CHAPTER 9

DIGITAL COMMUNICATION TECHNOLOGIES

# DIGITAL COMMUNICATIONS SYSTEMS

IALA Standard S1060 applies to Digital Communication Technology. This Standard references normative and informative provisions, detailed in the listed IALA Recommendations, covering the following scope.

* Wide and medium bandwidth systems

R1007 The VHF Data Exchange System (VDES) for Shore Infrastructure

R0123 The Provision of Shore Based Automatic Identification System (AIS)

R0124 The AIS Service

* Narrow bandwidth systems
* Harmonised maritime connectivity

R0140 The Architecture for Shore-based Infrastructure 'fit for eNavigation'

R0148 The Need to Implement Regional e-Navigation Solutions Based on International Standards

In this era of near-instantaneous communication, digital technologies are gradually being integrated into the maritime environment. Limitations in communication, such as transmission range, data speed, and access cost, are steadily being addressed and overcome. In the upcoming years, it is expected that the availability of robust, cost-effective maritime digital communication systems will be improved. IALA has played a significant role in the development of such systems, with key contributions to technologies like AIS and, more VDES.

# THE IALA MARITIME RADIO COMMUNICATIONS MANUAL

The objective of the Maritime Radio Communications Manual (MARCOM) is to provide an overview of the use of radio communication to support the operational needs of IALA members, with a focus on Marine Aids to Navigation including Vessel Traffic Services (VTS). This includes the need for infrastructure to support communications between ships and shore considering current, developing, and future systems.

The MARCOM is designed to support radio communication within an increasingly digital maritime environment. It should assist in the formulation of policy for National and International spectrum allocation and usage and provide input to the ongoing work of the International Telecommunications Union (ITU). This MARCOM manual reflects the requirements for effective and secure communications identified by IMO, in addressing the needs of the maritime industry, including domestic commercial vessels and recreational craft.

# A VISION FOR DIGITALISATION OF SHIPPING AND MARITIME TRANSPORTATION

This document outlining IALA's vision for the digitalization of waterways and shipping. The key focus of the discussion paper is to outline the roadmaps for the IALA’s digital technology developments (i.e. S200, VDES, MASS, Digital Communications, Maritime Digital Twin, Maritime Robotics, Maritime Cybersecurity).

# AIS (COMMUNICATIONS ASPECTS)

An overview of the Automatic Identification System (AIS) was introduced in a previous chapter 6.7. To recap, it is a VHF maritime mobile system designed as a tool to argument navigation data for ship-to-ship collision avoidance and VTSs, and, as a means for littoral States to obtain information about ships and their cargo. AIS also allows for the exchange of safety related data between ships, from ship to shore and from shore to ship. There are numerous types of AIS devices, known as stations, which are identified by a unique Maritime Mobile Service Identity (MMSI) or a freeform maritime identity and use the AIS international open standard to communicate. AIS enables the automatic exchange of shipboard data from vessel sensors (dynamic data), as well as manually entered static and voyage related data, between one vessel and another and between a vessel and a shore authority using terrestrial or satellite communications. AIS has been mandated as a shipboard carriage requirement for vessels under the revised Chapter V of the International Convention for the Safety of Life at Sea, 1974 (as amended) (SOLAS 74) section 19.2.4. In addition, some administrations require AIS carriage on non SOLAS vessels. The main benefits of AIS are summarized below:

* Data exchange, such as identification and course, between vessels within VHF

range of each other, increasing situational awareness;

* Data exchange between a vessel and shore authorities, such as a VTS, to improve traffic management in waterways, coastal and remote areas where AIS is sometimes the only mean to exchange data;
* Automatic reporting in areas of mandatory and voluntary reporting;
* Exchange of safety related information between vessels, and between vessels and shore station(s).

The development of AIS has broadened to encompass devices such as AIS for Aids to Navigation (AIS AtoN), AIS on search and rescue aircraft, and AIS search and rescue transmitters (EPIRB-AIS, AIS-SART, and AIS-MOB). The success of AIS has led to its increased adoption and expansion, raising concerns about the system’s reliability as it becomes overloaded. As a result, the International Maritime Organization (IMO) issued Resolution MSC.347(91) Annex 15 to protect AIS. This concern also served as a driving factor for the development of the VHF Data Exchange System (VDES), which is discussed in the next section (8.4).

Moreover, the use of Autonomous Maritime Radio Devices (AMRD) on AIS frequencies has been restricted by the IMO and the International Telecommunication Union (ITU) to only those devices that enhance navigational safety. These devices are referred to as AMRD group A. For equipment that does not meet the criterion of improving navigational safety, AMRD group B, a new channel (2006) was allocated at the World Radiocommunication Conference 2019 (WRC-19), where AIS technology can be utilized. The relevant documents addressing AMRDs include IMO Resolution MSC.441(99) and ITU recommendations ITU-R M.1371 and ITU-R M.2135.

IALA Guideline G1082 provides a comprehensive overview of AIS and an extensive listing of all AIS related documentation from various international organizations in its Annex.

It is important to note that AIS does not provide any cyber security protection.

# VDES

The VHF Data Exchange System (VDES) is a radio communication system that operates in the VHF Maritime Mobile band. The VDES consists of 4 components:

* The AIS uses channels AIS 1, AIS 2, CH75 and CH76. AIS 1 and AIS 2 are for terrestrial

communications while satellite uplinks can use all channels, AIS 1, AIS 2, CH75 and CH76;

* The Application Specific Messages (ASM) component of VDES uses channels ASM 1

and ASM 2, for both terrestrial communications and satellite uplinks.

* The VHF Data Exchange Terrestrial (VDE-TER) component of VDES uses channels 1024, 1084, 1025, 1085, 2024, 2084, 2025 and 2085 for terrestrial communications.
* The VHF Data Exchange Satellite (VDE-SAT) component of VDES uses channels

1024, 1084, 1025, 1085,1026, 1086, 2024, 2084, 2025, 2085, 2026 and 2086, for both

satellite uplink and downlink communications.

The sections below provide a short introduction to each VDES component other than AIS which was already discussed above. There are 4 IALA documents that provide additional information on VDES and its sub-systems.

* + Recommendation R1007 – The VHF Data Exchange System (VDES) for Shore Infrastructure
  + Guideline G1117 - VHF Data Exchange System (VDES) Overview
  + Guideline G1158 VDES R-Mode
  + Guideline G1181 VDES VDL Integrity Monitoring
  + Additionally, these ITU documents provide important technical information for

VDES:

* + ITU-R M.2092, Technical characteristics for a VHF data exchange system in the VHF maritime mobile band.
  + Report ITU-R M.2231, Use of Appendix 18 to the Radio Regulations for the maritime

mobile service

* + Report ITU-R M.2435-0 [VDE-SAT]

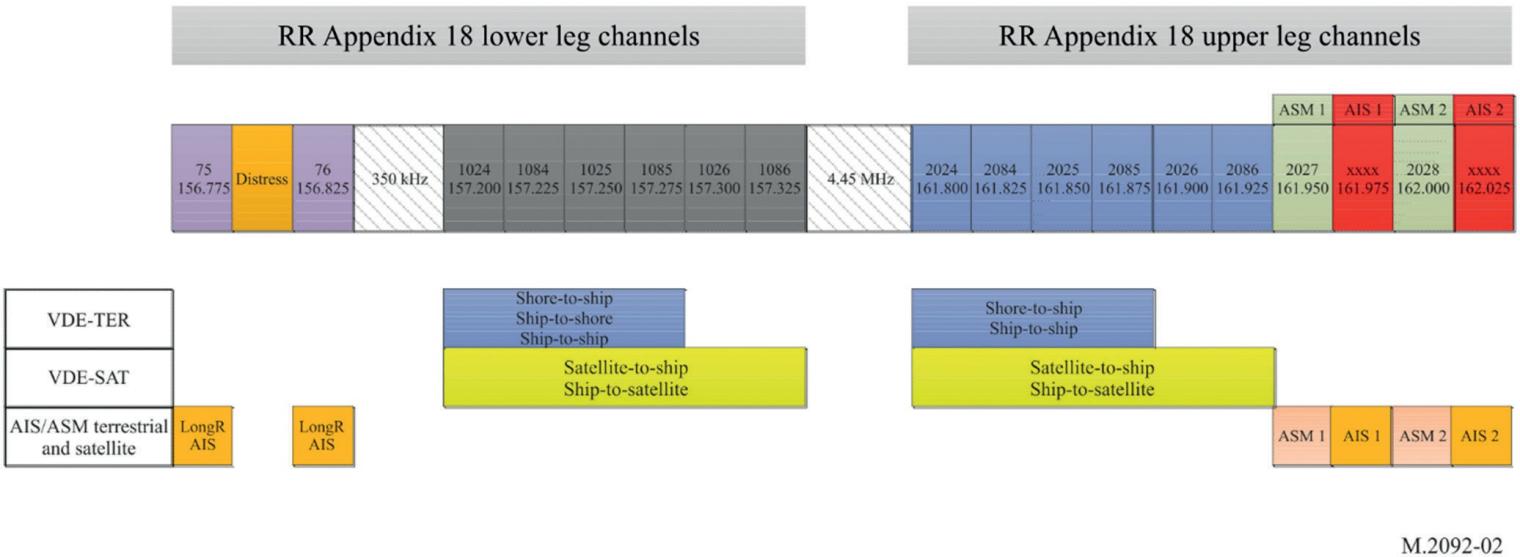


Figure 36. VDES frequency usage

* + 1. WHY VDES INCLUDES AIS?

VHF Data Exchange System (VDES) comprises a suite of channels in the VHF Maritime mobile band and forms a contiguous block of frequencies that includes both international AIS frequencies as shown in the figure above. For this reason, the VDES was designed in such a way to simplify radio equipment complexity allowing a single “smart” radio box to perform all VDES functionalities, including AIS. Anchored in VDES design is the protection of AIS and the situational awareness it provides to mariners and shore authorities. As such, all AIS functionalities are a part of VDES just as they would be available on an independent AIS device. In principle, a VDES unit could replace the AIS equipment using the same antenna, power and connectivity. For shore authorities to make use of the full capabilities of VDES, improvements to the infrastructure might be necessary.

* + 1. ASM COMPONENT OF VDES

The Application Specific Message component of VDES uses 2 channels (ASM1 and ASM2). The purpose of ASM is to offload the AIS channels from the growing use of various messages to exchange data that is safety related, but not directly relevant to collision avoidance. The deployment of ASM across the globe should relieve AIS frequencies from such usage and ensure the availability of AIS for collision avoidance and safety purposes, increasing its effectiveness. Examples of ASM data that are currently carried over AIS frequencies include meteorological / hydrological data, waterways obstructions, recommended routes, etc. The ASM channels use a more efficient signal modulation than the original AIS frequencies which allows for more data, almost twice, to be carried in the same time slot/ frame. Existing AIS messages could be simply reused on ASM or VDE channels.

IALA maintains a list of all available Application Specific Messages on all physical links (AIS, VDES-ASM and VDES-VDE) that have been created and are used across the world for ASM purpose. The list can be found on the IALA website https://www.iala-aism. org/asm/ and where also new proposed ASMs can be registered. It is important to note that VDES does not provide any cyber security protection and has to be implemented as ASM.

* + 1. VDE-TER COMPONENT OF VDES

The purpose of the VDE-TER component is to provide a communication system capable of supporting e-Navigation growing requirements within VHF range (approx. 40 to 60 km). It is expected that ASM will not be able to meet the native transfer requirements of the S-100 suite (S-1xx, S-2xx, S-4xx, etc) of data products. As e-Navigation standardize on S-100 data products, the maritime safety data will be in need of a communication system with expanded capacity to carry this information to and from ships in waterways and coastal areas. This is the gap that is filled with VDE-TER.

VDE-TER uses 4 duplex channels to achieve 100kHz of bandwidth available to carry data from ship-to-ship, shore-to-ship and ship-to-shore. The maximum total capacity of the channel is approximately 230kbps that is divided amongst the users (ship or shore stations) of the system in a specific area. For example, there could be one shore station and 5 ships using VDE-TER simultaneously to exchange data, each getting about 38kbps of throughput.

VDE-TER is providing much more capacity than AIS and ASM, but it is still an order of magnitude slower than other commercial communication systems such as cellular 3G/4G/5G. This limitation will require VDES to be carefully managed by shore authorities to make sure priority is given to safety related data pertinent to the ship’s context.

* + 1. VDE-SAT COMPONENT OF VDES

The purpose of the VDE-SAT is to extend VDE coverage beyond the shore-based coverage of VDE-TER and offer global coverage. As such VDE-SAT is an essential supplement to terrestrial VDE coverage provided by VDE-TER in support of e-Navigation services.

VDE-SAT use 2x150kHz, of which 2x100kHz are shared with VDE-TER and 2x50kHz are identified for VDE-SAT only. The VDE-SAT downlink support data rates ranging from about 2 kbps to 48 kbps, depending on link quality. The VDE-SAT uplink support data rates ranging from about 1 kbps to 95 kbps, depending on link quality and interference environment observed by the satellite. These data rates are total system rates for a 50 kHz channel of which can be allocated to and shared between 1 and 6 users.

VDE-SAT is capable of supporting the same services envisioned for VDE-TER. However, the reduced data rates and inherent store and forward operations mode of VDE- SAT may not be suitable for all services. As for VDE-TER the resources available in VDE-SAT should be carefully managed by the satellite operators to ensure priority is given to the appropriate services.

# R-MODE

As GNSS signals are not always reliable and subject to jamming and spoofing, it is desired to have alternative means of maritime navigation. One approach for that is to equip communication systems on the shore with the option to transmit ranging signals (R-Mode), which vessels can use to determine their position when within range of these stations.

Establish the VDES R-Mode System as a contingency Positioning, Navigation and Timing (PNT) system for maritime shipping. The operational concept is that, when the Global Navigation Satellite System (GNSS) service on board is interrupted, the VDES R-Mode system (possibly together with other terrestrial PNT systems such as MF R-Mode and eLoran) provides ranging measurements to an on-board navigation system so that the impact of the GNSS service outage on the ship’s ability to navigate safely is minimised.

VDES R-Mode should, as far as possible, use pre-existing shore side infrastructure, including shore stations and Monitoring and Control Centres (MCC’), and pre-existing AIS/VDES shipborne installations. Monitoring and control data is likely to be carried between the Base Stations, Far-field Monitoring Stations (FMS’) and one or more Monitoring and Control Stations (MCS’) via pre-existing Wide Area Networks.

VDES R-Mode will be synchronized to an external Time Source traceable to a common time scale in order to facilitate interoperability with other PNT systems.

The accuracy of ranges between the base station on land and the vessel at sea, measured by means on the received radio signal, depends on the utilized bandwidth and of the received signal power versus the power of other noise sources.

# LTE-M AS A COMMUNICATIONS INFRASTRUCTURE

The objective of LTE-Maritime or (LTE-M) is to provide high data rates in the order of megabits per second within the communication coverage of 100km from the shoreline.

In 2017, in order to confirm the feasibility of LTE technology on maritime field, a testbed was developed in the Republic of Korea and several field experiments were conducted. The experiment results show that, although there exist the interference issues with other communication signals, LTE-Maritime can provide the data rates over Mbps and the communication coverage around 100km.

* + 1. LTE-M

LTE-M is based on LTE technology that is a promising solution for wireless maritime network. To support the requirements of various data services, the maritime communications providing high-speed data rates and extended communication coverage need to be developed. Unfortunately, the conventional communication systems of maritime field such as VHF, MF/HF were operated on the terrestrial radio frequency specified on the maritime missions of GMDSS convention. In case of satellite like Inmarsat, the channel capacity and operative cost are not reasonable for the private user purpose. They could be a good communication system on GMDSS missions globally but not a good solution to be used as a communication system for the various services like e-Navigation, especially in specific

local water requiring high data rates for their own services.

LTE is capable of providing increased data rate, capacity, and spectral efficiency even in dynamic propagation environments with the support of advanced techniques such as multiple-input multiple-output (MIMO) and carrier aggregation (CA). Furthermore, it has the potential to provide the communication coverage about 100 km depending on the cell environments, though LTE for commercial mobile communication is designed with a relatively short cell coverage. This superiority of LTE makes us develop a single-hop network enabling ship-to-shore data communication based on LTE technology.

In general, the wireless mesh networks are vulnerable to link failures caused by radio interference and they could not assure reliability. Contrary to existing maritime networks for extending the communication coverage with multi-hop transmission, LTE-Maritime enables ships to directly communicate with onshore BSs and it could improve reliability. Therefore, it is more suitable especially for the safety related maritime services that require high reliability as well as low latency.

LTE-Maritime can support various e-Navigation services for marine accident prevention and effective navigation. The e-Navigation services include navigation monitoring and assistance, ship-borne system monitoring, safe and optimal route planning service, real-time electronic navigational chart distribution and streaming, pilot and tug assistance, and maritime environment and safety information.

In addition, LTE-maritime network could provide various data services for maritime users with improved reliability, high data rate, long enough coverage, and low cost compared to current maritime networks.

# LOW POWER COMMUNICATION SYSTEMS

There are proprietary and Internet Protocol Suite (TCP/IP) based systems (mostly in low earth orbits (LEO) available and partly GMDSS approved.

Especially LEO satellite constellations offer high bandwidth communication coverage for wide sea and coastal areas. This is able to cover a lot of communication requirements. By providing sufficient bandwidth suitable cyber security protection can be implemented. It is already be used for fleet monitoring, predictive maintenance and applications like chart updates. Standards for provision of Maritime Safety Information (MSI) are under development.

Developments in solid state antenna suitable for the maritime environment, along with increasing number of satellites in the constellations, could provide significant capability. Upfront costs for users related to the terminal, antenna and monthly data plan subscription.

# LOW POWER COMMUNICATION SYSTEMS

Low power communication systems, such as LoRa (Long Range), Sigfox, and NB-IoT (Narrowband IoT), are emerging technologies that have the potential to significantly impact maritime communication. These systems are designed to provide long-range, low-power wireless connectivity, making them ideal for various IoT (Internet of Things) applications in the maritime sector.

LoRa technology, some issues related to costs (unknown / ongoing fees) and risks associated with licensed and unlicensed services. NB-IoT – licenced – guarantee of service; ISM bands by nature unlicensed with no guarantee of service.

Sigfox technology would require encryption before being used to control AtoN. This technology may be suitable to monitor AtoN without additional encryption. Additional encryption will require additional bandwidth, which then limits the available bandwidth for transfer of data.

IALA recognizes the importance of exploring and evaluating the potential of low power communication systems for maritime use. These technologies could be employed for various purposes, such as tracking and monitoring assets, environmental monitoring, and enhancing safety and efficiency in port operations.

IALA could encourage its members and the maritime community to study and assess the feasibility of these technologies for maritime applications. Additionally, IALA could facilitate collaboration among its members, industry partners, and other relevant organizations to identify best practices, develop standards, and promote interoperability of low power communication systems within the maritime domain.

# AUTONOMOUS MARINE RADIO DEVICES

There are numerous maritime radio devices that operate autonomously. These include but are not limited to: devices on towed or unpowered ships and barges, “man overboard” devices, diver locating, alerting and radiotelephony devices, fishing net marker buoys, oil spill tracking buoys, oceanographic, and other drifting buoys.

Some types of autonomous maritime radio devices (AMRD) use AIS or digital selective calling (DSC) technology. They can also transmit synthetic voice messages or employ a combination of these technologies. These devices have been developed for and are operating in the maritime environment, with their numbers expected to grow.

Certain devices do not enhance the safety of navigation or serve the purpose of communication between coast stations and ship stations, or between ship stations, or between associated onboard communication stations, or survival craft stations and emergency position-indicating radio beacon stations. Nevertheless, they occupy the spectrum and identities of the maritime mobile service.

There is a need to categorize and regulate the usage of autonomous maritime radio devices. In 2023, the ITU published a new recommendation ITU-R M.2135, which provides the definition of AMRD. The categorization of AMRD and relevant information are also contained in the new recommendation and AMRD Group B devices will operate on a new channel (2006). In principle, these devices use AIS technology but are not limited to it.

The generally agreed IMO position states that:

* the integrity of AIS and the Global Maritime Distress and Safety System (GMDSS) should be protected;
* autonomous maritime radio devices which enhance the safety (of navigation)

should be regulated for the use of frequencies and identities of the maritime mobile service; and

* for autonomous maritime radio devices which do not enhance the safety (of

navigation), regulation of the use of frequencies, and technical and operational characteristics, should benefit both the user of devices as well as maritime safety.

* + 1. AMRD GROUP A

This group consists of Mobile Aids to Navigation (MAtoN) and Man Over Board Class M (MOB). Their technical and operational characteristics are described in the most recent versions of Recommendations ITU-R M.2135, ITU-R M.1371 and ITU-R M.493.

Mobile AtoN and MOB should use the numbering scheme defined in ITU-R M.585 “Identities in the maritime mobile service,” i.e., for MAtoN, it is 99MIDXXXX.

* + 1. AMRD GROUP B

All other AMRDs that do not enhance the safety of navigation are categorized as AMRD Group B. The characteristics of AMRD Group B were further developed and are contained in two annexes, one for devices using AIS technology and the other for devices using other technologies.

The AMRD Group B numbering scheme is provided in ITU-R M.585-9.

# 3GPP

IALA has a focus on evaluating various communication technologies for maritime use. Some of the technologies assessed include 3GPP, LTE-M, and others.

IALA cooperates with 3GPP as one of the vertical industries and contributes to its development by sharing maritime viewpoints. However, IALA acknowledges that it cannot represent the entire maritime industry. This collaboration helps bridge the gap between the maritime sector and telecommunications, ensuring that the specific needs of the maritime environment are considered in the development of 3GPP standards.

One of IALA’s primary interests is the satellite component of 3GPP, which has the potential to significantly change the maritime communication environment by addressing coverage issues in remote and offshore areas. This advancement will enable seamless connectivity and improved communication capabilities for the maritime domain.

Additionally, IALA is also interested in exploring side link technologies within the 3GPP framework, which can facilitate direct communication between devices without relying on network infrastructure. These technologies can enhance safety and operational efficiency in various maritime scenarios.

IALA’s position is that communication based on 3GPP (currently 4G) technology is an emerging technology for IALA and the maritime domain.

It may be beneficial to describe IALA members’ 5G requirements, identify other larger segments with similar requirements, join forces with the custodians of these segments, and work jointly with 3GPP and CIRM, as appropriate, to adopt the requirements.

* + 1. WHAT IS 3GPP?

The use of mobile communications has been increasingly recognized as a valuable means of communication for ships at sea.

3GPP (3rd Generation Partnership Project) was created in 1998 with the signing of “The 3rd Generation Partnership Project Agreement.” 3GPP unites seven telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, and TTC), known as “Organizational Partners.” It provides their members with a stable environment to produce the reports and specifications that define 3GPP technologies.

The original scope of 3GPP was to produce technical specifications and technical reports for a 3G Mobile System based on evolved GSM core networks and the radio access technologies they support (i.e., Universal Terrestrial Radio Access (UTRA) in both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) modes). The scope was later expanded to include the maintenance and development of Global System for Mobile communication (GSM) Technical Specifications and Technical Reports, including evolved radio access technologies.

The project covers cellular telecommunications network technologies, encompassing radio access, core transport networks, and service capabilities such as codecs, security, and quality of service. It provides complete system specifications, also offering hooks for non-radio access to the core network and interworking with Wi-Fi networks.

More detailed information about 3GPP can be found in [http://www.3gpp.org/about-3gpp.](http://www.3gpp.org/about-3gpp)

* + 1. 5G-NR POSITIONING

5G-NR Positioning is developed by 3GPP, and the standards specifications are published by 3GPP and ETSI for global deployment. Deployment of 5G-NR positioning technology is subject to international, regional and/or national regulations related to spectrum allocation, zoning and land use, cybersecurity and privacy, among others.

5G-NR Positioning may be more resilient to GNSS jamming/spoofing. 5G-NR networks are deployed with specific timing requirements at each node and also synchronization requirements across the nodes. Given the individual node timing requirements, 5G-NR is typically deployed with a relatively high-quality stable clock which can withstand loss in external synchronization signals (e.g. GNSS). Such a deployment model is especially helpful in the case of GNSS jamming for extended periods of time. Such robustness requirements can also be built into the design and the selection of the clock, based on the requirements of the end application.

This technology has not been deployed yet. Recent industry focus has been on the deployment and optimization of 5G-NR networks for best communication, coverage and reliability. It’s expected 5G-NR positioning will be deployed as part of upcoming network enhancements.

# DIGITALIZATION OF MARINE VHF VOICE CHANNELS

The digitalization of marine VHF voice channels is a significant development in the maritime communication landscape. This transformation aims to enhance communication clarity, increase channel capacity, and improve overall communication efficiency. There are several options to implement voice over VHF, including:

* digital Private Mobile Radio (dPMR) that uses Frequency Division Multiple Access

(FDMA) and

* Digital Mobile Radio (DMR) that uses Time Division Multiple Access (TDMA) technology.

IALA has assessed that digital voice over VHF, using the example of dPMR, is a suitable candidate for consideration in meeting the needs of IALA members. However, a suitable vocoder needs to be identified as a standard for maritime use to ensure interoperability, and in addition to the ongoing research work at ITU for the digitalization of the maritime mobile VHF Channels, further work on the development and implement of digital VHF voice for use in the maritime domain is required.

IALA could be actively support and promote the transition to digital voice communication, while ensuring that the chosen technology aligns with the needs of its members and the wider maritime community. To achieve this, IALA may work towards fostering collaboration among its members, relevant organizations, and industry partners to identify and adopt suitable vocoder standards, as well as facilitate the smooth integration of digital voice technologies into existing maritime communication infrastructure.

# DIGITAL HIGH FREQUENCY RADIO

The data transfer of files and e-mails at a reasonable cost for the mariner is now possible with the digitalisation of the HF frequencies which has been study at ITU-R WP5B. The available HF data transfer protocols currently used in the maritime mobile service (MMS)

for the exchange of data and electronic mail on MF/HF frequencies are described in the Recommendation ITU-R M.1798 (Characteristics of HF radio equipment for the exchange of digital data and electronic mail in the maritime mobile service). Three HF electronic mail systems and one wideband HF data exchange system for point-to-point communication are proposed in this Recommendation.

# IMT-2030 TECHNOLOGY

The International Telecommunication Union (ITU) has published the framework for the development of standards and radio interface technologies for the sixth generation of mobile systems (IMT-2030 Framework), with the prospect of getting a final set of IMT-2030 technology standards approved by 2030.

The IALA has begun developing the IALA Guideline and Recommend on Marine AtoN over IMT-2030, which includes use cases and service requirements with regulatory aspects for Marine AtoN, which contribute to formulating inputs as served for incorporating demands of Marine AtoN related stakeholders into 3GPP standardization for IMT-2030.

# EMERGING TECHNOLOGIES

IALA acknowledges the importance of staying informed about emerging technologies that could be beneficial to its members and the maritime industry. As a proactive organization, IALA has developed a guideline, G1153, titled “A Template for the Review of Emerging Technologies for Possible Use by IALA Members,” to systematically review and assess these technologies in terms of their advantages, limitations, and applicability to the maritime domain.

The objective of this guideline is to encourage the identification of existing or emerging technologies that may be of interest to IALA members. By evaluating these technologies, IALA aims to ensure that its members are aware of the latest developments and can make informed decisions about their adoption and implementation.

The G1153 guideline provides a structured framework for assessing new technologies and considering their potential impact on user requirements and the needs of IALA membership. It serves as a valuable resource for IALA members who are looking to stay updated on the latest advancements in maritime technology and explore potential opportunities for innovation and improvement in their operations.

* + 1. EXAMPLES OF EMERGING TECHNOLOGIES

Emerging technologies that IALA has been examining include:

* + - * Low Power Wide Area Networks (LP-WAN) - These systems enable long transmission with limited power consumption. They have potential applications in tracking and monitoring systems for lightweight boats and experimental studies of transmission over seawater.
      * Low Earth Orbit (LEO) Satellite Constellations - With the growth of digital

communication capabilities from different low earth orbiting satellites, LEO constellations offer promising opportunities for maritime communication.

* + - * Alternative Data Transmission Systems - IALA is also monitoring developments

in alternative data transmission systems presented at various international organisations, including the IMO and ITU.

* + - * Light-based Wireless Communication - Technologies such as LiFi, which is based

on Visual Light Communication (VLC) and uses LEDs to network a wireless system, offer unique opportunities for maritime communication.

* + - * Metal Surface Wave communication (MS @ MS)-The MS @ MS wave is a kind of radio-free wireless communication, more efficient and capable of overcoming the limitation of metal surrounding structure for wireless network and for primarily applying to the wireless IoT network in maritime sector.
      * Ships Air Draft Remote Measurement Technology (SADRMT)- The SADRMT is a typical technical concept of multiple sensing devices and data combination analysis. The system tracks ship targets and accurately measures the ship's air draft through image analysis.

# DIGITAL COMMUNICATIONS IN VTS

The adoption of digital communications in Vessel Traffic Services (VTS) is on the rise as a means to improve communication quality and reduce misunderstandings caused by mishearing or language barriers between ship-to-shore and ship-to-ship communications. Digital communication can be used with human interference, but also can be used in automated processes without human interference.

VTS have been implementing various digital communication systems, such as satellite, internet, and mobile phone networks, to communicate not only with vessels but also with other stakeholders. For instance, some VTSs use Integrated Maritime Services (IMS) to provide centralized communication services, including digital selective calling

(DSC), satellite communications, and email.

Moreover, there is a growing interest in adopting emerging digital communication technologies like VHF Data Exchange System (VDES), alternative data transmission systems, and 5G networks for maritime communications. These technologies offer the potential for higher data rates, lower latency, and better coverage, which can further enhance the efficiency and effectiveness of VTS operations.

The increasing use of digital communications in VTS is expected to facilitate more efficient information exchange, provide better situational awareness, and support the development of future e-Navigation services. To provide digital communication in a globally harmonized way, a common understanding of the operational procedures and standardised technical services is necessary.

# IALA AND GMDSS MATTERS

IALA takes an active interest in maritime mobile services, including the Global Maritime Distress and Safety System (GMDSS) and radio determination services. The organization closely follows the ongoing GMDSS modernization efforts led by the International Maritime Organization (IMO), aiming to adapt the system to the evolving needs of the maritime industry and incorporate new technologies and innovations.

As part of these efforts, IALA emphasizes the development of the VHF Data Exchange System (VDES), VDE-SAT (Satellite VDES), AIS, and Autonomous Maritime Radio Devices (AMRD) operating in the maritime VHF mobile band. These technologies are expected to significantly enhance communication capabilities, data exchange, and the overall efficiency of the GMDSS.

The GMDSS modernization plan, initiated by IMO, covers various aspects such as incorporating new satellite systems, updating the functional requirements for GMDSS equipment, revising the operational guidelines, and incorporating new digital communication technologies. These updates aim to ensure that the GMDSS remains relevant, effective, and capable of meeting the needs of the modern maritime industry.

By actively participating in GMDSS-related matters and staying informed about its modernization efforts, IALA supports its members and the broader maritime community in leveraging the latest advancements in maritime communication technologies and services.