS antenna;
- RF front end;
- demodulator;
- file demultiplexer;
- controller;
- power supply.

NAVDAT MF ship receiver performance specifications has been showed on Table 2 [6].

Table 2. Performance specifications of NAVDAT MF ship receiver

Frequency band	495 to 505 kHz
Adjacent channel protection	> 40 dB @ 5 kHz
Noise factor	< 20 dB
Usable sensitivity for BER = 10−4 after error correction	< −100 dBm
Dynamic	> 80 dB
Minimal usable RF field (with adapted receiving antenna)	25 dB(μV/m)

The system uses Orthogonal Frequency-Division Multiplexing (OFDM) which is a modulation technology for digital transmissions. In the 10 kHz channel bandwidth with RF propagation, the raw data rate available for the data stream (DS) is typically around 25 kbit/s with 16-QAM signal.

Another new communications technology planned for use in the e-navigation and in the modernized GMDSS is the VHF Data Exchange System (VDES). The VHF Data Exchange System (VDES) was developed by International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) to address emerging indications of overload of the AIS VHF Data Link (VDL) and simultaneously enabling a wider seamless data exchange for the maritime community. The initial concept of VDES includes the function of the Automatic Identification System (AIS), Applications Specific Messages (ASM), VDE terrestrial component and VDE satellite component. The VDES is one of the potential elements of e-navigation. The VDES is capable of exchanging ASM, facilitating numerous applications for safety and security of navigation, protection of marine environment, efficiency of shipping and others. The VDES will prospectively have a significant beneficial impact on the maritime information services including Aids to Navigation (AtN) and Vessel Traffic

Service (VTS) in the future. It can potentially provide local MSI.

The VDES concept includes a satellite component. This system component might be suitable to be used for the transmission of MSI information in remote areas [5].

Insufficient study on sharing and compatibility between the VDE satellite component and incumbent services in the same and adjacent frequency bands was the cause that the spectrum issue could not be resolved at World Radiocommunication Conference in 2015 (WRC-15). Consequential to WRC - 15, the ITU standard for VDES, Recommendation ITU - R M.2092 - 0, was approved in 2016. An outstanding issue regarding the satellite component for VDE channels was approved at WRC-19 (see point 2.2).

VDES builds on the experience gained through the development of AIS, and provides the capability to communicate to [4]:
- a specific vessel (addressed);
- all units in the vicinity (broadcast);
- a group of vessels (addressed); and
- a fleet of vessels (addressed).

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 [4]:
- as a means of AIS.
- as a means of radiocommunications equipment through exchange of digital data between ship to ship, ship to shore including satellite, via AIS, ASM and VDE.
- as a means of applications external to the VDES equipment itself. These applications use AIS, ASM or VDE separately or combined.

In order to meet the above functional requirements, the ship's VDES device should include [4]:
- antenna(s), capable of transmitting and receiving data through terrestrial and satellite link;
- an AIS as set out in resolution MSC.74(69) Annex 3 [12];
- a multi-function data communication and timing process that is interoperable with AIS, ASM and VDE;
- a multi-function transmitter, capable of operating on the designated AIS, ASM and VDE frequencies;
- multi-function receivers, capable of operating on the designated AIS, ASM and VDE frequencies;
- a means to automatically input data from other sources;
- a means to automatically output data to other devices;
- a means of ensuring the integrity of the data;
- a means to automatically or manually update the device software as needed;
- functionality of a built-in test equipment (BITE); and
- GNSS receiver to support AIS and to possibly serve as a secondary source of Positioning Navigation and Timing (PNT).

IMO identifies following the Maritime Services in the context of e-Navigation as defined by IMO e-navigation strategic implementation plan (SIP) and their updated E-Navigation Strategy Implementation Plan - Update 1 (IMO MSC.1/Circ.1595)[9]:
- VTS Information Service (INS);
- Navigation Assistance Service (NAS);
- Traffic Organization Service (TOS);
- Local Port Service (LPS);
- Maritime Safety Information (MSI) service;
- Pilotage service;
- Tugs service;
- Vessel Shore Reporting;
- Telemedical Maritime Assistance Service (TMAS);
- Maritime Assistance Service (MAS);
- Nautical Chart Service;
- Nautical Publications Service;
- Ice Navigation Service;
- Meteorological Information Service;
- Real-time hydrographic and environmental information Services; and
- Search and Rescue Service.

It should be emphasized that the VDES satellite component will offer additional communication in the polar regions and other remote areas for the above use cases. All these use cases are related to e-navigation and GMDSS modernization.

4 CONCLUSIONS

The modernization of the GMDSS was closely connected with the development of the e-navigation project and the detailed role of the radiocommunication in this process. Undoubtedly, the ICT network of the modernized GMDSS will be one of the most important elements of e-navigation.

The main issue in the work on the modernization of GMDSS was the preparation of good changes to the SOLAS Convention and appropriate changes to the Radio Regulations. It should be noted that it was very important that the work on the amendments to the Radio Regulations was correlated with the work of the IMO on the modernization of the GMDSS system.

In addition, in this work it was very important to ensure that it would be a continuous and open process to ensure that it remains modern and fully responsive to changes in requirements and technology development and that it meets the expected requirements in the field of e-navigation. To ensure this, it was also necessary to create a mechanism, more than hitherto, for the continuous evolution of maritime radiocommunications (GMDSS) in a systematic way. In this approach to the development of the GMDSS, it was very important that the integrity of the GMDSS was not compromised.

According to the author, taking into account the results of the modernization of GMDSS, both in terms of legal and technical changes, and especially the modernization of existing systems and devices and the introduction of new communication technologies, the above has been fulfilled. For example, the VDES and NAVDAT systems will make a significant contribution to digital communications for e-navigation and the modernization of the Global

Maritime Distress and Safety System (GMDSS) (See Chapter 3.3).

It should be noted that the key to the success of the GMDSS modernization project will be not only the timeliness of legal works (see Introduction), but also the timeliness of the implementation of the adopted changes.

In the above context, it should be noted the reported problems with the availability of new GMDSS radio equipment from 1 January 2024 [11]. The performance standards in resolutions MSC.511(105) on Performance standards for shipborne VHF radio installations capable of voice communication and digital selective calling and MSC.512(105) on Performance standards for shipborne MF and MF/HF radio installations capable of voice communication, digital selective calling and reception of maritime safety information and search and rescue related information, require the development of new equipment with some new features.

In addition, in the case of shipborne VHF installations, further definition is required from the ITU on interface matters, and these are currently still under study within the ITU.

In the case of shipborne MF and MF/HF radio installations, resolution MSC.512(105) introduces the new feature of the Automatic Connection System (See Chapter 3.2). This will require frequencies for the channels for its operation which are intended to be made available by the ITU World Radiocommunication Conference due to be held from 20 November to 15 December 2023 (WRC-23). These frequencies should then be available in the new edition of the Radio Regulations which will probably come into force in January 2025.

The result of the issues above is that, regrettably, the manufacturing industry finds itself unable to meet the date of 1 January 2024 for new installations of shipborne VHF radios and shipborne MF and MF/HF radios complying with the provisions of resolutions MSC.511(105) and MSC.512(105). According to the author, to solve this problems, January 1, 2026 should be taken as a realistic date for the installation of these new devices on ships.

And finally, according to the author, the key to the final success of the GMDSS modernization and e-navigation projects will be not only the timeliness of works and implementation, but above all the flexibility of both systems, allowing for more efficient introduction of further changes, taking into account technological progress.

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