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Modern communication systems concerning future evolution of maritime safety

Dimitrov Georgi L, Grozev Grozdyu

73, Vasil Drumev street, Varna 9026, Nikola Vaptsarov Naval Academy
g.dimitrov@nvna.eu , g.grozev@nvna.eu

Abstract. The Global Maritime Distress and Safety System (GMDSS), was a major change to the international requirements governing the use of radio by ships at sea. The new technique of digital selective calling was an effort to automate the watch on the terrestrial maritime bands, High Frequency (HF), Medium Frequency (MF) and Very High Frequency (VHF) in order to provide stable communications by eliminating the voice radio. The satellite EPIRB system alerts have suffered numerous efforts to validate signals before launching rescue boats and aircraft. Inmarsat migrates the GMDSS Services from the I-3 satellite constellation to the I-4 satellite constellation. During this process a manual intervention of the mobile earth stations might be necessary. After that the coverage areas of the GMDSS services will change. This paper discusses the expected evolution of the communication services in GMDSS, with regard to safety improvement, having in mind the countless cases of false alerting, as well as registered distress situations and critical events in the Black Sea region. A systematic process will be needed to modify the GMDSS to ensure it will remain modern and fully responsive to changes in the requirements and evolution of technology. It is necessary to ensure that man-machine-interface and the human element will be taken into account. The communications and information are indispensable part of maritime and inland shipping, and undoubtedly belong to the family of front end technologies. New and substantial final decisions of WRC 15, as well as decisions of other organizations, concerning the following: Channelizing in Appendix 18 of the Radio Regulations, technical characteristics like modulation and coding schemes, the benefits from terrestrial and satellite parts of VDES, its usage in VTS, GMDSS, e-navigation, inland shipping, and its potential in search and rescue activities are described

1. Introduction

Planning for the GMDSS started more than 30 years ago, so elements of it have been in place for many years. There have been numerous advances in the use of maritime radio communication to maritime safety, security and environmental protection during this period. Nowadays, there are some obsolete GMDSS equipment and systems or the ones that have seldom or never been used in practice. Twenty years have passed since the time when the Global Maritime Distress and Safety System (GMDSS) became introduced.

On the other hand there are a lot of new digital and information technologies. So, the time seems tight to start the wide discussion on what the real condition and needs of the marine radio communication are, in particular with reference to the current discussion on the e-navigation strategy. It is necessary first to identify real user needs and secondly to realize that the modernization of the maritime radio communication should not be driven by technical requirements. The lessons learnt from the original development and operation of GMDSS should be taken into

account in the modification of GMDSS as well. Furthermore a systematic process is needed to review and modify the GMDSS to ensure it remains modern and fully responsive to changes in requirements and evolutions of technology and it will meet the expected e-navigation requirements.

2. Decisions of IMO to have modernized GMDSS in 2024

It will be another five years before a comprehensively updated GMDSS enters into force worldwide [2]. IMO's Maritime Safety Committee (MSC) approved a modernization plan for the Global Maritime Distress and Safety System (GMDSS), which saves hundreds of seafarers' lives every year, at its session - MSC 98, 2017 [3]. The plan will require comprehensive amendments to SOLAS Chapters III and IV, together with related and consequential amendments to other existing IMO instruments. The committee has decided to extend the implementation of enforcement of these SOLAS changes to 2024. It has decided the year 2022 to be a realistic target year for completion of the modernization work and for its formal adoption of the draft amendments.[1] The effective entry into force would then follow in 2024, subject to fulfilment of the Solas tacit amendment procedure.

GMDSS was adopted in 1988 and became fully implemented in 1999. Inmarsat continues to be the sole IMO-recognized GMDSS service provider to date. However, it is expected that the application of Iridium for recognition as an additional provider will receive formal approval at MSC 99 in May 2018. The MSC based its decision on the final technical assessment of Iridium's capability as a mobile satellite service provider conducted by the International Mobile Satellite Organization (IMSO). Inmarsat has also applied to gain formal approval of GMDSS on its Fleet Broadband services, and expects to obtain this at MSC 99 [4]. Acknowledging the need to replace existing SOLAS references to Inmarsat with the generic reference "recognized mobile satellite service," MSC 98 agreed a definition of the term for the purposes of SOLAS Chapter IV. This definition is also needed in order to avoid inconsistencies with the radio regulations of the International Telecommunication Union (ITU), which accords a different meaning to the term.

Other safety communications decisions taken at MSC 98 include the formal adoption of a new MSC resolution recommending generic performance standards for every ship earth station that operates on a mobile satellite service recognized by IMO for use in the GMDSS. The resolution distinguishes between a mobile satellite service recognized before January 2021 and one that is recognized after that point in time. It also allows a transitional period to maintain current equipment functionality. Inmarsat C and Fleet 77 are designated as legacy systems and services under Section 7 of IMO Assembly Resolution 1001(25), which covers the criteria and requirements for the provision of mobile satellite communication systems in the GMDSS. MSC 98 also approved draft texts for amendments to SOLAS chapter IV, together with revised equipment certificates to incorporate the generic reference 'recognized mobile satellite service' in order to address the anticipated future use of mobile satellite services for the GMDSS. Their formal adoption is expected at MSC 99, which will also decide on their entry-into-force date. The huge task of updating GMDSS will mainly fall on IMO's sub-committee on safety of navigation, communication, and search and rescue (NCSR). Starting from the NCSR 5 session in February 2018, a total of four sessions are foreseen to complete the work, with support from other sub-committees – for example, with regard to the development of new model courses to address seafarers' training needs.

The revision is driven by the urgent need to adapt GMDSS to the use of modern communications systems and to discard carriage requirements for obsolete systems that ships no longer use to meet the functional requirement of the GMDSS.

3. Regulatory modification of the GMDSS

At a regulatory level, the modification of the GMDSS is coordinated by two international organizations: International Maritime Organization (IMO) and International Telecommunication Union (ITU). IMO modifications are mainly concerning the amendments to Chapter IV of the International Convention for the Safety of Life At Sea (SOLAS) and to the IMO resolutions. [2]

From the Radio communication point of view, the most important modification was adoption by IMO of Resolution A.1001(25) dated 29.11.2007 on Criteria for the Provision of Mobile Satellite Communication Systems in the GMDSS and revision of Chapter IV of IMO SOLAS Convention extends the International Mobile Satellite Organization (IMSO) oversight to GMDSS Services provided by any satellite operator which fits criteria. ITU modifications are mainly concerning the amendments to Radio Regulations. These amendments were adopted by two World Radio Communication Conferences (WRC). These took up the following main issues.[5],[14]

3.1. Consideration of Appendix 13 and Resolution 331 (Rev.WRC-97). This should be done with a view to their deletion and, if appropriate, to consider related changes to Chapter VII and other provisions of the Radio Regulations, as necessary, taking into account the continued transition to an introduction of the Global Maritime Distress and Safety System (GMDSS) (Agenda Item 1.9)

3.2. Studies concerning MMSI number resources and shore-to-ship communication priorities. Necessary actions should be taken, relating to exhaustion of the maritime mobile service identity numbering resource (Resolution 344 (WRC-97)) (Agenda Item 1.10.1) Necessary actions should be taken with regard to shore-to-ship distress communication priorities (Resolution 348 (WRC-97)) (Agenda Item 1.10.2)

3.3. Measures to address harmful interference in the bands allocated to the maritime mobile and aeronautical mobile (R) services This should take into account Resolutions 207 (Rev.WRC-2000) and 350 (WRC-2000), and to review the frequency and channel arrangements in the maritime MF and HF bands concerning the use of new digital technology, also taking into account Resolution 347 (WRC-97) Agenda Item 1.14 [6]

3.4. Resolutions 729 (WRC-97), 351 (WRC-03) and 544 (WRC-03), The procedure concerns reviewing of allocations to all services in the HF bands between 4 MHz and 10 MHz, excluding those allocations to services in the frequency range 7 000-7 200 kHz and those bands whose allotment plans are in Appendices 25, 26 and 27 and whose channeling arrangements are in Appendix 17, taking account the impact of new modulation techniques, adaptive control techniques and the spectrum requirements for HF broadcasting (Agenda Item 1.13)

3.5. Regulatory and operational provisions for Maritime Mobile Service Identities (MMSIs) Considerations on equipment other than shipborne mobile equipment, should be taken into account in Resolutions 344 (Rev.WRC-03) and 353 (WRC-03) (Agenda Item 1.16).

4. Considerations upon modernization of GMDSS

The modernized GMDSS will provide for enhanced and more reliable search and rescue capabilities with the introduction of terrestrial communications using digital technologies for receiving maritime safety information and by including the COSPAS-SARSAT MEOSAR system. New carriage requirements for search and rescue-locating devices on lifeboats and liferafts are under consideration. Existing ships will be able to continue using their existing communications systems, in accordance with the customary grandfathering principle. The revision will also take account of IMO's work related to developments in e-navigation as these have implications for both radio- and satellite-based communications. There is a compelling need to harmonize the IMO provisions with the ITU's radio regulations.

As a procedural consideration, it is recommended that the IMO could schedule one or more intercessional meetings on Modernization or lacking that, commission a Correspondence Group to work by email and report to COMSAR at each session. After initial modernization adjustments,

continuing development could be managed by a special COMSAR Modernization Panel functioning much as the NAVTEX and SafetyNet panels presently operate.[7]

There appears to have been a higher level of usage of the 2 MHz system (without DSC) in recent years and to the extent that domestic users may be required to upgrade to DSC, a more reliable performance of the system can be expected. The principal motivation for continuing with the upgrade is to improve coverage, facilitate ship-to-ship usage at ranges greater than VHF [6], utilize VDES, improve Coastal Marine Safety Information (MSI) Broadcasts (see Fig.1).

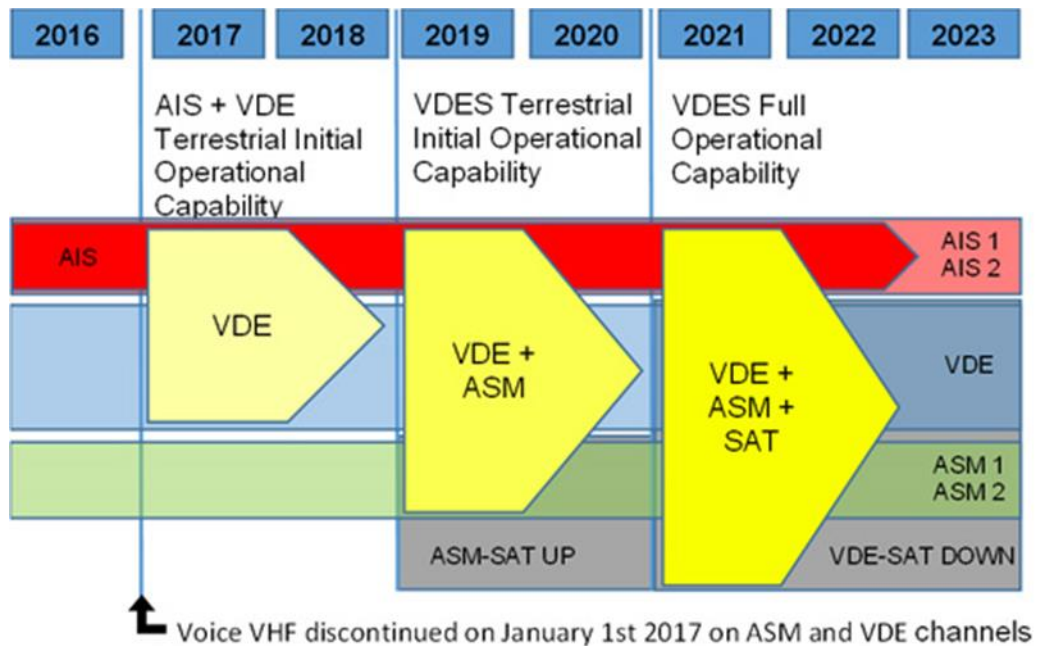


Fig.1 VHF Data Exchange system for the next generation of maritime digital communications

IMO's procedures for including additional participants, Resolution A. 1001 (25), needs revisions to remove barriers and encourage additional satellite systems to join the GMDSS system. The Iridium System will provide for a promising global coverage including the Arctic Ocean where there is expanding navigation in the region. Once systems are introduced and tested successfully in the Polar Regions, the need for MF to cover these regions would be reduced or eliminated. Subsequent to the Assembly, Iridium announced plans for its next generation and awarded a contract to build it. IMO should establish performance parameters including watch standing, redundancy, and connectivity to the MRCC/RCC network. Candidate satellite systems could not perform all functional requirements such as broadcasting of MSI since ships can still be required to watch NAVTEX and SafetyNet. [8],[9]

With the modern systems now in use and the high degree of automation, probably it will no longer be necessary to have four levels of priority in radio communications. A single category of "Priority" for communications relating to distress and the safety and movement of shipping, with provisions of availability speed of service and service availability would be adequate.

AIS could be used for distress alerting and messaging. The expanding use of AIS under the concept of e-Navigation calls attention to the present reluctance to endorse that same messaging capability for distress alerting. [18] The AIS position report message navigational status could be adapted to include a distress alerting capability. AIS could be used as an alternative to the 121.5 MHz homing signal. This has been considered by COMSAR because of its clearly superior performance, but it was not adopted due to concerns of some administrations that few aircraft were

equipped to home on the AIS signal. The EPIRB power budget will not economically support both homing options, it is recommended that COMSAR [12] accepts the AIS homing signal as an alternative to the 121.5 MHz homing beacon in the same fashion that the AIS SART was accepted as an alternative to the Radar SART.

AIS, SSAS and LRIT could be included in the GMDSS systems. This should be declared in addition to its other applications for safety of navigation.[17]

There have been numerous suggestions that along with GMDSS Modernization there should be an overhaul of lifesaving appliances on survival craft. The option to include a handheld satellite phone should also be included.

There is also a general need to prepare for a transition to making MSI available on web sites for use by mariners. This is often referred to as “pulling” MSI as opposed to “pushing” by broadcasting. Of the currently available broadcasting systems, NAVTEX coastal broadcasts are overloaded and too slow, SafetyNet broadcasting to the high seas seems generally adequate, and HF broadcasting is done by very few countries and the extent of its usage by ships is hard to evaluate. The NAVTEX system needs to transmit on a much higher data rate to accommodate the volume of coastal warnings being broadcast. As the SafetyNet system can handle present volumes, there’s need to monitor implementation of broadcasting MSI by Inmarsat Fleet Broadband, which may overcome the problem of having to track specific satellites for intended reception. [16]

The emerging concept of e-Navigation is likely to utilize many of the same communication systems used for GMDSS, especially VHF which is already heavily loaded. In addition, the expanding e-Navigation requirements overlap in some cases such as the use of MMSI identifiers. Integration of radar and AIS displays on electronic charts invites further integration of MSI warnings as well. While GMDSS requirements apply only to SOLAS vessels, it is customary for most administrations to apply some of the GMDSS requirements to non-SOLAS vessels under domestic regulation. More effective safety outfit for fishing vessels could be a domestic issue, but simplification of GMDSS requirements and recognition of alternate satellite systems will provide more options for improving the safety of non-SOLAS vessels.[10],[11]

Many ships use the satellite option for GMDSS communications due to its reliability and operating simplicity, but the HF option is still preferred by those ships looking for lower cost alternatives or operating partially in Sea Area A4. False alerts continue to be prevalent in the HF systems due to system complexity and poor operator training. The Inmarsat and COSPAS-SARSAT systems also experience false alerts but benefit from an aggressive follow up by their system management. There is no central authority to follow up on HF false alerts unless the individual countries operating HF Coast Stations adopt their own aggressive follow up program including coordinating with the flag states of offending ships. The Scoping exercise output should propose a broad plan for participating administrations to follow up on false alerts including a report to each session of COMSAR. It should consider also how commercial HF providers could become part of the GMDSS.

5. Conclusions

In the end of this paper, there could be presented the latest definition of GMDSS: “Global Maritime Distress and Safety System (GMDSS) means the global radio communications service based upon automated systems, both satellite and terrestrial, to provide distress alerting, promulgation of maritime safety information and general radio communications for mariners.” [13],[15]. The future of the GMDSS Modernization Plan is closely connected with the development of the e-navigation project and the detailed role of the Radio communication in this process. It is necessary first to identify real user needs and secondly to realize that the modernization of the maritime radio communication should not be driven only by technical requirements. In addition, it is necessary to ensure that man-machine-interface and the human element will be taken into account including the training of the personnel.

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