Overview of Standards for Electronic Navigational Charts

Pregled normi za elektroničke navigacijske karte

Dejan Lovrinčević
Hydrographic Institute of the Republic of Croatia, Split
e-mail: dejan.lovrincevic@hhi.hr

Ivka Kljajić
Faculty of Geodesy, University of Zagreb, Zagreb
e-mail: ikljajic@geof.hr

UDK 656.61:528.913
Stručni članak/ *Professional paper*
Rukopis primljen / *Paper accepted*: 11. 3. 2014.

Summary

In the early 1980s, with the rapid development of geospatial technologies the development of Electronic Navigational Charts – ENC began. With a heavy emphasis on data security, because of its navigational purpose, the implementation of ENC was approached very cautiously. One of the key features of every product, which enables easier global use, is its standardization. The paper provides basic information related to the ENC and by studying all editions of publications for ENC, the reports of the Working groups of the International Hydrographic Organization – IHO and articles that followed the implementation process of ENC standards an overview of ENC standards is given, with the focus on two basic standards published in S-57 and S 52 publications. Also described is a new, currently under construction, standard for ENC (S-100) and the prediction of the future development guidelines with the concept of e-Navigation in mind.

KEY WORDS
maritime navigation
ENC
ECDIS
standards
S-52
S-57
S-100

Sažetak

Početkom 1980-tih naglim razvojem geoprostornih tehnologija počeo je razvoj elektroničkih navigacijskih karata – ENC. S velikim naglaskom na sigurnost podataka, zbog svoje navigacijske svrhe, implementaciji ENC-a se pristupilo vrlo oprezno. Jedna od ključnih osobina proizvoda, koja olakšava globalnu primjenu, jest njegova normizacija. U radu se pružaju osnovni podaci vezani uz ENC te proučavajući sve verzije publikacija normi za ENC, izvještaje radnih grupa Međunarodne hidrografske organizacije – IHO i članaka koji su pratili proces implementacije normi za ENC dan je pregled normi za ENC s naglaskom na dvije osnovne norme objavljene u publikacijama S-57 i S-52. Opisana je i nova, trenutno u izradi, norma za ENC (S-100) uz predviđanje budućih smjernica razvoja u vidu koncepta sustava e-navigacije.

KLJUČNE RIJEČI
pomorska navigacija
ENC
ECDIS
norme
S-52
S-57
S-100

INTRODUCTION / *Uvod*

The development of information technology and the importance of spatial data have led to a large number of geoinformation systems. Maritime navigation has experienced a rapid development in accordance with the development of electronic systems. The pace of development of Electronic Marine Navigation Systems is controlled by the development of international standards. Electronic Navigational Charts as an essential part of the new navigation system required a thorough preparation of standards. These standards had to align the requirements of users (mariners) with the rules of chart production (cartographers) and thus raised their level of communication. The basic rule, given the uniqueness of the navigational charts in their preparation, is to ensure safety of the data. The wider range of possibilities for electronic charts has impeded the development of quality standards. The process of developing standards for electronic charts has gone through the initial phase of development, testing phase, the primary implementation and is now developing ideas in the form of upgrades to increase the interoperability of ENCs.

To the authors' knowledge, only the standard published in S-57 publication was described in the works of Croatian authors [16]; [3], while most of the information about the historical development of ENC standards is in the official publications [5]; [7]; [10] and Information papers about S-100 publication for IHO [17].

ELECTRONIC NAVIGATIONAL CHARTS / *Elektroničke navigacijske karte*

Electronic Navigational Chart – ENC enabled the development of quality alternative to paper charts. National Hydrographic Offices, by the recommendations of the IHO, are responsible for the development and maintenance of official charts in the

jurisdiction of the state and have to ensure the distribution system to the user. Hydrographic Institute of the Republic of Croatia (HHI) in Split, released 94 ENC (2014) of which overview, general and coastal charts with 100% coverage area, and the approach, harbor and berthing charts in the degree of coverage of about 80%, and is using one of two Regional Coordination Centers for ENC, PRIMAR Norway to provide distribution.

Maritime navigation is increasingly based on Electronic Chart Display and Information Systems – ECDIS. The first electronic charts and systems related to them have appeared in the early 1980s. These charts have been scanned and digitized reproductions of paper charts – Raster Electronic Charts. There are two basic types of electronic charts: those that are in accordance with the Standards of performance for ECDIS and all other types of electronic charts, generally regarded as the Electronic Chart Systems – ECS. Charts in accordance with the Standards of performance for ECDIS can be divided into two basic types: Raster Navigational Chart – RNC and Electronic Navigational Chart – ENC. The RNC is the file format of the image and is created by scanning existing paper charts. This type of chart is easier and cheaper, and for navigation with RNC it is necessary to have an adequate paper chart. The ENC is a file containing the data that a program for displaying electronic charts interprets and creates an image on the screen. These charts are complex and expensive, and do not require an adequate paper chart for navigation if at least two ECDIS are on board. The ENC is a chart derived from the database with standardized content, structure and format [4]. The ENC is a small part of a navigational system on board, system that in the last two decades experienced a significant improvement, and so paper charts and compasses are joined by GPS, radars, etc.

The ENC unlike paper charts allows automatic threat detection, route monitoring, speed and other parameters in real-time and updating is easier and faster. It can also contain additional information from a variety of publications (eg, information from Sailing Directions, List of Lights), necessary for safe navigation. Thus the quality of content in the ENC database is the foundation of navigational safety and requires strict control. ENC as a database and ECDIS as a complex system require a full range of well-defined standards to ensure first and foremost a minimum level of data safety and quality.

STANDARDS / *Norme*

The standardization of spatial information is important for the establishment of transfer between different users, applications, systems and locations. Creating and adapting standards should cover the processes and procedures of defining and describing data, structuring methods and encoding as well as procedures for the distribution and maintenance of data. This ensures a uniform flow of data from the producer to the user [1]. Standardization of spatial information takes place at several levels: at the national level (each country defines its own standards), regional level (Comité Européen de Normalisation – CEN) and international level (ISO).

ISO is an international non-governmental organization for standardization, which together with the IEC (International Electrotechnical Committee) and ITU (International Telecommunication Union) deals with the planning, development and elaboration of international standards. While the scope of the IEC and ITU is narrowly specific (electrical and telecommunications), ISO covers virtually all other areas. Acronym ISO does not denote the notion„International Standard Organization", how is often thought, but comes from the Greek word „isos" meaning „equally". Its geographical definition, ISO standards are considered to be global (international) standards. Today ISO gathers 163 members, i.e. national Committees for Standardization. There are three categories of membership: full members (attend meetings and have the right to vote, 112 members), corresponding members (attend meetings but without the right to vote, 47 members) and subscriber members (follow the work of the organization without the right to participate in meetings, 4 members). The work is organized by Technical Committees – TC and Sub-Committees – SC, within the committees work is organized by Working Groups – WG. Participation is open and free for everyone, so members can be scientists, businessmen, manufacturers, ordinary users, and others. ISO standards are voluntary in its use, and each state decides whether a particular standard is incorporated into its legal framework or the laws and regulations will refer to it as the technical basis [1].

For digital geoinformation standardization, in 1994. ISO technical committee under the number 211, called Geographic Information/Geomatics (ISO/TC211) was founded. The scope of work for the committee is to establish a structured set of standards concerning objects or phenomena that are directly or indirectly associated with the position of the Earth. IHO is among other organizations that develop spatial standards related to ISO/TC211. The standards define methods, tools and services for data management (including definition and description), data collection, processing, analysis, data access, display and transmitting data in digital/electronic form between different users, systems and positions. In Europe for the issue of standardization the competent organization is European Committee for Standardization (Comité Européen de Normalisation – CEN). In addition to CEN, dealing with standardization there are other international organizations such as Digital Geographic Information Working Group – DGIWG [2].

From the manufacturers of hydrographic data point of view, the need for standardization stems from the fact that the high cost of data collection (hydrographic survey) requires the exchange of information in order to avoid duplication of effort and cost. Collecting hydrographic data often consists of a large number of hours of field work, large financial amounts of ship and crews daily expenses and the time-consuming job of processing data and their quality control. In this context, the exchange of information between hydrographic offices is an absolute necessity in order to ensure higher data quality and reduce cost of their collection. From the users of hydrographic data point of view, mariners need uniformity on a global scale because by ocean navigation a number of different banks are visited and they are forced to use a large number of hydrographic data obtained from different manufacturers.

IN THE BEGINNING – ENC EXCHANGE FORMAT / *U početku – ENC format za razmjenu*

With the emergence of new technologies, such as ENC and ECDIS in hydrography, marine cartography and navigation, they go through the initial process of integration at the local level. ENC was initially an idea that has been developing in large Hydrographic Offices, and each office developed its software

to produce ENC in its own format. The need for data exchange between Hydrographic Offices was the starting point in a joint effort by IHO, IMO (International Maritime Organization) and ECDIS manufacturers to define a standard format for the exchange of hydrographic data.

The first step was the establishment of the Committee on the Exchange of Digital Data – CEDD. The committee was tasked to do research on the basis of then existing software for ENC production and then existing formats, analyze different hydrographic data display and propose a standard format for data exchange. In the XIIIth International Hydrographic Conference in Monaco in 1987, the committee presented the first standard format that describes the basic structure of the data and defines a new format for data exchange, DX-87. The description of data structures was upgraded very quickly in the form of adding a definition of topological relations and codes to define objects, resulting in a new format for exchange, DX-90. The standard format indicated the problem of data exchange between Hydrographic Offices, however implementation of the format in practice did not go satisfactorily due to the small number of software for a quality transformation from ENC defined in individual offices in to a new format for the exchange. It was concluded that defining an exchange format was only a small part the incompatibility problem because Hydrographic Offices, in the absence of standard definitions, edited the hydrographic data in different ways appropriate to their internal organizations [14].

When the ENC from one Hydrographic Office was transferred to another office a problem of data integration in their system would emerge, and it was concluded that the main obstacle for the integration is the lack of a common definition of hydrographic objects and their characteristics. There was also a problem of displaying the data on ECDIS. ECDIS, a system for displaying electronic charts was using Raster Navigational Charts, but the obvious intention was to implement ENC.

S-57 PUBLICATION DEVELOPMENT / *Razvoj publikacije S-57*

Transfer Standard for Digital Hydrographic Data is published in the Special publication No. 57, or S-57. Standard is the outcome of the IHO Committee on Hydrographic Requirements for Information Systems – CHRIS, and first edition became the official IHO standard at the XIVth International Hydrographic Conference in Monaco, 1992. The aim was establishing an effective exchange of hydrographic data and has been extended to the problem of developing a set of data for the implementation of official ENCs into a newly developed ECDIS. The S-57 1.0 used the implementation methodology of the International Standard ISO 8211. ISO 8211 is a specification document that describes details of the exchange of information and is used for standardizing the processing procedure of such information. It was primarily developed to define data exchange between the unadjusted computer systems.

The first step was the conversion of local data (ENC database – ENC DB) in the Hydrographic Office into then standard format for data exchange DX-90. Then distributors could distribute either in the data exchange format or in a format made especially for hydrographic data display on ECDIS called System Electronic Navigational Chart – SENC. If mariners received a chart in DX-90 format, then a subroutine in ECDIS made a conversion into SENC format for display on the screen [13].

The S-57 1.0 consisted of three parts A, B and C:

- A – contains a description of the coding scheme for the definition of concepts such as hydrographic models, object classes, attributes and symbolizing codes,
- B – contains an introduction to the ISO 8211 standard for data transfer, the connection between DX-90 and ISO 8211 formats, the data structure of DX-90 exchange data set,
- C – contains basic conventions during digitalization for generating DX-90 data set from analog data in navigational charts.

In practice the need to upgrade the first edition of the S-57 quickly revealed in form of a document that will describe in detail all hydrographic objects in the real world, i.e. Object Catalogue (S-57 Appendix A IHO Object Catalogue). An example of the object and attribute catalog can be found on the internet [18]. Object catalog consists of two chapters and defines object class and object attributes (approximately 190 attributes are defined). Object classes are divided into: feature objects and objects.

Feature objects contain descriptive characteristics of the object (approximately 180 feature object classes defined), while spatial objects contain positional information (coordinates, depth). Four types of feature objects are defined:

- Geo – consist of descriptive characteristics associated with objects in the real world, most of the objects: (159 objects),
- Meta – contains information about other objects (13 objects),
- Collection – describes relationships between other objects (3 objects),
- Cartographic – contains information about the cartographic representation of real world objects (5 objects).

Feature objects have a unique six characters acronym, such as depth area – DEPARE, land area – LNDARE, lateral buoy – BOYLAT. For each object class three sets of related attributes are defined:

- Attribute set A – describes the individual characteristics of the object,
- Attribute set B – contains information relevant to data usage, e.g. for data presentation,
- Attribute set C – contains administrative information about the object and its feature data.

Attributes also have the six characters acronym, such as object name – OBJNAM. By upgrading the first edition of the object catalog in March of 1994 a second edition of the S-57 was released as S-57 2.0. In November, 1994 at the Sixth CHRIS meeting the idea of developing detailed specifications for ENC was discussed (ENC Product Specification – ENC PS).

In February of 1995 IHO organized a workshop attended by ECDIS manufacturers and representatives of the Hydrographic Offices to define the content of the ENC PS and it was found that in order to meet all the requirements of ECDIS manufacturers and Hydrographic Offices, a new edition of the S-57 publication had to be made [5].

As a result of the workshop a new working group TSMAD (Transfer Standard Maintenance and Development Working Group) was established, which started preparations for S-57 3.0 and a new edition of the associated ENC PS. TSMAD met four times during 1995/96 to complete the job. Changes in the new edition compared to 2.0 include:

- new ENC cell structure concept,
- new data updating system,
- binary format implementation as in addition to ASCII,
- addition of four levels of topology for vector data.

S-57 3.0 organization was also changed so that it consists of three main parts and two appendices:

- 1) General Information,
- 2) Theoretical Data Model,
- 3) Data Structure,
- Appendix A) IHO Object Catalogue,
- Appendix B) ENC Product Specification.

The S-57 edition 3.0 for ENC became official in November 1996. One of the most important innovations was a updating system of data in the ENC and in SENC. This system enabled the issuance of IMO permission to navigate via official ENC data in accordance to the Law of the Sea, when such data are maintained using update system from the S-57 3.0 [15].

Due to the large number of changes, it was decided that the S-57 3.0 will freeze, remain unchanged for a period of 4 years from the date of its official issue, in order to make the application for the Hydrographic Offices and manufacturers of ECDIS easier. In this period of implementation the Hydrographic Offices noticed a number of attributes that should be introduced in the Object Catalogue, and so it was agreed that after a period of four years a new minor edition S-57 3.1 should be issued, which will include 38 new attribute values in the object catalog. The S-57 3.1 was officially released in November 2000 and was frozen for 2 years. The IHO has twice made small revisions in cooperation with the manufacturers. The first was released in January 2007 (S-57 3.1.1) and the second was released in June 2009 (S-57 3.1.2).

S-52 PUBLICATION DEVELOPMENT / Razvoj publikacije S-52

Parallel with the S-57 IHO was developing a new standard for the presentation of ENC content on ECDIS (Specifications for Chart Content and Display Aspects of ECDIS) published in the Special publication No. 52, or S-52. In November 1988 Colours and Symbols Maintenance Working Group – CSMWG was established to develop the first edition. Based on two years of research and testing in June 1990 the S-52 1.0 was presented.

The objective of S-52 is to contribute to safe operation of ECDIS by:

- ensuring a base and supplementary levels of display for ENC data, standards of symbols, colors and their standardized assignment to features, appropriate compatibility with paper chart symbols as standardized in the Chart Specifications of the IHO,
- ensuring the display is clear and unambiguous,
- ensuring that there is no uncertainty over the meaning of colors and symbols on the display,
- establishing an accepted pattern for ECDIS presentation that becomes familiar to mariners and so can be recognized instantly without confusion.

A first draft of the S-52 publication was given to the Hydrographic Offices and ECDIS users for a revision, and in accordance with their proposals in the next five years there were as many as 5 new editions. The most important change was in 1994. completing Annex A – Presentation Library. The Presentation Library contains detailed descriptions of colors and symbols, and a detailed description of ENC display, it links each object class and attribute within SENC format with the appropriate presentation on the ECDIS display [7].

- The latest edition of the S-52 publication 6.0 was released in March 2010. It consists of:
- The Specifications for Chart Content and Display Aspects of ECDIS, which describes the requirements and methods in relatively general terms,
- Annex A, the Presentation Library as a separate document,

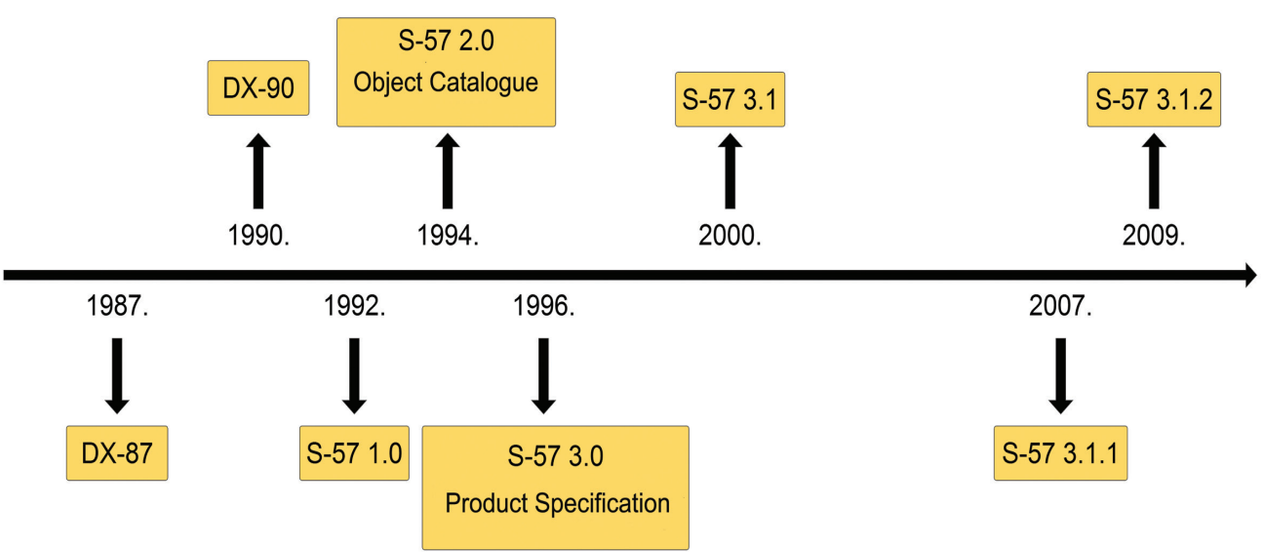

Figure 1. The S-57 publication development timeline
Slika 1. Vremenska skala razvoja publikacije S-57

- Annex B, which specifies procedures for initial color calibration of displays and the verification of that calibration,
- Annex C, which specifies a procedure for maintaining the calibration of displays,
- Appendix 1, Guidance on Updating the Electronic Navigational Chart.
-

OTHER STANDARDS / *Ostale norme*

The S-52 and especially S-57 were considered basic publications for ENC and for some time have been the only one. Over time some minor standards related to the ENC have evolved separately or from the S-52 and S-57, and all are available for downloading in publications at IHO site [19]:

- S-58, Recommended ENC validation checks,
- S-60, User's handbook on datum transformations involving WGS 84,
- S-62, List of data producer codes,
- S-63, IHO Data protection scheme,
- S-65, ENSs: Production, maintenance and distribution guidance,
- S-66, Facts about Electronic charts and carriage requirements.

The S-58 was previously Appendix B1, Annex C of S-57 Edition 3.1. in accordance with the IHOs decision to freeze the S-57 3.1 in November 2000, Appendix was isolated as a separate publication because of it's easier updating. The latest official version was released in February 2011 as S-58 4.2.0. The publication contains descriptions of the minimum checks manufacturers of ENC validity must incorporate. This software is used by Hydrographic Offices to ensure compatibility of their ENC data with the S-57, Appendix B1 product specifications for ENC [10].

All violations are defined as errors or warnings. Errors are defined as serious violations, or when the ENC data does not comply with the mandatory requirements of the ENC product specification, while warnings are defined as doubt of the accuracy of the data on the chart.

The S-58 4.2.0 contains a list of ENC data validation:

- checks relating to S-57 Data Structure,
- checks relating to ENC Product Specification,
- checks relating to ECDIS,
- checks relating to Use of Object Catalogue for ENC,
- checks relating to allowable attribute values for particular object classes.

The S-60 contains transformation constants and formulas to relate local/regional geodetic datum's to WGS-84. It was developed by the National Imagery and Mapping Agency – NIMA of the United States of America and it was ceded to be released as a special publication of the IHO. The first edition was released in June 1994, the second edition in November 1999, and the last official edition the S-60 3.0 in July 2003 with the last revision in August 2008 [6].

The S-62 data manufacturers list of codes was originally released in November 1996 as Appendix A to Annex A of S-57 as Codes for production agencies of IHO. As the list of codes is subject to change much more frequently than the S-57, subsequently was decided to publish it as a separate publication. It contains codes for IHO member states, codes for non-member states and codes for other relevant organizations.

The S-63, copyright infringement and unofficial distribution of nautical data were a serious danger of the digital age that the IHO had to face. At the 13th CHRIS meeting (Athens, Greece, September 2000) The Data Protection Scheme Working Group – DPSWG, which is responsible for making the scheme for data protection, and it was decided that the administrator of the standards will be the IHB (International Hydrographic Bureau). DPSWG presented the plan of development and CHRIS approved it in February 2002. The results were presented at the 14th CHRIS meeting (Shanghai, China, August 2002) and were sent to Hydrographic Offices.

In October 2003 S-63 1.0 was officially released. The publication was rebuilt twice, in March 2008 with the release of edition 1.1 and the last official edition in April 2012 S-63 1.1.1. The purpose of data protection is threefold:

- Piracy protection: to prevent unauthorized use of data by encrypting the ENC information,
- Selective access: to restrict access to ENC information to only those cells that a customer has been licensed for,
- Authentication: to provide assurance that the ENC data has come from approved sources.

Piracy protection and selective access are achieved by encrypting the ENC information and providing cell permits to decrypt them. Data Servers will encrypt ENC data provided by producer nations before supplying it to the Data Client. The encrypted ENC is then decrypted by the ECS/ECDIS prior to being reformatted and imported into the systems SENC. Authentication is provided by means of digital signatures within the data. The scheme allows for the mass distribution of encrypted ENCs on hard media (e.g. CD-ROM or DVD) and can be accessed and used by all customers with a valid license containing a set of permits [11].

The S-65 includes a guide defined by 10 basic steps needed to create, maintain and distribute ENCs. Additionally it contains a list of reference documents that serve as the basis for each step. The main purpose of the publication is to provide insight to Hydrographic Offices which are in the process of ENC creation (less developed countries) in the basic production processes in the preparation of ENC, and systems that must be in place to ensure production. Last official version S-65 2.0.0 was released in April 2012 [12].

The S-66, Joint Information Working Group – JIWG of Primar and IC-ENC Regional ENC coordination center – RENC issued in 2007 edition 2.0 of the publication by the same name. The IHO adopted the document in 2008 and in January 2010 released it as S-66 1.0.0. The publication was issued because the negative comments of ENC and ECDIS users (distributors, mariners, port authorities, etc.). The aim was to clarify all the information and tools on the market, which of them are official and which of them are in which situations mandatory for navigation [8].

FUTURE OF ENC STANDARDS (S-100) / *Budućnost normi za ENC (s-100)*

The IHO in the late 1990s saw the shortcomings of the S-57 concept. Although it proved to be a good standard that has enabled considerable development of ENC yet significant

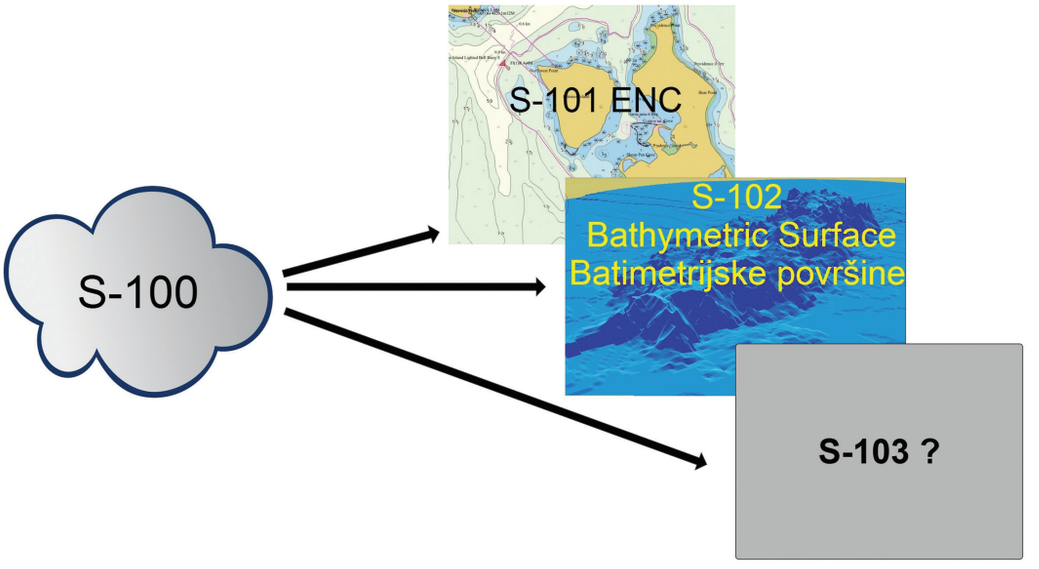

Figure 2. S-100 contains components for making different product specifications for all types of hydrographic data [9]
Slika 2. S-100 sadrži komponente za izradu različitih specifikacija proizvoda za sve tipove hidrografskih podataka [9]

restrictions were noticed:

- it is primarily developed to meet the requirements of ENC for deployment in ECDIS,
- it has an inflexible maintenance regime, repeated freezing of standards for long periods is counterproductive,
- the current structure of the standard does not support future technical requirements (grid bathymetry),
- installation of a data model within the format limits the flexibility and the ability to use a wider range of mechanisms for data transfer.

Because of these and other shortcomings CHRIS had planned a thorough revision of S-57 already in November 2000. Over the years, the use of S-57, many identified with the standard ENC product specification. This misconception has resulted in the conclusion of many in the ENC and ECDIS community that by a revision of the current standards radical changes in the current ENC would occur thus affecting the existing production. As that was not the intention, IHO replaced the name of the planned S-57 4.0 in 2005 to S-100: Universal Hydrographic Data Model.

Each publication subsequently released will follow the S-10n series, so that eventual issuing of a new product specification would follow as S-101 (Fig. 2) [17].

The TSMAD working group was put in charge to create and maintain the S-100 publication. Universal Hydrographic Data Model S-100 1.0.0 was officially released in January 2010 and it supports a much wider range of hydrographic data sources, products and customers. It is fully compliant with international spatial standards, especially with the ISO 19100 series of geographic standards and thus enables easier integration of hydrographic data and applications in geospatial solutions.

Other features include:

- Separating the data content from the carrier (file format). In this way, data can be manipulated and encoded without being permanently tied to a single exchange mechanism.
- Manageable flexibility that can accommodate change. The content of product specifications will be a subset of S-100, including separate feature catalogues. This allows the core standard to evolve (through extension) without the need to introduce new versions of product specifications.
- An ISO-conforming registry on the IHO web site containing registers for feature data dictionaries, portrayal and metadata. The registers accommodate both core hydrographic content and other chart related content, such as, nautical publications information.

All ISO standards developed by TC/211 are considered to be a part of the ISO 19100 series of spatial standards. For all types of spatial data these standards define methods, tools and services for development, management, processing, analyzing, accessing, sharing, and presenting information. Since January 2011 there are more than 50 standards in the 19100 series along with 20 additional standards in the development. These standards include the spatial and temporal schema, metadata, image and network data encryption, etc. The S-100 refers to a series of standards, and will be closely linked to all products and applications based on the 19100 series of standards (Fig. 3) [17].

A number of terms and definitions that were used in the S-57 3.1 have been changed to comply with the terms in ISO TC/211 standard. The most significant change is the introduction of the registry. Registry is designed as an information system within which there are secondary registers. Registry is a collection of tables in a database containing identifiers assigned to items with descriptions of related items. Descriptions may contain various types of information such as names, definitions or tags.

In the case of S-100, IHO has developed a registry on the internet [20] which enables a system to access and maintain a

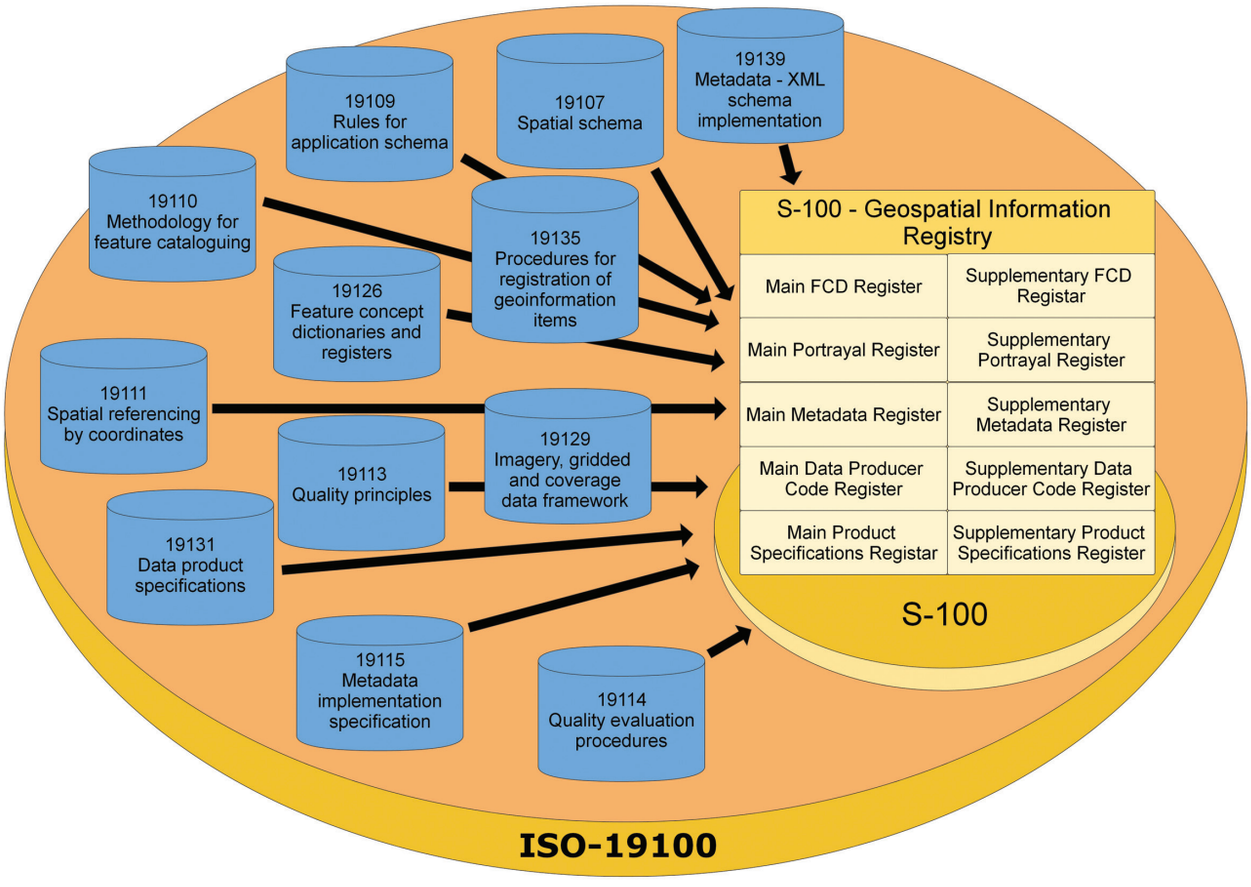

Figure 3. S-100 is compliant with the international ISO 19100 geographical series of spatial standards [9]
Slika 3. S-100 je usklađen s međunarodnim prostornim normama, serijom geografskih normi ISO 19100 [9]

variety of secondary registers.

Geospatial Information Register contains the following secondary registers:

- Feature concept dictionary – FCD,
- Portrayal register,
- Metadata register,
- Data producer code register,
- Product specification register.

IHO has, in order to make the implementation faster and easier, in January 2011 announced the publication Operational Pocedures for the Organization and Management of the S-100 Geospatial Information Registry also known as S-99 1.0.0. This publication describes the roles, responsibilities and procedures for the management and maintenance of S-100 and its secondary registers in more detail. ENC Data based on S-57 3.1 will continue to be official in the foreseeable future. Currently a ENC product specification based on S-100 named S-101 is in development. It is planned that the S-101 product specification system enables an updating system plug and play, improvements to symbols and software as well as more efficient use of additional data on the S-100. The S-100 and the S-100 product specification will take some time to work together with the S-57 3.1 and its product specification, so it is planned that all software related to ECDIS and ENC that are upgraded to S-101 are able to use data based the S-57 3.1 until the data based on old standards is no longer produced.

The IMO is planning in the future a new concept called e-Navigation, which is defined as: The Harmonized collection, integration, exchange, presentation and analysis of marine information onboard and ashore by electronic means to enhance berth to berth navigation and related services for safety and security at sea and protection of the marine environment.

For this purpose, IMO has established the Correspondence Group – CG for concept development and research of existing appropriate data structure. S-100 Geospatial Information Register was intentionally designed to be upgraded to the widest possible use of hydrographic data and other related data types. It is recognized that the S-100 Geospatial Information Register is suitable as the basis for the concept of e-Navigation. The CG stated in the beginning of 2011 in a report for the IMO that S-100 Geospatial Information Register should be used as a basic guide when designing e-Navigation concept, and subsequently if a more appropriate data structure isn't found to take into account the use of existing structures such as S-100 [17]. In this context, it is logical that the S-100 will play a key role in the organization of hydrography and other maritime disciplines in the near and distant future.

CONCLUSION / *Zaključak*

The standardization process for ENC is ongoing for about 30 years. Standards require constant re-evaluation and improvement as they must be in accordance with the technological development of the product.. We are in a transitional period were the whole navigation system could be improved on a global scale. Transitional periods are due to the

size and volatility of the market, always slow and difficult, from every aspect.

The aim of the study was to show how standards are developed, which organizations were involved in the beginning and what are involved today, what is the impact rating of users (mariners) and producers (hydrographic office) to changes in standards. The aim was also to draw attention to the whole system, which contains a number of people, institutions, regulations, meetings, specifications, which are often in the shadows, behind a product.

The future is already looming in the plans of the e-navigation concept. Despite the existence of technologies required for this innovative step, the challenge lies in ensuring access to all system components, including ENCs. Potential development of accurate and secure system of maritime information on land and at sea with global coverage is a worthy goal that will be developed in accordance with the S-100.

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