UDC 656.052.4

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ECDIS – VHF INTEGRATION IN RIVER INFORMATION SERVICES

Harmonization of River Information Services (RIS) is one of the key objectives of the EU transport policy. In order to implement the RIS system in the territory of the European Union, it is necessary to develop and deploy a communications system which will enable exchange of all the information required for safe inland navigation. RIS system modules must ensure integral data exchange, achieved through standardization of the applications and technologies used. One of the main characteristics of the RIS is efficient and reliable flow of information. It can be effectively achieved in real time through VHF communication, which is of key importance in maritime navigation and has been implemented to meet the requirements of inland waterway shipping services.

The strategies outlined in the relevant EU directives encourage the use of high-end radio communication solutions in the management of inland waterway traffic and transport. In this direction in Odesa National Maritime Academy, Maritime University of Szczecin, Poland, Vessel Traffic Station, port of Odesa and RIS Operating Centre in Szczecin, Poland the researchers on implementation of modern navigation and communication systems having been conducted during last years.

Electronic Chart Display and Information System (ECDIS) have proved its efficiency for save navigation. Inland ECDIS with connected Automatic Identification System (AIS) is potentially an important terminal component of RIS. In the paper [1] the classification of the electronic navigational charts, primary functions and performance standards for electronic chart systems for open sea, coastal, off-shore, harbour, sea-river and inland navigation are presented. The varieties and the problems connected with ECDIS utilization in the maritime (open sea, coastal and harbour) and inland navigation (rivers, channels, navigable lakes) and sea-river navigation areas are arisen. The title of article is inspired by the idea of making unified ECDIS standard for all above mentioned six water areas.

In the article [2] the importance of VHF communications for safe navigation and effective management in inland RIS is discussed. The feasibility of implementation of Global Maritime and Distress System (GMDSS) subsystems for integrated navigational data transmission in maritime and inland navigation at the Poland RIS centre has been discussed.

The aim of the present paper is application of integrated ECDIS – VHF system in inland and sea-river navigation, analysis of the achieved benefits and the design of a practical technical realization.

Methodology of VHF radiotelephone communication is grounded on utilization of two phases: call procedure and actually voice messaging. In GMDSS the first phase is assigned to Digital Selective Calling (DSC) system. For this purpose a special channel 70 (156.525 MHz) is dedicated to transmit exclusively short digital message with all priorities (distress, urgency, safety and routine). Subsequent radiotelephone communication is taking place on another – work – channel. Vessel's identification is produced in DSC format and duplicated by voice transmission.

Inland VHF of continental Europe doesn't use DSC. The first call phase is produced by the voice on watching channel 16, which is also used another messages with the highest priorities. The further messaging is coming on another working channel. Identification of transmitting station is produced verbally and digitally by means automatic transmitter identification system (ATIS) at the end of transmission after releasing push-to-transmit (PTT) button. ATIS transmits call sign or Maritime Mobile Service Identity (MMSI) of the transmitting vessel for duplication of voice identification or automatic message processing.

In spite of inland VHF communication in the countries of EU doesn't use DSC procedures, the proposed integration positively changes performances of VHF communication. The core problem of enhancing lies in ECDIS – DSC linking and adaptation ECDIS software for interaction with DSC controller.

At present inland and maritime VHF radiotelephony utilizes analog channel. In the future radiotelephone communication might be moved on digital channels. But whether analog or digital channels are in use the general methodology of communication is obligatory must be engaged: firstly call, then conversation. This methodology is supported also in other communication systems, for example, in commonly used mobile telephony. Could you imagine if smartphone user personally choses channels for conversation?

For communication by means VHF radiotelephony voice or DSC in coastal waters is needed. But in congested navigation these methods do not provide suitable communication because of inherent complexity and unfriend DSC interface in practical applications especially in extraordinary ship-to-ship communications and intense VTS radio traffic, when targeted, smart and clearly understood voice communication is necessary.

Appropriate integration and data processing from navigational ECDIS/AIS and communication VHF/DSC parts allows obtaining the new

abilities of cooperative application of ECDIS/AIS and VHF/DSC installation which unable in its single utilization. The proposed integration would:

eliminate need of manually set up the DSC call. Instead, clicking on the vessel's AIS mark on the ECDIS would automatically initiate the necessary actions to establish the DSC call;

automatically identify the calling vessel on the electronic chart, thus making it immediately obvious to the recipient who is calling and their position relative to the navigation situation. This would allow the officer-of the-watch to give prompt consideration the situation and make more effective decisions; and

open addressed voice communication, without wasting any time on clarifying communicating parties.

Integration ECDIS/AIS – VHF/DSC was suggested and further discussed for maritime application in the papers [3 – 5]. ECDIC and AIS are also used in inland navigation. On internal water of continental Europe DSC is not used, but for rivet-sea navigation this system is obligatory. For RIS the proposed integration gives the following user benefits which are explained below:

Elimination of manual operations;

Loading and mistakes reduction;

Smart addressed voice communication;

Standardized human-machine interface;

Direct identification of calling ship;

Compatibility;

No additional installation and procedures.

Elimination of manual operations. Terrestrial communication in the GMDSS hasn't automatic connection of subscribers. To organizing voice communication ship (or shore) station must make digital call to needed station, receive acknowledge and after that conduct telephone exchange on the working channel which was established in the call or acknowledge. All operations for forming calls must be executed by operators manually on the background of assessment of current navigation situation. Such situation is in obvious contradiction to the basic principle of e-Navigation which states that navigator has to operating with information, but not with numerical data. It is very important to pay attention on definitions of notions "Data" and "Information" as given in [6]:

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 presented in a manner which is understandable to humans.

In our design we just avoid operations with a raw numerical data (MMSI, position), but use only information directly presented in understandable to navigator form on an ECDIS screen.

Loading and mistakes reduction. In the congested environment and especially operators of Vessel Traffic Systems (VTS) suffer from a great loading. Any mistakes in DSC operations are inadmissible because of safety degradation. In a common system to communicate with a needed ship should: 1) determine MMSI of the desired ship from AIS, ECDIS or another manner and keep in mind or write down 9-digit number; 2) form DSC call at VHF/DSC installation using its keyboard interface and enter the needed MMSI, working channel, other details of DSC format. Minimum twenty elementary pressings are necessary for typical DSC forming. During these actions the various errors are possible including confusion vessels, entered numbers, etc. The proposed integration would minimize such mistakes and correspond with the principles that underpin IMO's e-Navigation concept [7]. 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".

Shore facilities and ship operators will have more economical and efficient instrument for exchanging the information they need for the safe and effective operation.

Smart addressed voice communication. DSC supports rate of 1200 bps in VHF band. The whole call takes in air about 0.7 sec. Acknowledge takes the same duration. But really access to addressed voice communication is much longer because of manual manipulations on the both sides of communication. That's why in urgent situations navigators usually ignore DSC and instead at once pick up the telephone on channel 16. However, shunning DSC and switching to VHF telephone does not really improve matters. Time is wasted trying to establish who needs to talk to whom. The navigator making the call has to quickly and clearly announce their intended recipient, while officers-of-the-watch (OOW) on vessels in the vicinity need to discriminate whether or not they are that recipient, based on an understanding of their location and other traffic in the area.

Instead, the proposed integration makes VHF communication as click-to-talk procedure without any violation DSC protocol.

When a necessity for establishment VHF communication appears in extraordinary situation, the navigator needs to be able to count on quick ac-

cess 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.

Consequently, in its present incarnation DSC/radiotelephone does not lend itself to quick operational communication and needs to be modified.

Keyboard of DSC controllers is not standardized. Numerous producers of DSC devises carry out their keyboard input interface in a different way that requires specific training of mariners in the GMDSS courses. But IMO model courses provide only common training on the base of any DSC producer. Variations in DSC operation make user rejection of DSC devices in VHF communication.

Instead coming to unified commonly utilized computer interface it would make DSC operation more user friend and intuitively clear. As pointed in [7] users require uniform and consistent presentations and operation functionality to enhance the effectiveness of internationally standardized training, certification and familiarization. It is not accidently that Nautical Institute has proposed S-Mode concept to manipulate with standard information presentations, menu and functions. S-Mode is not considered as a simplified or restricted display mode, but instead offers a high degree of functionality. If DSC function were introduced in standard ECDIS functions it would eliminate all problems of DSC keyboard variety. Anyone trained in the use of S-Mode with included DSC function would therefore be competent and confident to make the best use of navigation systems on any ship so equipped.

Direct identification of calling ship. In separate DSC system calling station transmits number of working channel or position. An operator of the receiving station has to somehow correlate current position of the calling vessel, its course and speed to adequate appreciation of navigational environment. In the proposed system this operation is executed by means automatic identification the calling vessel on the electronic chart, thus making it immediately obvious to the recipient who is calling and their position relative to the navigation situation. This would allow the OOW to give prompt consideration the situation and make more effective decisions. This advantage is especially useful for VTS centers and Rescue Coordination Centers when distressed vessel is identified by blinking red mark.

Compatibility. The proposed ECDIS – DSC fusion ensures internal and external compatibility. Internal compatibility implies regular interaction with existing navigational and communication equipment. The new connection ECDIS – DSC hasn't any effect on appropriate operation of other devises. And what is essential is that the present manual method of making/viewing calls is preserved as a supplementary means to the automatic

method of making calls in the integrated system. If necessary, all components of integrated system may be used separately in regular regimes.

External compatibility means interaction with DSC and AIS devices another ship and shore stations, not equipped with the proposed system. Integrated ECDIS/DSC and standard systems cooperate with each other without any deviation from existing regime. Therefore it is reasonable to introduce new system step by step, beginning from VTS equipping.

No additional installation and procedures. The integration ECDIS/AIS – 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 ECDIS software updating and standard NMEA cabling are necessary to implement DSC function.

The problem is that interconnection between standard ECDIS and DSC installations doesn't foreseen. To realize ECDIS – DSC integration by optimal way, the scheme shown in Fig. 1, *a* was designed [4].

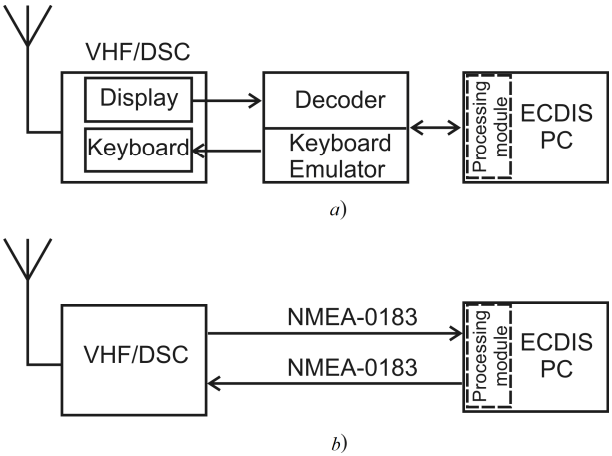

Fig. 1. Integration of ECDIS and DSC installations

For experiments DSC modem RM-2042 (Sailor) was utilized. To implement automatic forming of digital call a special interface was projected. This interface doesn't need any invasions into hard and soft wares of the DSC modem. The main idea of the interface is based on electronic emulation of key board and signal decoding from liquid crystal display (LCD)

matrix. Principle of its operation consists in electronic emulation of button pressing instead of physical pushbuttons. The emulator is driven by appropriate command sequence from ECDIS personal computer. Received DSC outputted from LCD matrix is processed in decoder. Extracted data (MMSI, Format Specifier) are inputted in ECDIS PC for further processing. The processing module is completely software worked out and included in the modernized ECDIS software [5].

Advantage of such interfacing is that it is suitable for DSC controller which doesn't support DSC NMEA sentences. This interface was utilized only for laboratory testing of additional software for ECDIS – DSC integration. The designed integrated ECDIS/AIS - VHF/DSC complex has convincingly demonstrated the possibility of practical implementation and advantages of the discussed integration.

For further progress into practical implementation it is proposed connection on the base of standard NMEA-0183 (National Marine Electronics Association) interface and its international version IEC 61162-1/2 (Fig. 1, *b*).

Presently NMEA-0183 is widely used for interconnection of various maritime navigational devises. It is one directional, one talker and several (up to 10) listeners; supports rate 4.8 kbit/sec (38.4 kbit/sec for version NMEA-0183HS).

In the NMEA-0183 interface data transmission is realized by means transferring information packets named as sentences. There are 4 sentences that officially approved for DSC utilization [8]:

DSC – Digital Selective Calling Information,

DSE – Expanded Digital Selective Calling,

DSI – DSC Transponder Initialize,

DSR – DSC Transponder Response.

Format of DSC sentence is presented in Fig. 2. It completely coincides with technical format of digital selective calling and can be used for bidirectional interaction between ECDIS and DSC controller.

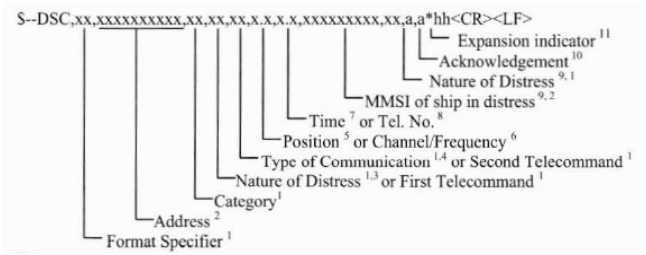

Fig. 2. Format of DSC NMEA-0183 sentence [8]

At the present time it is known VHF transceivers, for example, GX2000/GX2150 [9] which support NMEA-0183 output sentences DSC and DSE. We don't know whether transceivers which support input DSC sentence is manufactured, but it is quite obvious that there is no any obstacles for industry to build in this interface in the VHF transceiver.

Notes to Fig. 2.

1. Use two least-significant digits of symbol codes in ITU-R M.493 Table 3.

2. Maritime Mobile Service Identifier (MMSI) for the station to be called or the MMSI of the calling station in a received call. For a nine-digit MMSI "0" shall be added as the tenth digit. For calls to a geographic area the area is coded in accordance with ITU-R M.193 paragraph 5.3 and Fig. 6. System configuration (wiring) and the Talker ID are used to confirm if the sentence is transmitted or received. The MMSI of the calling station for transmitted calls is inserted automatically in the ITU-R M.193 transmission at the radiotelephone.

3. Distress calls only.

4. Distress, Distress Acknowledgment, Distress Relay, and Distress Relay Acknowledgment calls only.

5. Latitude/longitude, degrees and minutes, 10 digits, coded in accordance with ITU-R M.493 paragraph 8.1.2.

6. Frequency or channel. six or twelve digits, coded in accordance with ITU-R M.493 Table 13.

7. Time (UTC) of position, four digits, hhmm (hours and minutes).

8. Telephone number, 16 digits maximum, odd/even information to be inserted by the DSC equipment.

9. For Distress Acknowledgement, Distress Relay and Distress Relay Acknowledgement calls only, null otherwise.

10. Acknowledgement type: R = Acknowledge Request; B = Acknowledgement; S = Neither (end of sequence).

11. Expansion indicator "E", null otherwise. When set to "E" this sentence is followed by the DSC Expansion sentence $--DSE, without intervening sentences, as the next transmitted or received sentence.

Presented ECDIS/AIS – VHF/DSC integration and combined data processing in the modernized ECDIS gives to user on a vessel and shore cervices new abilities in VHF/DSC communication, navigational decision making and management in VTS and RCC systems. It eliminates manual routines in VHF/DSC radiotelephony and transforms DSC operations in automatic regime. Presentation of DSC radio activity on ECDIS display in real time facilitates the most effective decision making by an officer-of-the-watch or operator VTS and RCC, especially in the hard traffic.

The proposed integration rids an OOW off the complex and prolonged manual operations and raw data utilization. It brings down the loading on operator and human errors while increasing general safety, effectiveness of VTS management and RCC immediacy.

Analysis of testing of laboratory complex showed that there are no any technical obstacles for practical implementation of the proposed integration. All processing operations may be implemented on a soft level and included in updates of ECDIS software.

Physical interconnection is executed as standard NMEA-0183 interfacing between ECDIS and VHF/DSC devices. Therefore financial expenses for ship owners to install the proposed integration are minimized.

The main factor should be settled – introduction of corresponding amendments which should be added only in the ECDIS performance standards. Industry would be actively involved in developing that kind of modernization after the adoption of corresponding amendments.

This suggestion is fully compatible with the e-Navigation development strategic direction which envisages further development and integration means of radiocommunication and navigation and the implementation of modern digital information technologies in navigation.

REFERENCE

1. Weintrit A. Six in One or One in Six Variants. Electronic Navigational Charts for Open Sea, Coastal, Off-Shore, Harbour, Sea-River and Inland Navigation //TransNav – International Journal on Marine Navigation and Safety of Sea Transportation. – 2010. – Vol. 4. – № 2. – P. 165 – 177.

2. Lisaj A. Maritime Communications in RIS System for Inland Navigation //TransNav - International Journal on Marine Navigation and Safety of Sea Transportation. – 2015. – Vol. 9. – № 2. – P. 287 – 291.

3. Miyusov M.V., Koshevoy V.M., Shishkin A.V. 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. – 2011. – Vol. 5. – № 2. – P. 159 – 161.

4. Koshevoy V.M., Shishkin A.V. Enhancement of VHF Radiotelephony in the Frame of Integrated VHF/DSC – ECDIS/AIS System // Marine Navigation and Safety of Sea Transportation. Navigational Problems. – CRC Press/Balkena, 2013. – 339 p.

5. Koshevyy V., Shyshkin O. Modernization for Enhancing Addressed VHF Communication //TransNav, – International Journal on Marine Navigation and Safety of Sea Transportation. – 2015. – Vol. 9. – № 3. – P. 327 – 331.

6. Alexander L., Lee S., Baranovski A., Porathe T. Harmonised Portrayal of e-Navigation-related Information //TransNav – International Journal on Marine Navigation and Safety of Sea Transportation. – 2013. – Vol. 7. – № 1. – P. 39 – 43.

7. Patraiko D., Weintrit A. e-Navigation and the Human Element //TransNav – International Journal on Marine Navigation and Safety of Sea Transportation. – 2010. – Vol. 4. – № 1. – P. 11 – 16.

8. NMEA 0183 Standard for Interfacing Marine Electronic Devices. Version 4.00. November 1. – 2008. – 236 p. http://www.worldcat.org/title/nmea-0183-standard-for-interfacing-marine-electronic-devices/oclc/768778517.

9. Matrix series GX2000 and GX2150 25 Watt VHF/FM Marine Transceivers. Owner's Manual. – 2012. – 144 p.