ECDIS Modernization for Enhancing Addressed VHF Communication

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ABSTRACT: Standard ECDIS configuration doesn't foresee interaction with Digital Selective Calling (DSC) device. We propose a reasonable way to eliminate the drawbacks of existing VHF radiotelephony using DSC and obtain new advantages in communication and navigation in the frame of existing conventional installations. The proposed innovation is based on ECDIS software updating and the interconnection to DSC equipment. ECDIS modernization would get rid a navigator of the routine procedures and handling with abstract data replacing them by understandable actions on ECDIS display. The proposed integration gives new abilities for smart addressed VHF/DSC communication by estimating the current navigational situation around the ship that is especially important in congested ports, waterways and poor visibility regarding human factor. The proposed modernization retains in operation all standard DSC and ECDIS functions and provides full compatibility with commonly used non-integrated equipment. Financial expenses to its implementation for ship-owner are minimal due to only software updating and standard cabling.

1 INTRODUCTION

Electronic Chart Display and Information System (ECDIS) [1] is one of the most important navigation and decision support tools, in the high degree due to the integration with the other systems and peripheral vessels equipment and the ability of real-time operating. Contemporary ECDIS clearly demonstrates an emergency and synergetic effect of complex system. Thanks to system approach in ECDIS development it manifested the new properties for maritime navigation.

An evident effect was gained due to linking Automatic Identification System (AIS) to ECDIS. Nevertheless, it's potential in high-performance and safe navigation is not depleted. In our opinion the next step in the strengthening of ECDIS effectiveness for navigation is bringing together ECDIS/AIS and VHF/DSC radio. This assessment is originated from the obvious drawbacks of maritime communication using Digital Selective Calling (DSC).

DSC is a new feature of communication comparing with before the Global Maritime Distress and Safety System (GMDSS) epoch. But imperative implementation of DSC as a part of Very High Frequency (VHF) communication is hardly introduced in a practical application because of certain reasons that were analysed in document [2]. In particularly an existing VHF/DSC radios require numerous number of manual operations to compose correct call. Thus entering only Maritime Mobile Service Identity (MMSI) needs nine elementary manual actions at DSC controller key board. In the whole the time period needed for digital call – acknowledgement procedures, that are executed in the ideal condition and by skilled navigator is

comparable to responding time in urgent circumstances. But the worth is that the navigator just neglects DSC procedures and immediately takes up the receiver on channel 16 relying on desired ship-to-ship communication. In this situation the question "who is who?" cannot be settled identically and at once. Instead, omitting the DSC, the navigator doesn't get secure clear and addressed VHF communication.

Proposal to improve VHF/DSC communication has been voiced in the proposition [3] and involved in paper [4]. It was further settled that the complete solution of the discussed problem calls for some modernization of ECDIS at the software level. In the present paper this modernization and its influence on VHF communication are discussed.

2 ECDIS UPDATING TO DSC CONNECTING

2.1 *Contemporary state*

ECDIS is the most important navigational tool which deals with Electronic Navigational Chart (ENC) information and much navigation data from the different external sensors. General scheme of contemporary ECDIS [1] is shown in Figure 1.
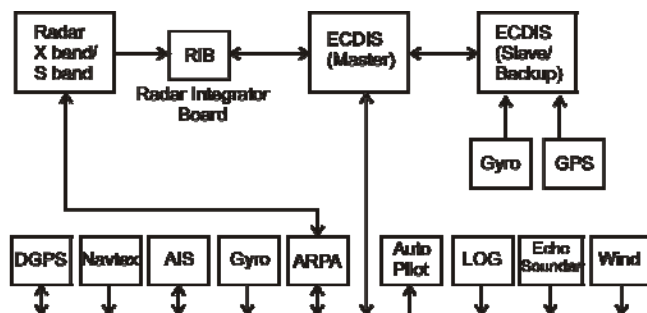

Figure 1. General scheme of contemporary ECDIS

Contemporary ECDIS is a main source of navigation-related information. According to [5] navigation-related information includes chart and operational information. Chart-relation information is drawn from ENC. Sources of operational information are various navigation tools. It should be noted the trend of ratio between chart information and operational-related information (See Figure 2). Volume of chart information is bounded by ENC content and has to be stable. Instead the relative part of operational information is rising. Leading growth should be explained by the ascending ability of presentation of information to humans in convenient visual form.

It is very important to pay attention to definitions of notions "Data" and "Information" as given in [5]:

Data - information in numerical form that can be digitally transmitted or processed.

Example/context: **Data** are a raw collection of facts which can exist in any form without any evident meaning or sequence of usability.

Information - the communication or reception of knowledge or intelligence.

Example/context: Data becomes **information** when it is presented in a manner which is understandable to humans.
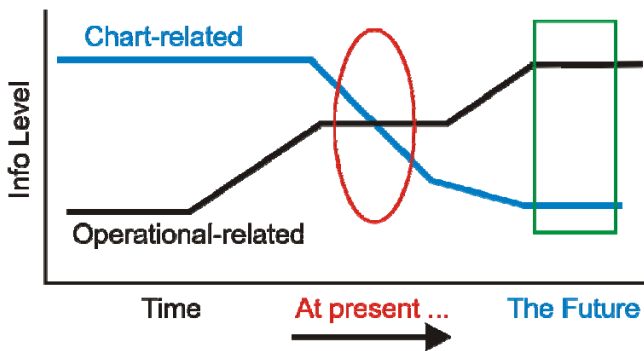

Figure 2. Trends of chart and operational-related information (from [6])

In our design we have just avoided operations with a raw data (MMSI, position), but using only information directly presented in the form understandable to a navigator.

2.2 *Compelling need*

Careful analysis showed that certain, mainly software applications must be entered into ECDIS without any intrusion in its standard functions.

An objective of proposed ECDIS modernization is the development and implementation of such technical improvements which could give the ability to: 1) providing DSC communication automatically directly from ECDIS; 2) displaying the calling vessel by blinking AIS mark on called vessel's ECDIS (and red blinking mark in the case of distress call) and thus to make immediately the process of attachment of calling vessel to current navigation situation.

The completion of these two tasks can be achieved within the frames of the currently used vessel equipment, through the ECDIS/AIS integration with VHF/DSC. 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 and thus requires special connection between ECDIS and DSC controller.

The problem is that in existing ECDIS the connection to DSC is not foreseen. So the corresponding modernization of ECDIS should be done. Connection of the VHF/DSC and ECDIS may be implemented by means of bi-directional interface.

Generally the integrated system is suitable not only for ship-to-ship communication, but also for shore-to-ship and ship-to-shore communications which is very important for application in the Vessel Traffic Services and SAR operations.

Alongside the intrinsic advantages gained by connecting DSC controller to ECDIS, such integration would correspond with the principles that underpin IMO's e-Navigation concept. One of core objective related to the e-Navigation concept particularly says:

"integrate and present information on board and ashore through a human-machine interface which maximizes navigational safety benefits and minimizes any risks of confusion or misinterpretation on the part of the user".

Integration of data of VHF/DSC and ECDIS/AIS systems allows optimizing control of a vessel, to avoid possible misses and incorrect decisions of the navigator.

The most important is that VHF/DSC presents a necessary part of GMDSS but because of unpractical user interface it is employed by mariners incorrectly or ignored at all [2]. There is a sharp compelling need to improve DSC user interface to gain benefits from digital calling which have been projected. The proposed modernization and integration naturally solve the above mentioned issues while not claiming any expenses from ship-owners. Only amendments to performance standards and software updating are needed. Additional hardware results in appropriate DSC – ECDIS cabling. If necessary, soft updating may be distributed in application form.

2.3 Data processing in ECDIS

To compose a DSC navigator has to know MMSI of the vessel to whom the call is addressed. The needed MMSI is commonly may be read out from AIS display (or ECDIS). In this routine sequence of MMSI digits presents a certain numerical data which say nothing to navigator itself. Why does he have to handle MMSI digits?

When receiving DSC call a navigator has to handle again an abstract digits (MMSI, position), wasting time needed for making decision on navigation.

Settlement of this problem may be obtained by realization of a certain procedures:
1 providing MMSI transferring to the DSC controller automatically directly from ECDIS (AIS data already have it). The parameters, for example, the working channel number, can be set by default (or can be chosen manually if necessary using standard computer actions); and
2 displaying the calling vessel by blinking AIS mark on called vessel's ECDIS (and red blinking mark in the case of a distress call).

The above mentioned functions were software-based implemented as presented in Figure 3. An innovative ECDIS functions are realized in the dot lined modules. Standard ECDIS comprises Processing Unit with Electronic Navigation Chart mass storage, Display and external information transducers: Radar, AIS, GPS receiver, Log and Gyrocompass. In a case of DSC call officer of the watch (OOW) should only select the vessel to which he intends to communicate. It is not necessary to look for MMSI of the called vessel because it is already known from AIS information. All necessary operations for calling message assembling are provided in the module of DSC message forming module. Calling sequence is directed through the Output port to the external DSC controller.
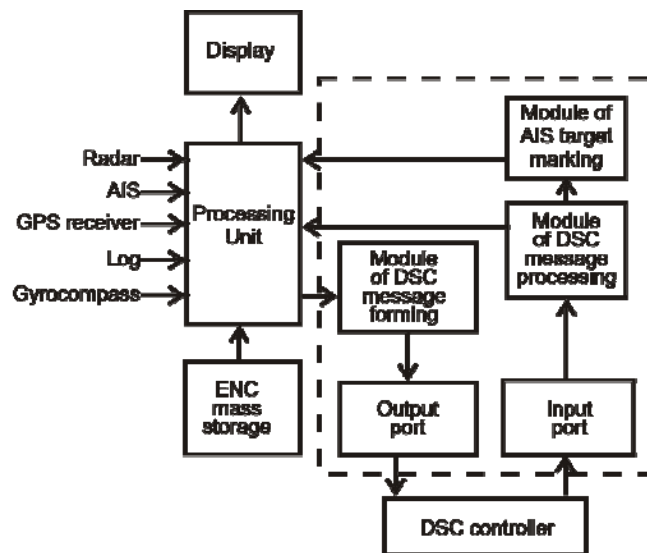

Figure 3. ECDIS with DSC-related information processing

The second new ECDIS function supports information received from DSC controller. In a case of getting DSC call that is addressed to the own vessel the received sequence is directed through Input port to module of DSC message processing. Comparing MMSI from DSC controller with AIS target MMSI makes possible to mark the calling vessel among other ships. OOW is able to estimate immediately the current navigational situation not wasting any time on the properly DSC actions. After acknowledge, if necessary, again by clicking the AIS mark of the calling vessel operator can start voice communication. It is essentially that addressed and clearly understood recipient side communication is guaranteed without additional explanations.

2.4 Benefits

The e-Navigation initiative will need to focus on the challenge of keeping shipboard system up to date and error-free. Evolving technologies and e-Navigation application will continue to drive change in the maritime communication system. Shore facilities and ship operators will have more economical and efficient choices for exchanging the information they need for the safe operation of ships.

The ECDIS/AIS integration with VHF/DSC will ensure further enhancement of safety of navigation while simplifying the navigator's interface with communication and navigational equipment and accelerating actions of operator for ship-to-ship, ship-to-shore and shore-to-ship communications (COMSAR 15/INF.3). These last two are very important for application in the Vessels Traffic Services and the SAR operations. When a necessity for establishment VHF communication appears in extraordinary situation, the navigator needs to be able to count on quick access to clear voice communication, without wasting any time on fulfilling unnecessary operations for this, and should be able to concentrate on the main task, in particular, connected with safety navigation (with proper observant of the COLREGs, of course). This suggestion is fully compatible with the e-Navigation development strategic direction which includes further development of means of communication and

navigation and the implementation of modern digital information technologies in navigation.

The integration of ECDIS-AIS and VHF DSC can be achieved within the currently used vessel's equipment and requires no changes to the existing radiocommunication operational procedures (if necessary, all components of integrated system may be used separately in regular regimes). What is essential is that the present manual method of making/viewing calls will be preserved as a supplementary means to the automatic method of making calls in the ECDIS-AIS-DSC system. Only two additional operations for ECDIS are needed to be implemented:

1 providing MMSI transferring to the DSC controller automatically directly from ECDIS (AIS data already have it). The parameters, for example, the working channel number, can be set by default (or can be chosen manually if necessary using standard computer actions); and

2 displaying the calling vessel by blinking AIS mark on called vessel's ECDIS (and red blinking mark in the case of a distress call).

Integrated ECDIS/AIS – VHF/DSC system will be also employed in Vessel Traffic Services to benefit their efficiency and safety of port operations, Maritime Rescue Coordination Centers, Search and Rescue operations.

2.5 *Influence of human factor*

Considered proposition is tightly connected with user's interface and therefore concerns a question on human factor. In the document [7] the results of assessment of GMDSS on board equipment on communication and navigation in the frame of e-Navigation are presented. It was noted that as many of the communication requirements including those within GMDSS were directly associated with navigation tasks regarding to collision avoidance, port operations and SAR operations. Thus integrating navigation and communication tasks could aid the effective planning, execution and reporting functions for a ship's voyage.

Among user needs it was emphasized clear identification of addressees both for broadcast and point-to-point communication and for all forms of communication.

2.6 *Testing*

An experimental hardware-software complex ECDIS/AIS – VHF/DSC has been constructed to verify practicability of the proposed ECDIS modernization. The complex includes standard VHF/DSC controller RM-2042 (Sailor), AIS transponder MT-3 (Transas), specially designed software to customize ECDIS functionality for DSC interconnection and specific interface for DSC controlling. In the future this interface may be replaced by standardized interface.

Testing demonstrated the full operability of the newly proposed ECDIS click-to-talk and call presentation functions in ECDIS environment. DSC function is realized in the separate presentation layer and may be switched off. All others standard ECDIS performances and external connections were not degraded.

2.7 *Physical interface*

Implementation of the designed ECDIS demands additional hardware interface between ECDIS station and DSC controller. This interface should be chosen from maritime interfaces of instrumental level. There are two suitable candidates: NMEA 0183 (National Marine Electronics Association) ant its international version IEC 61162-1/2 and NMEA 2000 (IEC 61162-3) [8]. Presently NMEA 0183 is widely used for interconnection of various maritime navigational tools, but according to its characteristics it is not quite suitable for up-to-date information exchange on the bridge in real time mode and is the most important standard for ship instruments interconnection.

The next generation of maritime interfaces is NMEA 2000. Today it is widely implemented mainly on the small and pleasure non-SOLAS vessels where it combines not only navigational means but also transducers of propulsive system and ship's automatic machinery. Comparative interface characteristics are given in the Table 1.

Table 1. NMEA 0183/2000 characteristics

NMEA 0183	NMEA 2000
Rate 4.8 kbit/sec (38.4 kbit/sec for version NMEA 0183HS)	Rate 250 kbit/sec (on general bus length 200 м)
One directional, one talker and several (up to 10) listeners	Bidirectional
There is no any special demands to connectors	Only uniform waterproof connectors in maritime realization
Needs for additional activation on a program level	Implements plug-and-play function
Point-to-point implementation. Needs for numerous cable interconnections between installations, especially for backup	Use the general bus (backbone) for switching all instruments, that minimizes the connectors number

In the NMEA 0183 interface data transmission is realized by means transferring information packets named as sentences. There are 4 sentences that officially approve for DSC utilization:

– DSC – Digital Selective Calling Information,
– DSE – Expanded Digital Selective Calling,
– DSI – DSC Transponder Initialize,
– DSR – DSC Transponder Response.

Analysis of these sentences makes possible to resume that they contain all necessary information for bidirectional interaction between ECDIS and DSC controller. Therefore NMEA 0183 standard is fully suitable for our application. Unfortunately the NMEA 2000 standard is publically closed and arguments on its application are not possible. In general coming from comparison in the Table 1 the preference should be given to NMEA 2000.

Some manufactures of marine installation already produce VHF/DSC transceivers with NMEA 0183/2000 DSC supporting interfaces.

Convergence of technologies may require a similar approach to some navigational and communication elements. The existing system of standards setting may not be suitable in all cases to all modernized elements, due to the rapid change and increasing use of software based systems. The proposal of the ECDIS/AIS integration with the VHF/DSC requires corresponding amendments which should be added only in the ECDIS performance standards. Industry would be actively involved in developing that kind of modernization only after the adoption of corresponding amendments.

Of course, the wholesome conservatism is warranted by aspiration of maritime community to safe navigation. But the progress in the commonly used info-communication technologies should be taken into consideration again for the sake of maritime navigation. Common placed computer actions are perceived friendlier than particulars of DSC functions in VHF/DSC radios from various manufactures.

3 CONCLUSION

Presented ECDIS modernization and its interfacing to VHF/DSC transceiver essentially simplify an active address communication and reliable vessels identification in relation to current navigating conditions. Effect is achieved by eliminating manual operations on DSC forming replacing them by clear and understandable actions on ECDIS display according to standard computer operations.

The proposed technology realizes one of the basic principles in execution of communication and navigation tasks: transition from handling with raw data to clear understandable information at ECDIS display.

Implementation is based on standard conventional ship born installation. Only two additions are needed: 1) software ECDIS updating and 2) interconnection ECDIS – DSC via NMEA protocol, providing the DSC controller supports this interface.

The proposed integration makes free mariners from DSC complexity by replacing routine manual functions by "smart" system that could execute automatic detection free/open working channel.

The proposed system establishes standard interface for communication operations on a base of ECDIS. Currently DSC controllers differ with regard to user interface. Integration them to ECDIS would resolve the problem of "unfriend" DSC interface.

No appreciable expenses from ship-owners have to be undertaken because the proposal is grounded on existing standard installation and requires only software updating and ECDIS – DSC cabling without any additional equipment.

The discussed modernization has been formulated in the proposal to Maritime Safety Committee [9]. Proper amendments in ECDIS performance standards must be done for implementation ECDIS/AIS – VHF/DSC integration.

REFERENCES

[1] A. Weintrit. The Electronic Chart Display and Information System (ECDIS): An Operational Handbook. – CRC Press/Balkema, 2009. – 895 p.
[2] Simplification of DSC equipment and procedures. Submitted by Finland / Sub-Committee on Radiocommunications and Search and Rescue 8/4/1, 27 November 2003.
[3] M.V. Miyusov, V.M. Koshevoy, A.V. Shishkin. "Increasing Maritime Safety: Integration of the Digital Selective Calling VHF Marine Radiocommunication System and ECDIS", TransNav – *International Journal on Marine Navigation and Safety of Sea Transportation*, Vol. 5, No. 2, pp. 159 – 161, 2011.
[4] V.M. Koshevoy, A.V. Shishkin. "Enhancement of VHF Radiotelephony in the Frame of Integrated VHF/DSC – ECDIS/AIS System" / Marine Navigation and Safety of Sea Transportation. Navigational Problems. Editor A.Weintrit. CRC Press/Balkena, 2013. – 339 p.
[5] L. Alexander, S. Lee, A. Baranovski, T. Porathe. "Harmonised Portrayal of e-Navigation-related Information", TransNav – *International Journal on Marine Navigation and Safety of Sea Transportation*, Vol. 7, No. 1, pp. 39 – 43, 2013.
[6] L. Alexander. "e-Navigation, ECDIS and MIOS: At Present and in the Future". Electronic presentation. Available at http://iho.int/mtg_docs/com_wg/HSSC/CHRIS20/ENC-ECDIS_Seminar/6C-LA_e-Nav_ECDIS_and_MIOs.pdf
[7] Scoping exercise to establish the need for a review of the elements and procedures of the GMDSS. Shipboard User Needs. Submitted by the Nautical Institute / COMSAR 15/INF.3, 31 December 2010.
[8] O.J.Rodseth, M.J.Christensen, K.Lee. "Design challenges and decisions for a new ship data network", ISIS 2011, Hamburg, 15th to 16th September 2011. Available at http://www.mits-forum.org/resources/lwe-paper-isis-v9.pdf
[9] Proposal for an unplanned output dedicated to modernization of ECDIS. Submitted by Ukraine / Maritime Safety Committee, MSC 94/18/2, 26 July 2014