TRANSNAV International Journal on Marine Navigation and Safety of Sea Transportation
Volume 3 Number 1 March 2009

Some Radiocommunication Aspects of e-Navigation

K. Korcz
Gdynia Maritime University, Gdynia, Poland

ABSTRACT: In the paper some radiocommunication issues concerning Global Maritime Distress and Safety System (GMDSS) in respect of the e - Navigation have been described. Some aspects of the existing technical and regulation constraints and limitations referring to GMDSS equipment and systems have been given. The issues relating to the need of GMDSS modernization taking into account new technology and the discussion on the e-Navigation program have been presented.

1 INTRODUCTION

The MSC (Maritime Safety Committee) at its eighty-first session agreed to add a high priority item on the Development of an e-Navigation strategy to the work programme of Safety of Navigation (NAV) and Radiocommunications, Search and Rescue (COMSAR) Sub-Committees. As outlined in the document MSC 81/23/10 which proposes the development of an e-Navigation strategy, it is envisaged that a data communication network will be one of the most important parts of the e-Navigation strategy plan. In order to realize efficient and effective process of data communication for e-Navigation system, existing GMDSS equipment, as well as new radio communication systems could be utilized.

Ten years have passed since the time when the Global Maritime Distress and Safety System (GMDSS) became introduced. Planning for the GMDSS started more than 25 years ago, whereas its elements have been in place for many years.

There have been numerous advances in the use of telecommunications to further maritime safety, security and environmental protection during these periods. Although Inmarsat has provided significant advances for the collection and dissemination of Maritime Safety Information (MSI), distress alert reception and follow-on Search And Rescue (SAR) coordination communications, and the changes and upgrades, such as paperless NAVTEX receivers have been made, there is no systematic, planned programme to ensure the GMDSS remains modern and fully responsive to the needs of maritime safety and security.

On the other hand there are some obsolete GMDSS equipment and systems which had saldom or never been used in practice. For example NBDP had never been used for distress and safety purposes. After the activation of a distress alert on MF/HF DSC, the distress and safety communication is established on a MF/HF radiotelephony frequency only.

Not only in the Author's opinion, the time is ripe to start the wide discussion on the real condition of the marine radiocommunication, with reference to the current discussion on the e-Navigation strategy. In the paper the discussion course at COMSAR Sub-Committee meetings has been taken into account as well.

2 GMDSS AND THE E-NAVITATION PROGRAMME

For e-Navigation purposes, the COMSAR Sub-Committee considered the implications of developing a common information data source, delivering resilient communications, data provision and integrity, based on the requirements and the general conclusions from the preliminary user needs analysis.

In the consideration the following high level user needs have been addressed as a minimum:

- Common Maritime Information Data Structure;
- Automated and Standardized Reporting Functions;
- Human Centred Presentation Needs;
- Effective and Robust Ship and Shore communications;
- Human Machine Interface;
- Data and System Integrity;
- Analysis.

During the discussion at the COMSAR Sub-Committee meetings it was agreed that the needs of seafarers were central in the development of the e-Navigation strategy. However, authorities also had valid security, environmental, and search and rescue responsibilities. Ship and shore needs needed to be treated as a whole. Further e-Navigation can be used as a way to increase shore control over shipping. This should not be implied in the consideration of the needs of the shore component. The need for ships to keep appropriate autonomous control was to be maintained.

Although it was appropriate to start work on the technical aspects of communications supporting e-Navigation now, the e-Navigation strategy was still not complete, so this work had to be considered as preliminary and would have to be revised at a later date. However before further consideration some basic assumptions should be made:

- it should concern data communications; voice communications would also form a part of e-Navigation, but the present emphasis was primarily on data transfer;
- there would be different requirements for data availability depending upon the nature of the information being transmitted; for instance, information that was time and safety critical needed to be transmitted and received by the affected users quickly and reliably, whilst less time critical information would have a lower priority;
- the ship would receive a lot of information and it was important for the crew to be able to manage these data effectively;
- e-Navigation should not be seen as limited to safety and security at sea and protection of the marine environment functions only, as efficiency was an important potential benefit for ships and their crews; and
- data communications via satellite, as well as over terrestrial links, e.g., Medium Frequency (MF), High Frequency (HF), and Very High Frequency (VHF) would be used.

In general a ship in port could receive e-Navigation information through a wire. For wireless systems the expansion of bandwidth needs in the future should be expected. Therefore a wide variety of communications links could be foreseen, and it was too early to exclude any possibility.

Based on the findings of the Correspondence Group on e-Navigation strategy, including the above mentioned assumptions and discussion during the COMSAR Sub-Committee meetings the following recommendations and guidance could be given.

2.1 *Existing international regulations and standards relevant to the high level communications*

With respect to existing international regulations and standards relevant to the high level communications, it can be agreed that the user needs, as identified in SOLAS regulation IV/4, were the following data functions (also see Table 1) (IMO. 2004):

1 transmitting ship-to-shore distress alerts;
2 receiving shore-to-ship distress alerts;
3 transmitting and receiving ship-to-ship distress alerts;
4 transmitting and receiving search and rescue co-ordinating communications;
5 transmitting and receiving on-scene communications;
6 transmitting and receiving signals for locating;
7 transmitting and receiving maritime safety information;
8 transmitting and receiving general radiocommunications to and from shore-based radio systems or networks; and
9 transmitting and receiving bridge-to-bridge communications.

While the COMSAR Sub-Committee meetings also noted that the user needs other than the GMDSS functional requirements and related equipment did not fall within its remit, however, it decided to additionally consider Automated Identification System (AIS), Long-Range Identification and Tracking System (LRIT) and Ship Security Alert System (SSAS) equipment, as specified in SOLAS regulations V/19, V/19-1 and XI-2/6 respectively. Additional user needs might be included at a later occasion as the development of e-Navigation was an ongoing process.

Table 1. Existing user needs relating to SOLAS Reg. IV/4

User needs SOLAS IV/4	1)	2)	3)	4)	5)	6)	7)	8)	9)
VHF-DSC	x	x	x	x	x			x	x
SART						x			
NAVTEX							x		
EGC							x		
EPIRB	x					x			
MF/DSC	x	x	x	x	x		x	x	x
Inmarsat SES	x	x	x	x	x		x	x	
HF/DSC	x	x	x	x				x	x
Two-way VHF					x			x	x

2.2 *Existing international regulations and standards identified which would need to be addressed, or further developed, to provide a harmonized resilient system*

There are about 130 performance standards and test standards related to GMDSS equipment mandatory or not mandatory according to SOLAS. As of today, taking into account present development of the marine electronics systems, about 10 of them should be modified or suppressed and about 40 should be definitely suppressed as obsolete. But it is difficult to identify in details which existing regulations and standards would need to be further developed or revised because the e-Navigation system was still at an early stage of development.

2.3 *Existing technical constraints and limitations, in terms of bandwidth, frequency and power consumption*

E-navigation should not be limited to communications using existing equipment, but the first phase should be to make better use of existing technology. Other technologies could come later. It had to be recognized that there were limitations on spectrum availability and that other types of technology might have to be used. It might also be necessary to pay for data communications. It is also recognized that the current systems were not adequate for expected types of high rate data (for example Inmarsat C had a data rate of 600 bps). There are no mandated requirement for a higher data rate but other satellite systems are available and can possibly be used for transfer of e-Navigation data.

2.4 *How should communications and information systems be developed and coordinated internationally and within technical standards for data structure, technology, bandwidth and frequency allocations?*

There is a need to have a common data structure and management so that the information would be available on board and could be used by different systems without the need to have to continually re-enter data. This would reduce the administrative load on ship crew as various reporting requirements could be extracted through filters automatically.

2.5 *Potential regulatory and technical problems that will need to be overcome considering that e-Navigation is to be scaleable across small and large vessels alike*

The question of e-Navigation being scaleable across small and large vessels alike is of relevance when small vessels and SOLAS ships needed to access e-Navigation data. National maritime administrations would need to include smaller vessels in the e-Navigation system. However, small vessels might have other means in addition to mandatory communications equipment such as VHF, of obtaining e-Navigation information such as mobile phones. Smaller vessels might also have power limitations and smaller presentation displays. In addition, the level of training might not be of the same standard as for SOLAS ships.

2.6 *Measures to reduce the number of false distress alerts*

The consequences need to be borne in mind. In order to reduce the occurrence of false distress alerts a unified written operating procedure and method in initiating distress alert had to be in place, a unified high rate of false alerts could be due to crew not being familiar with the operation of DSC devices, not following IMO guidelines and procedures or usage issues, i.e. the question of human machine interface problems.

The false alerts were occurring only in the GMDSS system and were an unintended consequence. The e-Navigation concept was still being developed but the possibility of similar unintended set of specifications for distress alert buttons should be provided to avoid confusion among users and a unified, effective and safe test function should be provided on the equipment.

The false alert problem touches on almost every subject of concern to the COMSAR Sub-Committee, including GMDSS, and Search and Rescue procedures. Because of the early and preliminary nature of the e-Navigation strategy development, there is no way to find a solution at this time from an e-Navigation perspective. However, it demonstrates the importance of standardization, clear procedures and effective training (MSC/Circ.1091) in the development of e-Navigation.

3 NEED OF GMDSS MODIFICATION

In 1988, the Conference of Contracting Governments to the 1974 SOLAS Convention on the Global Maritime Distress and Safety System (GMDSS) adopted amendments to the 1974 SOLAS Convention concerning radiocommunications for the GMDSS. These amendments entered into force on 1 February 1992. On 1 February 1999 the GMDSS became introduced for all SOLAS ships.

The following radio equipment and systems are provided for the GMDSS (Figure 1):

- Digital Selective Calling (DSC);
- INMARSAT Satellite System;
- SATellite Emergency Position Indicating Radio-Beacon (SATEPIRB);
- Search And Rescue Transponders (SARTs);
- NAVTEX System;
- Narrow Band Direct Printing (NBDP);
- Radiotelephony (RTF);
- Distress Message Control (DMC);
- navigational equipment (for support).
- Other elements of GMDSS to be showed in Figure 1 mean as follows:
- INMARSAT Coast Earth Stadion (CES);
- INMARSAT Ship Earth Station (SES);
- COSPAS/SARSAT Local User Terminal (LUT);
- Rescue Coordination Centre (RCC).

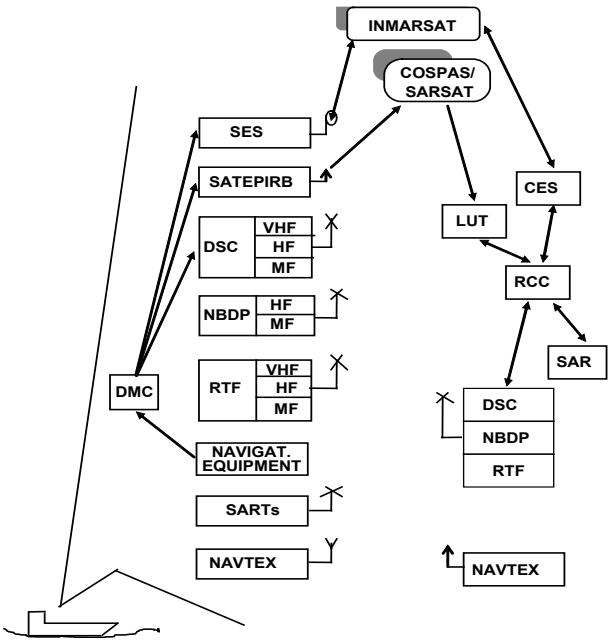

Figure 1. Equipment and systems of GMDSS (Korcz K. 2005)

Communications will be essential to e-Navigation, in particular for collecting and integrating sources of navigation information and providing the user with the optimum, relevant data on a multifunction display. The modes of communication covered by the concept are following:

- intra-vessel;
- ship-to-ship;
- ship-to-shore and shore-to-ship;
- shore-to-shore.

A systematic and continuing review is needed to ensure the GMDSS remains responsive. Below some categories suggested for review have been given.

3.1 *Functional requirements*

The GMDSS was built upon satisfaction of functional requirements (SOLAS Chapter 4, Reg. 4) mentioned above. Any review of the GMDSS should start with an examination of the functional requirements. At the beginning of these consideration the answers to the two following questions should be given: are deletions of any requirement possible? and do others need to be added?

Consideration of these questions allows to come to the conclusion that no functions were candidates for deletion, but at least two or more may need to be added – for example interoperability with non-SOLAS vessels and communications with commercial aircraft. Also, there may be a need for high data rate systems in some vessels for use during mass evacuation incidents.

3.2 *Carriage requirements and areas of operation*

Four areas were defined where carriage requirements differ. It should be considered if this concept is still relevant, taking into account large variety of the ship types and the sea routes.

3.3 *Advances in technology*

Much of the GMDSS equipment is built on technologies more than 20 years old. Some of them work well and others do not. Further, many new and less expensive technologies have emerged including:

- radio systems with embedded position information;
- Low Earth Orbit (LEO) satellite systems with hand held terminals; some provide excellent coverage in Polar Regions; the Polar Regions are growing in importance (new NAV/MET Areas have been defined to cover these areas);
- regional satellite systems have been implemented with attractive features;
- web-based access to non-alert MSI; further data rates supported by NAVTEX and SafetyNET may not be sufficient; the relationships between the historical "push" of information and new technologies that allow "pulling" it may need attention;
- inexpensive hand-held radios - for example, small cheap VHF-AM radios could be placed

in some survival craft for communications with commercial aircraft; and
- cellular phones.

3.4 *Related systems and initiatives have been or will be put in place*

At present above includes:

- Automatic Identification Systems (AIS);
- Ship Security Alert Systems (SSAS);
- Long-Range Identification and Tracking (LRIT);
- commercial HF service systems that are not part of the GMDSS, but they serve thousands of ships. These include HF e-mail, which is used widely, but it is not part of the GMDSS;
- e-Navigation programmes.

3.5 *In some cases implementation has not proceeded as planned*

Among other things it applies to:

- many HF/MF and VHF commercial stations have closed, and commercial use of DSC and NBDP has diminished;
- implementations of areas A1 and A2 have been slower than anticipated; and
- DSC is still not as widely used as expected.

4 CONCLUSIONS

One of the three main elements of e-Navigation is Communications. Taking into account the earlier consideration, doubtlessly the communications media for e-Navitation should include both terrestrial and satellite communications.

There is increasing demand for a common communication platform for two-way data communication between ship and shore. There is also a growing requirement for Internet access on ships, at sea as well as in ports.

There are many data communications technologies that are likely to play a role in e-Navigation. In addition to fixed communications, the mobile communications technologies that could be used include but are not necessarily limited to radio (HF, VHF or UHF - Ultra High Frequency), AIS, WiFI and Wi-Max, satellite communications including Internet Protocol (IP) broadband. Communications can be either point-to-point or broadcast and could be based on IP but not necessarily on the Internet itself.

The selection of the particular technologies used to provide services must be made carefully and should depend on the specific task to be undertaken.

So, the GMDSS equipment can be an effective way to increase the reliability of e-Navigation data communication network but must be improved. This goal can be achieved as the result of the work on two items (Korcz K. 2007):

- technical improvement of GMDSS; and
- utilization of technically improved GMDSS equipment for e-Navigation.

In addition, it is necessary to ensure that man-machine-interface and the human element will be taken into account including the training of personnel. The lessons learnt from the development and operation of GMDSS and AIS should be taken into account in the development of e-Navigation as well.

Taking into account the above mentioned a systematic process is needed for continuous review of the GMDSS to ensure it remains modern and fully responsive to changes in requirements and evolutions of technology and it will meet the e-Navigation programme requirements.

For assuming this process a mechanism for continuous evolution of the GMDSS in a systematic way should be created. Some evolutions are within the sole purview of the IMO (in particular COMSAR Sub-Committee) while others will require co-operation from others such as the ITU/ICAO, etc. The COMSAR Sub-Committee is competent to initially discuss these issues in part under several agenda items. These agenda items include:

- GMDSS;
- Developments in maritime radiocommunications systems and technology;
- Development of an e-Navigation strategy; and
- Development of procedures for updating ship-borne navigation and communication equipment.

REFERENCES

International Maritime Organization (IMO). 2004. International Convention for the Safety of Life At Sea (SOLAS), London

Korcz K. 1995. Przepisy radiokomunikacyjne w morskiej służbie ruchomej. Wydawnictwo Uczelniane Wyższej Szkoły Morskiej, Gdynia

Sub-Committee on Radiocommunications, Search and Rescue-COMSAR11. 2007. Report to the Maritime Safety Committee (MSC), International Maritime Organization (IMO), London

Sub-Committee on Radiocommunications, Search and Rescue-COMSAR12. 2008. Report to the Maritime Safety Committee (MSC), International Maritime Organization (IMO), London

Sub-Committee on Radiocommunications, Search and Rescue-COMSAR13. 2009. Input documents, International Maritime Organization (IMO), London

Korcz K. 2007. GMDSS as a Data Communication Network for E-Navigation. 7th International Navigational Symposium on "Marine Navigation and Safety of Sea Transportation" TRANS-NAV 2007, Gdynia