UDC 656.052.4

NOVEL FUNCTION OF ECDIS FOR SMART VHF COMMUNICATION

Koshevoy V.M., Shishkin A.V.
Odessa National Maritime Academy

Presently Electronic Chart Display and Information System (ECDIS) is stage-by-stage introduced on all marine merchant vessels. Due to its connection to various navigation sensors the ECDIS plays as the prime navigational mean of modern shipping. Further integration of ECDIS with the Very High Frequency (VHF) radio installation allows to enhance efficiency and operability of radio communication to increase safety of navigation.

The aim of the present paper is designing the new ECDIS function, that provides interaction with the Digital Selective Calling (DSC) controller of radio communication.

To implement this ECDIS function it is proposed to introduce modules for forming and processing DSC messages, module of Automatic Identification System (AIS) target marking and also input and output information ports by way of the connection to DSC controller is provided.

The obtaining advantages due to realization the new ECDIS function are analyzed. They are expressed in the eliminating of hand operations with the DSC controller and replacing them by automatic call forming, increasing efficiency of navigation situation analysis while simultaneously lowering the risk of "human factor".

In the article practicable maritime interfaces for DSC controller interconnection and symbols for displaying AIS targets are also considered and it's reflection in the case of DSC activation for different radio communication priorities is proposed.

Keywords: Electronic Chart Display and Information System, Digital Selective Calling, Automatic Identification System, radiocommunication

Introduction. Electronic Chart Display and Information System (ECDIS) [1, 2] is one of the most important navigation and decision support tools, in the high degree due to the ability of integration with the other systems and peripheral vessels equipment. Integration of various systems, development of the concept of the integrated navigating bridge allows to operate a vessel from one workplace – operator ECDIS. Another important tool in contemporary marine navigation is Automatic Identification System (AIS). The AIS gives to navigator officer the possibility of watching vessels in the vicinity on ECDIS display in the case of its linking to ECDIS. The progress in real time digital signal processing of radar images has made possible imposing these images upon electronic charts. Therefore AIS and navigational radar mutually supplement each other and eliminate the drawbacks of separate systems for the sake of navigation safety. It is already evident from the benefits of linking AIS, radar and ECDIS that appropriately integrated systems give a synergy effect. Alongside the intrinsic advantages gained by combining these instruments, such integration corresponds to the principles that underpin IMO's e-navigation concept [3]. Integration of various systems around the ECDIS allows to optimize control of a vessel, avoid possible misses and incorrect decisions of the navigator because of so called «human factor».

From the other hand maritime Very High Frequency (VHF) communication suffers from some drawbacks. Terrestrial (not satellite) communication in general and VHF particularly is based on Digital Selective Calling (DSC) technology. DSC is one of the core subsystem in Global Maritime Distress and Safety System (GMDSS). In accordance with GMDSS communication all radio telephone transmissions of any priority (distress, urgency, safety and routine) must be preceded by the proper digital selective call. Nevertheless, the procedures of radiocommunication with the use of DSC are often neglected either in cases of distress or with other priorities. In particular, VHF channel 16 is often used incorrectly for any calls attributed with routine priority as it was foreseen in the old (before GMDSS) system procedure instead of using DSC on channel 70. Shortcomings of VHF communication using DSC or VHF/DSC in abbreviation in its present state have been analyzed in document s [4 - 6]. In the document [5] and paper [6], in particularly, some measures towards simplification of VHF/DSC communication were proposed.

Taking into account the technical possibilities of ECDIS/AIS system and imperfection of VHF/DSC radiotelephony the next step in gaining the efficiency of ECDIS, to our opinion, gives the opportunity of linking ECDIS/AIS to VHF/DSC radio installation.

Aim of the paper. The main aim of this paper is designing innovative function of ECDIS that provides smart VHF communication under standard operational DSC procedures and preservation the up-to-date radio installation. Benefits from such function implementation in practical navigation and shore infrastructure are considered. Some decisions of technical interfacing and marking of calling AIS targets are also proposed.

Results of investigations. Maritime VHF communication in the GMDSS includes two stages: 1) preparing stage, which includes call on the channel 70 indicating the working channel by means of DSC controller, and 2) properly voice communication on the stated working channel after receiving appropriate acknowledge. In the other communication system with automatic switching of channels the first phase is realized beyond operator activity. The user doesn't make any actions for channel setting and not feeling this process at all. Unfortunately in the maritime communication all this burden falls on a navigator. After GMDSS coming in force DSC channel 70 became a calling (and watching) channel in VHF band instead of voice channel 16, but this introduction didn't solve the main problem of work channel settings.

Many additional manual actions and time are needed to establish the communication which slows down the speed of information exchange and decreases the safety of navigation especially during ship manoeuvres. Only entering Maritime Mobile Self Identity (MMSI) demands 9 push buttons. In general making DSC includes about 20 elementary manual operations on control panel.

In a pressing situation, for instance, when a ship intends to make any manoeuvre and there is a nearby ship which makes an obstacle to this, navigators, as usual, neglect DSC process and directly pick up the telephone on channel 16. Such elimination of DSC does not accelerate reliable and correct VHF communication because a lot of time may be needed for called/calling vessel's verbal identification among other vessels. The calling vessel has to explain verbally which vessel it wishes to call and this very called vessel must quickly understand that it is addressed to it by exactly this calling vessel (along with its location among other vessels). As mentioned in document [4], «it is sometimes necessary to call an unknown vessel, e.g.: The vessel next to … buoy, this is …, what are your intentions?» and «any DSC call, however simple it would be, would require more time than picking up the handset and making a call on radiotelephony».

Consequently, DSC is not suitable for quick operational communication with chosen vessel and needs to be modified. In any case, using or neglecting of DSC, VHF radiotelephony has a drawback apparent in the lack of prompt, clear and reliable identification of the called/calling vessel.

Overcoming this drawback is achieved within the framework of the currently used vessel equipment through the integration of the navigation equipment ECDIS/AIS and DSC controller. In this case, all of the basic functions of integrated systems are preserved.

The combination of the ECDIS/AIS system with the VHF DSC equipment allows:

– to eliminate just the routine procedure of DSC making while replacing them by a computer mouse click (or trackball action) on the ECDIS vessel's AIS mark and then a DSC call to chosen vessel is produced at once automatically;

– to provide the identification of a calling vessel on the electronic chart and thus to make immediately the process of attachment of the calling vessel to the navigation situation automatically. A calling vessel can be indicated on the display by a blinking mark which will allow officer of the watch (OOW) of the called vessel to quickly estimate the navigational situation and make an effective decision; and

– after that, pick up the handset and conduct an address radiotelephone communication and not waste any time on verbal identification of communicating vessels.

Another words the discussed integration allows excluding the manual routine of the first stage and exchange it by intuitively understandable «click-to-talk» operation on ECDIS monitor. This approach releases an OOW who is not professional radio specialist from keeping in mind and entering MMSI and other features of DSC message. All necessary operations for DSC forming are executed automatically.

Integration of the ECDIS/AIS and VHF/DSC requires no changes to the existing radiocommunication operational procedures (If necessary all components of integrated system may be used separately in regularly 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. Only two additional functions for ECDIS are needed to be implemented:

1) providing the DSC automatically directly from ECDIS. The parameters, for example, the working channel number, can be set by default (or can be chosen manually if necessary using standard computer actions). The entering of the MMSI is not required at all because AIS data already have it and MMSI can be sent to the DSC controller automatically; and

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

The above mentioned functions were software-based implemented as presented in fig. 1. An innovative ECDIS functions are realised in the dot lined modules. Standard ECDIS comprises Processing block with Electronic chart storage block, Monitor and external information transducers: Radar, AIS, GPS receiver, Log and Gyrocompass. In a case of DSC call OOW should only select the vessel to which he intend communicate. It is not necessary to look for MMSI of the called vessel because it already known from AIS information. All necessary operations for calling message assembling are provided in the DSC message forming module. Calling sequence is directed through the Output information port to the external DSC controller.

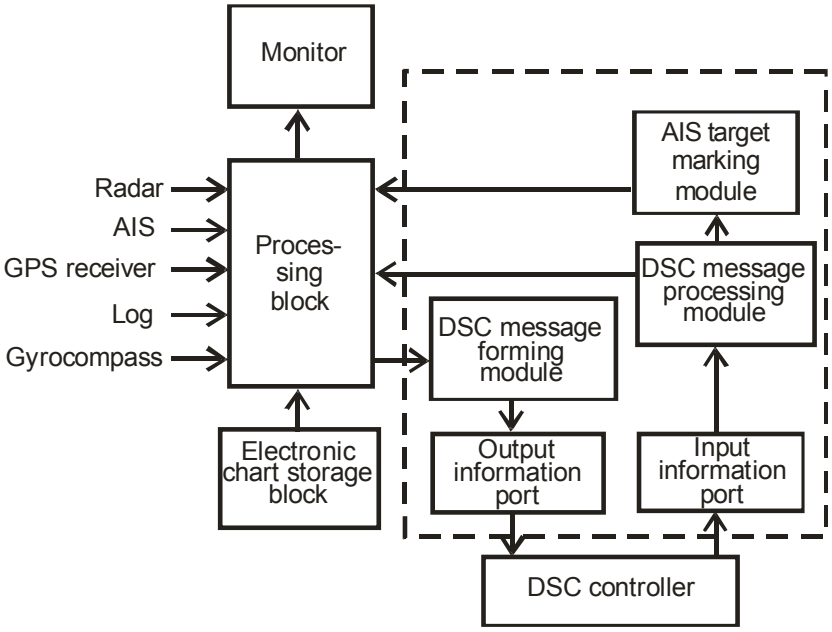


Figure 1 – Block scheme of ECDIS with DSC interaction function

The second new ECDIS function supports information received from DSC controller. In a case of getting relevant to own vessel DSC call the received sequence is directed through Input information port to DSC message processing module. Comparing MMSI from DSC controller with AIS target MMSI makes possible to mark the calling vessel among another 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.

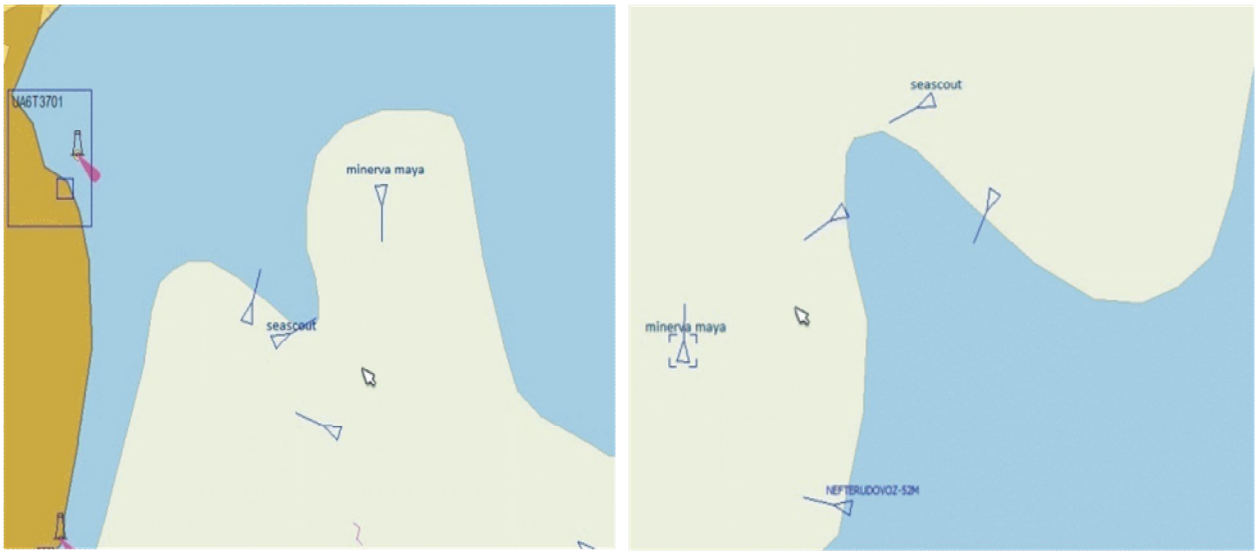
The involved tools and achieved new qualities in making addressed communication using ECDIS as interface for the communication means allow to name this type of communication as COMEC (Communication on the base of Electronic Chart). The proposed method was protected by national patents of Ukraine [7, 8] and patented in Germany [9].

Simulated navigation environment is presented in fig. 2. In this figure is given print screen for m/v Minerva Maya ECDIS on the first step, when she is calling to m/v Seascout. For Minerva Maya the vessel Seascout presents a potential risk. Therefore the vessel Minerva Maya must call just vessel Seascout to coordinate maneuver. Routine for Minerva Maya navigator consists in clicking Seascout AIS-mark, selection/default working channel in the menu and finally approving the DSC transmission. DSC format forming is produced automatically and any actions to DSC number identification at that are not necessary. All actions are executed quickly using standard computer methods which are not connected to DSC unit key boards of different manufactures.

In the fig. 2 ECDIS print screen at m/v Seascout is shown. AIS-mark of vessel Minerva Maya is blinking, pointing that it is the calling vessel. Seascout OOW is able to simultaneous estimation of navigation situation and acknowledge to calling vessel. After that vessel Minerva Maya begins an addressed communication without wasting time for ship's identification.

An additional automatic identification of radiotelephone transmissions in the frame of COMEC gives us one more aspect of the discussed integration. AI of radiotelephone transmissions on ECDIS is a developing of COMEC. AI on the base of «audio watermarks» is analysed in [6]. AI have to provide identification data of currently transmitting vessel in the form of Maritime Mobile Service Identity (MMSI) or/and ship's name/call sign. These data have to be passed from VHF equipment with AI function to ECDIS. Then the detected identification data should be compared with AIS target information and the transmitting vessel might be singled out among other vessels by special mark. This question is discussed below.

Implementation of the design ECDIS demands for 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) [10, 11]. Presently NMEA 0183 is widely used for interconnection of various maritime



a) b)

Figure 2 – Simulated navigation environment in COMEC system:
a) view from m/v Minerva Maya: m/v Minerva Maya is making individual DSC call to m/v Seascout
b) view from m/v Seascout: Marking of the calling vessel at m/v Seascout

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 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 tab. 1.

Table 1 – Comparative interface 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 an 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 Table 1 comparison the preference should be given to NMEA 2000.

In the designed ECDIS all information related to DSC interaction is presented in separate graphical layer. As it is well known ECDIS operates with vector formats of graphical presentation. Therefore not obligatory kinds of visual information (inscriptions, AIS marks, radar image, etc) may be switched on/off. To be correct according to the ECDIS performance standards information available for displaying during route planning and route monitoring should be subdivided into the following three categories, Display Base, Standard Display and All Other Information. It is proposed to present all information relevant to DSC in the separate layer and display AIS vessel's targets by blinking figure.

Standard pictures for displaying AIS targets are shown in fig. 3. The next symbols are shown:

a) sleeping AIS target;

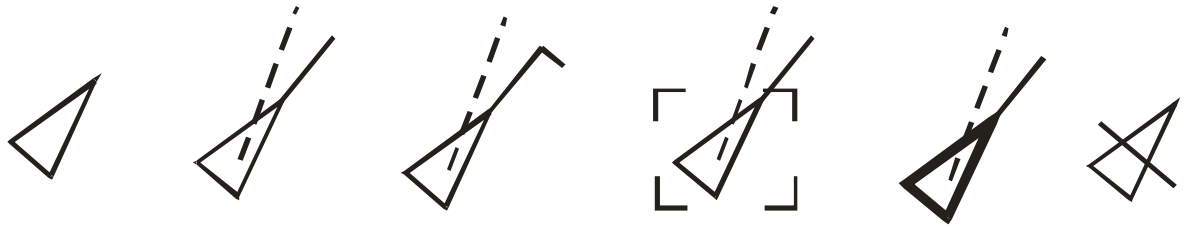
b) activated AIS target The COG/SOG vector should be displayed as dashed line starting at the centroid of the triangle The heading should be displayed as solid line of fixed length starting at the apex of the triangle;

c) a flag on the heading indicates a turn;

d) selected target. A square indicated by its corners should be drawn around the target symbol;

e) dangerous target. A bold line clearly distinguishable from the standard lines should be used to draw the symbol;

f) lost target.



a) b) c) d) e) f)

Figure 3 – Symbols for displaying AIS targets (SN/Circ.217 11 July 2001)

In our case the target that is calling by means DSC on channel 70 should be marked with blinking triangular AIS target. In the case of distress when the priority the AIS target should be coloured by red. In all other situations AIS targets are shown green as foreseen by ECDIS performance standards. Officer of the watch when received the call is able immediately estimate the navigational environment on ECDIS display, look through the containing in the DSC information and acknowledge if necessary the call again by means of trackball actions. The shouldn't turn his attention from watching navigation situation to DSC control panel and not wasting any time to the properly communication task but focusing entirely on navigation task. In this relation computer actions trackball are more intuitive understood rather than the manual operations with DSC controllers. Various control panels by different manufactures only complicate the situation.

After acknowledgement the blinking is stopped and navigator officer is able to communicate by radiotelephony again not wasting any time clarifying on what vessel he is addressing to.

Conclusions and perspectives for further studies. An experimental hardware-software complex VHF/DSC – ECDIS/AIS is worked out to implement the new function of ECDIS for clearly addressed and smart radiotelephone communication with DSC as directed in the GMDSS. The complex includes standard VHF/DSC controller RM-2042, AIS transponder MT3, specially designed software to customize ECDIS functionality for remote DSC controlling and bidirectional unconventional hardware interface for linking DSC controller and ECDIS personal computer. The necessity of this interface is caused by the absence of standard interfacing like NMEA for interaction with ECDIS. 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. If the DSC controller supports NMEA DSC sentences, then need to project additional hardware for interfacing is not necessary. But the software according Figure 1 for ECDIS – DSC interconnection is necessary in any way.

The experiments has demonstrated the full operability of the newly proposed ECDIS click-to-talk function. The proposed function doesn't have action upon another ECDIS functions and operations of DSC controller in standard regime. DSC overlaying function may be switched off, and DSC controller may be manually operated. All operational procedures are contained in the full scope, because the DSC sequence is forming automatically without any delay as in manual manner.

The proposed ECNIS function is especially effective for application in Vessel Traffic Systems (VTS) and Maritime Rescue-Coordination Centres (MRCC). VTS and MRCC operator is capable operating VHF communication as promptly possible from one ECDIS operator place. He is able to make situational analysis of navigational environment considering real time DSC activity in the area. Besides the coast infrastructure is not so strictly limited by IMO regulations as shipboard equipment. The functionality of VTS and MRCC doesn't depend upon vessel's ECDIS modernization.

The new ECDIS function is in full harmony with IMO strategic plan on e-navigation implementation because it responds to system integration principle and is compatible with standard installation without this function.

LIST OF THE USED LITERATURE

1. Вагущенко Л. Л. Интегрированные системы ходового мостика / Л. Л. Вагущенко. – Одесса : Латстар, 2003. – 169 с.

2. Weintrit A. The Electronic Chart Display and Information System (ECDIS) : An Operational Handbook. – CRC Press/Balkema, 2009. – 895 p.

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

4. Simplification of DSC equipment and procedures. Submitted by Finland / Sub-Committee on Radiocommunications and Search and Rescue 8/4/1. – 27 November 2003.

5. Proposal for simplification of VHF DSC radiocommunication and increasing DSC efficiency / Submitted by Ukraine / Sub-Committee on Radiocommunications and Search and Rescue. COMSAR 14/7. – 27 October 2009.

6. Miyusov M. V. Increasing Maritime Safety: Integration of the Digital Selective Calling VHF Marine Radiocommunication System and ECDIS / M. V. Miyusov, V. M. Koshevoy, A. V. Shishkin // TransNav, International Journal on Marine Navigation and Safety of Sea Transportation. – Volume 5, Number 2. – June 2011. – Pp. 159-161.

7. Патент 78762 (Україна). Пристрій для цифрового вибіркового виклику з підвищеною оперативністю / Кошевий В. М., Шишкін О. В., Заічко В. С. – Опубл. бюл. № 5/ 2007.

8. Патент 90497 (Україна). Інтегрована система цифрового вибіркового виклику / Шишкін О. В., Кошевий В. М., Заічко В. С. – Опубл. бюл. №9/2010.

9. Patent No. : DE 11 2007 003 617 T5 (Germany). Integriertes System eines digitalen Selektivrufs und einer elektronischen nautischen Seekartographie / Shishkin O., Koshevyy V., Zaichko V. – Date of Patent 03.12.2007.

10. Rodseth O.J. Design challenges and decisions for a new ship data network / O. J. Rodseth, M. J. Christensen, K. Lee ; ISIS 2011. – 23 p. : [Электронный ресурс] – Режим доступа : http://www.mits-forum.org/resources/lwe-paper-isis-v9.pdf

11. NMEA 0183. Standard for Interfacing Marine Electronic Devices. Version 4.00 – November, 2008. – 236 p. : [Электронный ресурс] – Режим доступа : http://http://www.plaisance-pratique.com/IMG/pdf/NMEA0183-2.pdf

Кошевой В.М., Шишкин А.В. НОВАЯ ФУНКЦИЯ ЭКНИС ДЛЯ БЫСТРОЙ УКВ РАДИОСВЯЗИ

В настоящее время электронная картографическая навигационная и информационная система (ЭКНИС) поэтапно устанавливается на все морские торговые суда. Благодаря подключению к ней различных навигационных датчиков ЭКНИС является важнейшим навигационным средством современного судовождения. Дальнейшая интеграция ЭКНИС с аппаратурой ультракоротковолновой (УКВ) радиосвязи позволяет повысить эффективность и оперативность радиосвязи в целях повышения навигационной безопасности.

Целью настоящей работы является разработка новой функции ЭКНИС, которая обеспечивает взаимодействие с контроллером цифрового избирательного вызова (ЦИВ) УКВ радиосвязи.

Для реализации данной функции в ЭКНИС предложено ввести модули формирования и обработки сообщений ЦИВ, модуль маркировки целей автоматической идентификационной системы (АИС), а также входной и выходной информационные порты, через которые осуществляется подключение к контроллеру ЦИВ.

Проанализированы преимущества, получаемые за счет реализации новой функции ЭКНИС, которые выражаются в устранении ручных операций с контроллером ЦИВ и замене их автоматическим формированием вызова, повышении оперативности анализа навигационной ситуации при одновременном снижении риска «человеческого фактора».

В статье также рассмотрены возможные морские интерфейсы для подключения контроллера ЦИВ, символы для отображения АИС-целей и предложена их маркировка в случае активации ЦИВ с различными приоритетами радиосвязи.
Ключевые слова: электронная картографическая навигационная и информационная система, цифровой избирательный вызов, автоматическая идентификационная система, радиосвязь.

Кошевий В.М., Шишкін О.В. НОВА ФУНКЦІЯ ЕКНІС ДЛЯ ШВИДКОГО УКХ РАДІОЗВ'ЯЗКУ

Сьогодні електронна картографічна навігаційна й інформаційна система (ЕКНІС) поетапно встановлюється на усі морські торговельні судна. Завдяки підключенню до неї різних навігаційних датчиків ЕКНІС є найважливішим навігаційним засобом сучасного судноплавства. Подальша інтеграція ЕКНІС з апаратурою ультракороткохвильового (УКХ) радіозв'язку дозволяє підвищити ефективність і оперативність радіозв'язку в цілях підвищення навігаційної безпеки.

Метою даної роботи є розробка нової функції ЕКНІС, яка забезпечує взаємодію з контролером цифрового вибіркового виклику (ЦВВ) УКХ радіозв'язку.

Для реалізації даної функції в ЕКНІС запропоновано ввести модулі формування і обробки повідомлень ЦВВ, модуль маркування цілей автоматичної ідентифікаційної системи (АІС), а також вхідний і вихідний інформаційні порти, через які здійснюється підключення до контролеру ЦВВ.

Проаналізовані переваги, що отримуються за рахунок реалізації нової функції ЕКНІС, які виявляються в усуненні ручних операцій з контролером ЦВВ і заміні їх автоматичним формуванням виклику, підвищенні оперативності аналізу навігаційної ситуації при одночасному зниженні ризику «людського фактору».

В статті також розглянуті можливі морські інтерфейси для підключення контролера ЦВВ, символи для відображення АІС-цілей і запропоновано їхнє маркування у разі активації ЦВВ з різними пріоритетами радіозв'язку.
Ключові слова: електронна картографічна навігаційна і інформаційна система, цифровий вибірковий виклик, автоматична ідентифікаційна система, радіозв'язок

Статтю прийнято
до редакції 9.04.14.