

Standardization of Interface for VHF, MF/HF Communication Using DSC within Its Integration with INS in the Framework of e-Navigation Concept

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ABSTRACT: Digital selective calling (DSC) has a certain drawbacks, which have led to the fact that it is practically not used in address radio communications. Attempts to improve it only within the DSC system itself did not lead to any noticeable results due to neglecting of real user needs. The article proposes an approach to improve the user interface of DSC based on the integration of VHF MF/HF DSC equipment with the INS within the three main outputs of strategic direction of e-navigation development related to the integration of communication and navigation systems and, in particular, the S-mode. This approach allows us to significantly simplify the DSC user interface, based on the standardization of DSC integration for all three VHF MF/HF communication sub bands. For implementation such standardization an additional inclusion into the integration a satellite AIS system should be done. The feasibility of the proposal is supported by the existence of relevant IEC standards and IMO documents. The possibility of increasing the cyber security level of AIS messages in this interface is also considered.

1 INTRODUCTION

Radio communications in the VHF, MF/HF bands have been, are and will continue to exist for efficient and safe navigation. Since 1999, to improve radiotelephone communication, a new Digital Selective Calling (DSC) communication subsystem in Global Maritime Distress and Safety System (GMDSS) has been introduced in operation. Hence for two decades of the GMDSS existence, the maritime communications using DSC has not adapted properly in the navigational community.

In our opinion, the reason for this is the neglect of real user needs. The unfriendly nature of the user interface of VHF and MF/HF equipment and the complexity of manual routines within communication protocol using DSC do not support effective using of equipment for the prompt establishment of addressed

radio communications. DSC imperfections appear especially in emergency situations [1, 2] and may adversely affect the safety of navigation.

The system solution to the problem of taking into account user needs is the concept of designing all the graphical interfaces on the vessel bridge in standard manner - S-mode [3, 4]. From a technical point of view, the S-mode is aimed at replacing the hardware control of each individual device with the interface connection of these devices to a single processor and operating them from a single graphic display. This concept is focused primarily on meeting the needs of the mass user, at the same time leaving the possibility of introducing innovations and individual user settings.

Within a framework of implementation the e-navigation solution to the problem of improving DSC interface it is designing on the base of the integration

of DSC and AIS-ECDIS [5-8]. However, the practical implementation of such a project is limited by three factors: 1) the ECDIS is overloaded by navigation tasks and 2) it should demands of the revising of ECDIS Performance standards 3) that approach was suggested only for VHF DSC. Therefore, in the present work, the Information Display of the integrated navigation system (INS) is selected as the graphical interface. Also for the user DSC interface standardization in all terrestrial communications bands VHF, MF, HF it was proposed in additional to use the sat-AIS technology to support the standardized user communication interface for MF/HF DSC (on the base of their common with VHF DSC communication protocol [9]). It should be pointed, that the standardized mode of operation is meant not only symbols unification, but also standardization of operations, particularly standardization of interface of VHF/MF/HF communications using DSC within its integration with INS.

In the document NCSR 6/11/1, (Germany) the First draft of resolution A.806 (19) is presented [20]. The draft refers to revision of SOLAS chapters III and IV for modernization of GMDSS. Particularly Germany proposes to introduce the new text in the part A, section 4, suggested to implement a simple process to connect station based on the MF/HF DSC protocol namely:

“4.2 The equipment should provide a standard interface to enable the selections of frequencies and setting of MMSI to be called from remote control unit (e.g. INS) by using standardized interfaces.

4.3 A function to establish a connection between stations of the mobile maritime service by simple means using DSC should be implemented.”

The document “Displaying distress alert relay information on shipboard navigation display systems” NCSR 5/9/4, (United States) [13] particularly poses the question on graphic display of distressed vessel on a navigation display unit and its possible linking to available target information “for displaying a distressed vessel. In addition, digital selective calling also is capable of providing of both: distress alert information from vessels, as well as distress alerts relays broadcast from shore.”

In document NCSR 6/7 [14], paragraph 12, it is pointed that the guidelines' conformance requirements would need to state that “conformance with Appendices 2 to 5 of these guidelines was demonstrated by meeting the applicable requirements of the *Performance standards for the presentation of navigation related information on shipborne navigational displays* (resolution MSC 191(79) and IEC publication 62288) and could not conflict with applicable performance standards for navigation equipment and would also mean adherence to the principles of human-centered design.

In this paper it is proposed the standardization of interface for VHF/MF/HF communications using DSC within its integration with INS. The standardization helps realized that integration by an appropriate way on the base of common communication protocol for all three DSC communication sub bands and significantly simplifies the DSC user interface. This

approach is based on the three main outputs of e-navigation strategic direction development related to the integration of communication and navigation equipment/systems, namely: Additional modules to the revised performance standards for INS (Resolution MSC 252(83)) related to the Harmonization of Bridge design and display of information; Guidelines for the Harmonized Display of navigation information received via communication equipment and Guidelines for the standardized modes of operation, S-Mode. Implementation of the standardization demands to include in that integration the satellite AIS system.

The feasibility of the proposal is supported by the existence of relevant IEC standards and IMO documents. The peculiarities of including in the integration satellite AIS system are also considered.

2 STANDARDIZE COMMUNICATION PROTOCOL FOR DSC

In documents NCSR 4/7 (annex 2) and NCSR 4/8 (annex) were pointed communication equipment/systems, which may be interfaced with an INS including VHF/MF/HF DSC in the frame of e-navigation concept.

E-navigation concept is supposed to simplify the exchange of information between ships, as well between ships and shore by means effective, user friendly tools with human factor principles consideration (MSC 95/19/8). This solution must be based on agreed guidelines.

The document NCSR 5/6/1 proposes the drafting of Guidelines for integration and presentation of available navigation-related information exchange provided via communication equipment by means of interfacing VHF/MF/HF DSC with an Information display (Conning display). An information display (Conning Display) incorporates all the relevant and important information for the vessel conning together to one place. Conning Display may be implemented in the frame of INS-Module F for integration and presentation of available navigation related information exchange provided via communications equipment. In particular, the Conning Display should be capable of displaying VHF/MF/HF DSC information (NCSR 4.7 (Annex 2), NCSR 4.8 (Annex)) and therefore should be connected to VHF DSC controller and MF/HF DSC controller. This display, in tern, is integrated within an INS (including AIS, ECDIS, and satellite AIS). All actions on information exchange by means of DSC are performed using software of the Information display on the base of standardization of DSC interface using the common communication protocol for VHF DSC controller as well as MF/HF DSC controller.

In order to provide connection to VHF DSC controller and to MF/HF DSC controller the same protocol may be used, which is described in NCSR 3/INF.15, paragraph 8; MSC 97/19/9, paragraphs 4,5,6; NCSR 4/7/1, paragraph 6), where instead of the software ECDIS the software of Conning Display is used. Due to this protocol the next actions should be provided:

- 1 Clicks on the vessel's AIS mark on the Conning Display for automatically sending the MMSI from Conning Display to DSC controller by transferring controlling commands to DSC for providing DSC call by this;
- 2 Display the calling vessel by a blinking AIS mark on the called vessel's Conning Display (a red blinking mark in case of distress call), transferring MMSI from DSC controller to Conning Display automatically for identification of the calling vessel on Conning Display by this;
- 3 Open exchange of information, without wasting any time on working out who is who. The working channel (frequency) can be set by default (or maybe chosen manually, if necessary, using standard computer actions).

The additional connection sat-AIS to Conning Display should be done (for MF/HF DSC). All actions according to the protocol are fulfilled using special software of Conning Display using of a common maritime data structure, based on the work of IHO and their S-100 data structure. The principle of layering of new information over existing one may be used. All of these enable to avoid introducing changes to PS ECDIS (resolution MSC. 232 (82)) for implementation of the communication protocol.

The integration scheme for proposed communication protocol implementation is shown in Fig. 1.

To keep the same approach for communications at medium and long distances in the MF/HF bands, satellite AIS must be applied.

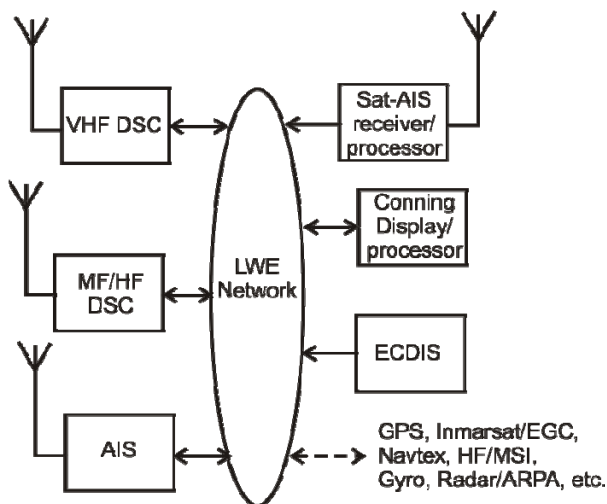


Figure 1. VHF, MF/HF DSC – AIS/Sat-AIS integration on the base of unified communication interface for proposed communication protocol implementation.

3 PARTICULARITIES OF SATELLITE- AIS APPLICATION

Satellite-AIS currently operate for global monitoring via LEO satellites and supports ship-to-satellite-to-coast station data transmission mode. Satellite-based AIS (Sat-AIS) uses existing AIS technology to improve tracking capabilities and overall maritime surveillance. Sat-AIS is based on monitoring signals from ship's AIS transponders using low-Earth orbit (LEO) satellites. The satellites receive AIS information

from the vessels and transmit the AIS information to ground elements and/or other vessels and coast stations. The main problem in Sat-AIS operation is the separation of signals received by the satellite simultaneously from a large number of ships borne AIS. Because of Doppler frequency shift arising from the satellite motion the received signals may be selected by frequency. Another factor is the difference in time delay transmission from each vessel. Also is used spatial selection of signals on the base of Synthetic Array Patterns realized due to satellite motion. So, Sat-AIS is able to receive and distinguish messages from various vessels in satellite foot-print area. The additional parameters of signals, are pointed above, that are appeared due a satellite motion, may be used also for increasing of Sat-AIS cybersecurity comparatively to usual vessel's AIS, which is very vulnerable to different sorts of cyber attacks.

In addition for using Sat-AIS technology it should be foreseen of using part of Conning Display screen, if necessary, to interface the region where a vessel is located for MF/HF communication.

4 ADDITIONAL SYMBOLS

The proposed standardization is demanded to introduce new symbols which should be described for possible addition to SN.1/Circ.243/Rev.1.

When the source is DSC the additional symbols may be used as presented in document NCSR 4/8, appendix (with possible corrections NCSR 5/6/1). Particularly, these additional symbols include symbols for graphically displaying of distressed vessel on Information display and can be used for both distress alert information from vessels as well as distress alerts relays broadcast from shore NCSR 5/9/4,(see document paragraph 4).

The proposed in NCSR 4/8 new symbols are shown in Fig.2

Topic	Symbol	Description
a) Vessel calling me Note Source is DSC		A square indicated by its corners centred around the target symbol. Upper left corner and lower right corner is formed from telephone symbol. The symbol is flashing until user answer the call.
b) Vessel I am calling Note Source is DSC		A square indicated by its corners centred around the target symbol. A symbol of telephone in the centre of the symbol.
c) Vessel in distress Note Source is DSC		A red (on colour display) double diamond indicated by its corners centred around the target symbol. The inner and outer diamond part of the symbol alternate in flashing until acknowledged

Figure 2. Proposed DSC related symbols upon AIS targets: a) another calling vessel, b) the vessel to be called, c) distressed vessel [19], which are complied with suggested communication protocol.

5 CONCLUSION

The standardization of interface for VHF, MF/HF communication using DSC within its integration with INS helps to realize that integration by an appropriate way on the base of common communication protocol for all three DSC communication sub bands and significantly simplifies the DSC user interface. This approach is based on the three main outputs of e-navigation strategic direction development related to the integration of communication and navigation equipment/systems, including standardized mode of operation (S-mode).

Implementation of the standardization due to a need of providing common communication protocol for VHF DSC and MF/HF DSC demands to include in this integration the satellite AIS system (for MF/HF DSC).

The standardization of interface for VHF, MF/HF communications using DSC within its integration with INS in framework of e-navigation concept realizes user-friendly solution with human element consideration as a result of DSC integration with the Information display. This integrated system allows getting the new quality which could not be reached using any of specified systems separately. Such an integrated system should enhance the quality of information available to the officer of the watch. The feasibility of the proposal is supported by the relevant IEC standards and IMO documents.

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