PROVISION OF NAUTICAL PUBLICATION INFORMATION IN AN S-100 BASED ECDIS

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SUMMARY

Since 2015, the IHO Nautical Information Provision Working Group (NIPWG) has built on over 10 years of work by the IHO Standardization of Nautical Publications Working Group (SNPWG) in developing product specifications for products which cannot be charted, but are nonetheless required for safe navigation.

Traditionally, Nautical Publications are provided as printed books, and due to the vital information they contain they are required to be carried by vessels obliged to comply with SOLAS V (Safety of Navigation). In an increasingly digital future, the challenge is how to provide the same information in a way that it can be integrated within ECDIS (type approved Electronic Chart Display and Information Systems) and other GIS (Geo-Information Systems) applications.

The IHO has developed S-100 as the Universal Hydrographic Data Model, with one of its main aims being the integration and interoperability IHO data types with wider ranging data, including that provided by IALA members.

This paper discusses current nautical publication information provision and the planned use of S-100 conformant digital products which will provide this information for passage planning, voyage execution and wider marine and maritime information management.

It describes the status of standards development for digital nautical information services with examples of their anticipated use.

RESUME

For authors who are unable to provide a summary in French, the IALA Secretariat will translate the English summary.

CONTENTS

1. INTRODUCTION

Nautical publications, in the sense used by the IMO, are special-purpose books designed to meet the requirements of marine navigation [1], that are issued officially by or on the authority of a Government, authorized Hydrographic Office or other relevant government institution. The information entity composed of nautical charts and books provides the mariner with a comprehensive collection of static information needed to navigate a vessel safely on the intended route. The term Nautical Publications includes Sailing Directions, Mariners' Handbook and List of Lights. Regulations and manuals pertaining mainly to ship and shore facility operations, e.g., cargo handling or crew management are generally not included. The content of nautical publications is under the purview of the IHO NIPWG. During the last 14 years, SNPWG and NIPWG developed a data model which allows the presentation of nautical publication information in future ECDIS systems and other GIS applications. Based on that data model, and taking into account recent S-100 developments, the group is now developing SOLAS V [1] conformant S-100 based product specifications for nautical information with the intention to replace the use of printed nautical publications.

2. THE HISTORY OF NIPWG AND THE DEVELOPMENT OF PRODUCT SPECIFICATIONS RELATED TO NAUTICAL INFORMATION

2.1. SHIFT OF OBJECTIVE FROM PAPER PRODUCTS TOWARD DIGITAL FORMATS

Initially, SNPWG was stood up with the aim to standardize the provision of nautical publications. It was quickly recognized that standardization of nautical information similar to the INT 1 standard for paper charts was not feasible. Based on that recognition, the Terms of Reference of SNPWG were amended from solely focusing on paper products to a new objective: "develop guidelines for the preparation of Sailing Directions in digital format, compatible with ECDIS."

2.2. THE 3-LEVEL HIERARCHY OF PROVIDING NAUTICAL PUBLICATIONS

Taking into account the intended implementation and presentation of nautical publication information in future ECDIS systems, and considering the growing technological advances in providing printed nautical publication information in digital formats, the IHO introduced at the XVIth International Hydrographic Conference in 2002 a 3-level-hierarchy defining different ways of providing nautical publications. According to the latest version of the IHO publication (Resolution M-3, dated July 2015) [3], a nautical publication is defined by the following:

1. NP1 publications are printed on paper and include paper charts, printed volumes of sailing directions, tide tables, etc. They are intended to be read by mariners and other human users in paper form.

2. NP2 publications are digital forms of existing paper publications. They can be read by humans on personal computers or other platforms including potentially ECDIS, but are not designed to be compatible with ECDIS. In other words, they are digitized text and graphics not intended for machine processing, retrieval, or for a geo-referenced symbolization of their information content.

3. NP3 publications are digital datasets containing information previously in NP1 or NP2 publications that are fully compatible with ECDIS and designed for machine processing and symbolized portrayal on a geographic display or GIS.

With the above mentioned amendments of the SNPWG Terms of Reference and with the provision of the 3-level hierarchy, SNPWG and its successor NIPWG focused on the provision of nautical publication information in NP3.

2.3. SCOPING NAUTICAL PUBLICATION INFORMATION

Starting in 2003, the group developed a scope of nautical publication content comprising all information which is stored currently in books, and which was considered as being necessary for safe navigation. Using that scope, development of a data model based on the IHO Transfer Standard for Digital Hydrographic Data (S-57), was started.

2.4. S-100 DEVELOPMENT

In the meantime, an IHO working group named TSMADWG developed a new IHO Universal Hydrographic Data Model named S-100 [2]. First released in 2010, S-100 has had significant impacts on the SNPWG data model. It now allows the option to extend the S-57 based data model by information objects, complex attributes and open or closed code lists. These new data model types offer greater flexibility to the nautical publications data model. Within the S-100 framework, product specifications define data products for information pertaining to specific domains.

2.5. ASSIGNMENT OF INFORMATION TO PRODUCT SPECIFICATIONS

After analyzing the scope of nautical publication content, SNPWG assigned individual information topics to different groups based on their semantics. These groups were used to develop ideas of potential product specifications and the semantically grouped information was assigned to these product specifications. At this stage, the group moved away from trying to work on a replica of the NP1, NP2 nautical publication, focusing instead on their replacement by a grouping of NP3 nautical publications designed to be functionally superior and more flexible than the current presentation.

3. PRODUCT SPECIFICATIONS DEVELOPMENT

The start of the Marine Protected Area (MPA) product specification development was initiated by a HSSC (IHO Hydrographic Standards and Services Committee) action item that based on a U.S. request to develop a marine environment protection program in 2009. The numbering system of the on S-100 based product specifications was not defined at this time.

In 2013, the growing amount of product specifications under development justified the development of a systematical assignment of numbers to product specifications. NIPWG proposed their product specification candidates to HSSC for consideration, which decided to assign the S-12x numbers to product specifications that are related to nautical publications.

NIPWG has the responsibility for developing the following product specifications:

- S-122   Marine Protected Areas, describing protected areas and related features, regulations, and similar information about protected areas.

- S-123   Radio Services, indicating the location, availability, type of radio communications, frequencies, and content of radio services for navigational information and other maritime radio communications.

- S-125   Navigational Services, describing navigationally features including lights and other navigation aids, both physical and virtual, temporary and seasonal marks, and local AIS application-specific messages.

- S-126 Physical Environment, describing marine and terrestrial topography, prevailing, seasonal, and hazardous currents, tides, weather, and other environmental conditions.

- S-127 Traffic Management, describing vessel traffic services, pilotage, routeing systems, and ship reporting systems.

- S-128 Catalogue of Nautical Products, describing the product, coverage, and publication information of various products, ranging from paper publications such as paper charts and printed sailing directions to digital products such as ENCs and e-Navigation services.

The relationship between the S-100 framework and product specifications for nautical publications is shown in the following figure.
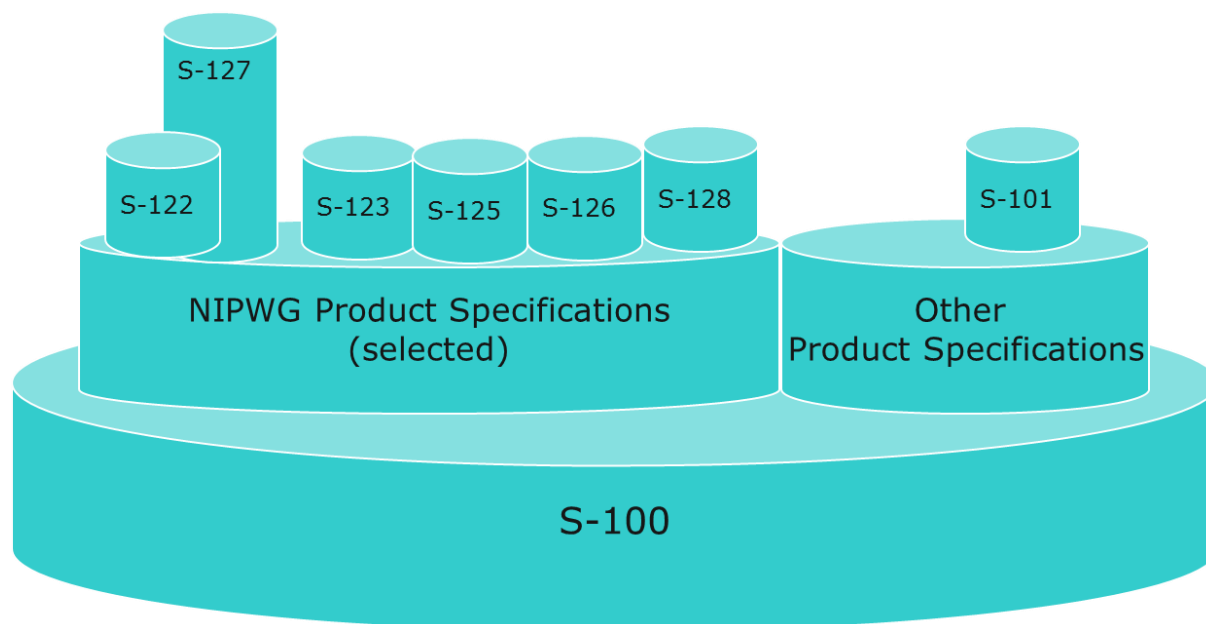

Figure 1. Relationships between the S-100 framework and product specifications

4. THE CURRENT WORK OF NIPWG

4.1. EVOLUTION OF PRODUCT SPECIFICATIONS

The S-100 framework introduced the provision of product specifications which can be integrated in future ECDIS systems and in many other GIS environments. Each product specification describes a data product consisting of information pertaining to a specific common area within maritime information, and is designed to conform to the S-100 framework.

4.2. S-100 BASED PRODUCT SPECIFICATION DEVELOPMENT

Based on a common style sheet, sub teams developed test data samples for product specifications as the basis for the scheduled product specification development. These test data samples are compilations of text parts which are consistent with NIPWG's semantic grouping of information but currently provided in different publications. They are text documents with structure and content similar to that of current text-based nautical publications, but which are designed to explore the capability of the data model developed by SNPWG and NIPWG to represent the content of text publications in the S-100 object-attribute data model. The testing of the data model is done by mapping as much as possible of the content to the data model defined in the appropriate product specification, and evaluating whether the model is capable of representing all the information the

group considers must be encoded in the relevant S-100-based dataset. This process often leads to amendments to the data model.

Relevant test data sample and other supplementary information can be accessed on:

http://www.iho.int/mtg_docs/com_wg/NIPWG/NIPWG_Misc/ProdSpecDevelopment.htm

The NIPWG data model and all the papers pertaining to the product specification development are being maintained on the following NIPWG Wiki site:

http://wp12183585.server-he.de/npubwiki/wiki/index.php/Main_Page

In parallel, the development of the S-122 and S-123 Product Specifications has been completed.

Although marine protected areas could be interpreted as traffic management measures, the S-122 Marine Protected Area Product Specification has been developed as an independent Product Specification. The reason for keeping the S-122 information outside of the Traffic Management product specification is the assumption that S-122 will work not only in ECDIS but also in other systems. Due to the fact that the GML format is used, products based on S-122 can also be integrated in most kinds of GIS.

Some products will complement other products. For example, products based on the S-123 Radio Services Product Specification will e.g. provide the static area information for which other Product Specifications such as S-124 (Navigational Warnings) will deliver the dynamic information.

5. EXPLORATORY PROTOTYPES

5.1. CONVERSION SAILING DIRECTIONS INFORMATION INTO A S-100 BASED DATA MODEL

Some additional product specifications as well as exploratory prototypes of applications have been developed to test the modeling approach and identify and explore issues which arise in the conversion of publications from text form to the new framework and the use of the resulting datasets. These explorations were often undertaken with the participation of individual NIPWG/SNPWG member organizations, but not sponsored by IHO or the working group.

Conversion from BSH (German Maritime and Hydrographic Agency) new-format sailing directions: This was a short project done in 2007-08 by BSH and Jeppesen exploring the possibility of encoding highly structured text in the object-attribute model of S-100. The project demonstrated round-trip convertibility of highly-structured NP1/NP2 text to digital form using the S-100 object-attribute model. The result could be used to generate multiple output formats, including a very close approximation to the original (PDF) text as well as web-friendly forms suitable for use in an interactive web site. The compact and highly-structured and text-fragment approach used by for BSH for its new sailing directions facilitated efficient conversion and round-tripping of information.

Discrepancy reporting and information retrieval: This project was part of the EU INTERREG-IVB funded Bringing Land and Sea Together (BLAST) project and demonstrated the ability to use data encoded in the S-100 model for discrepancy reporting for ENCs and digital publications as well as interactive retrieval of selected information.

One common theme in the prototypes is demonstrating how S-100 facilitates new ways of displaying and accessing information traditionally encoded in publications, as a chart overlay, independent graphic, or interactive web page. Figures 2 and 3 below contain examples of the varying kinds of applications, portrayal, and access.
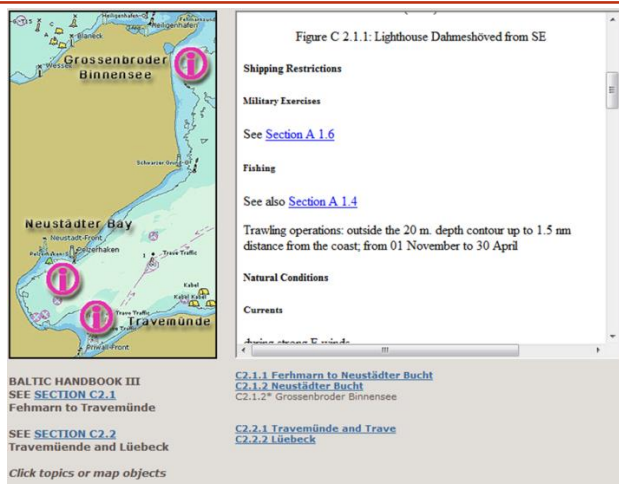
Figure 2. Interactive web page for BSH new-format sailing directions converted to digital data based on the S-100 format
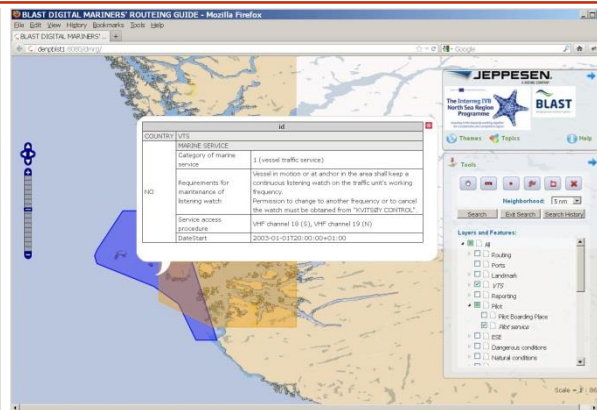

Figure 3. Interactive retrieval of VTS area information

5.2. OBSERVATIONS FROM EXPLORATIONS

Preliminary observations from these explorations include:

- Most nautical publications can be successfully converted into NP3 form and used to produce different types of applications and presentations – ECDIS layers, web pages, printed texts, etc.

- Conversion from ordinary narrative text to the object-attribute model often takes significant effort, especially in mapping from narrative text to features and attributes and creating feature geometry or identifying existing ENC features whose geometry can be reused. Often approximate geometry must be used. Sometimes corresponding features are not present in the ENCs or the conversion process sometimes uncovers discrepancies in the charts or ENCs, for example a feature displaced from its actual location.

- Spatial primitives proliferate as location-specific information is encoded more and more precisely. For example, different clauses in a regulation may apply to different sections of a waterway. It is necessary to manage the trade-off between conversion effort and complexity on the one hand and over-simplified dataset on the other.

- Laws and regulations are often complex and expressed as relatively long paragraphs, and a data model capable of capturing all the variations between multiple countries is not feasible. Mapping lengthy text regulations to an object/attribute model often requires preparing an extract of the original text, with references to the appropriate clauses in the full text. Including the text of laws and regulations in full as auxiliary information in transfer sets is technically possible, but contradicts the basic principle of providing information to the mariner in a concise and easily understandable form that is compatible with ECDIS.

- The S-100 framework is not designed for convenience in expressing procedural and rule-based information (i.e., as "if/then" statements, or conditions/result) and the encoding of rules conditional on vessel or cargo types is feasible but cumbersome.

6. INFORMATION PROVISION CHALLENGES

6.1. SPATIAL UNCERTAINTY

Nautical publication information relatively often describes facts which come along with a spatial uncertainty. For example, radio service availability relies on meteorological factors. The spatial extent of some hydrographic information such as wave heights and the presence of weather phenomena cannot be determined exactly.

Thus, the provision of nautical publication information in ECDIS is connected with the question how these uncertainties could be modelled and displayed. NIPWG developed a data model which addresses this problem and which offers the capability to determine certain levels of spatial uncertainty of information.

6.2. PROVISION OF NP3 INFORMATION

Nautical information is normally used for planning purposes. Only in very few occasions is access to the nautical publication information needed during the route monitoring process. Although it is intended that NP3 information overlays and interacts with an Electronic Navigational Chart (ENC), the information will rather not be seen on the primary navigational screen. The complexity and the pure amount of nautical information would clutter the ENC display, and potentially compromise safe navigation. Therefore, a second screen or a back bridge access to the NP3 information is favored as the preferable platform configuration.

6.3. CUSTOMIZING OF NP3 INFORMATION

The integration of an increasing numbers of products, and thus the increasing quantity of information in ECDIS systems, can stress the mariner with information overflow. It has been considered by NIPWG that the customization of information is vital to

- reduce the screen clutter,

- reduce the textual information content,

- improve the mariners' acceptance of the information provided, and

- improve the trust of the system.

Customization should ideally include the vessel's characteristics and present environmental conditions.

6.4. PORTRAYAL OF NP3 INFORMATION

Portrayal, including the design of appropriate symbols, patterns, area fills, color palettes, and rules for portrayal are an important part of work in progress for some of NIPWG's product specifications or planned for the near future for others. This work is carried out in conjunction with other IHO working groups such as the Nautical Cartography Working Group.

6.5. INTEROPERABILITY WITH OTHER S-100 BASED PRODUCT SPECIFICATONS

Another important issue which NIPWG has to consider during the product specification development process is the interoperation of different products with an ENC and with each other. Addressing this involves handling multiple issues simultaneously, such as dealing with features in one data product obscuring features in another, duplicated information in different products, varying levels of detail, discrepancies in feature coordinates, blended and compatible portrayals, etc. For example, ENCs often include area features for nature reserves, but S-122 (Marine Protected Areas) might contain more detailed information – how is this to be dealt with? Efforts are underway to define an interoperability architecture which is applicable across all S-100-based data products. Whether there

will be any implications for individual product specifications, and if so, how they will constrain NIPWG product specifications remains to be seen.

6.6. IMPROVEMENT OF PRODUCT SPECIFICATIONS

The future work of NIPWG concentrates on the completion of all product specifications for which the group has the responsibility. In addition, the maintenance and improvement of those product specifications which exist or which are under development are vital to ensure that these product specifications reflect the latest technology developments and to ensure that the mariners always have reliable information available.

7. CONCLUSION

Within the digital age, the move from paper products towards the provision of the information in digital format is a necessity. Nautical publications in their current paper version have not reached a sufficient level of harmonization that would make a transition into harmonized digital data provision possible. NIPWG has developed a data model which supports a harmonized provision of the nautical publication information. This information can be accessed by future S-100 based ECDIS systems and other GIS applications.

The provision of nautical information in future ECDIS systems will:

- increase the safety of navigation,

- reduce human errors caused by missing information,

- reduce the mariner's workload by providing customized information,

- increase the mariner's situation awareness by providing geo-referenced nautical information,

- reduce the administrative workload by providing appropriate update mechanisms.

8. REFERENCES

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[2] International Hydrographic Organization (IHO): S-100 – Universal Hydrographic Data Model, Edition 2.0.0. International Hydrographic Bureau, Monaco, January 2015. URL: http://www.iho.int/iho_pubs/IHO_Download.htm (retrieved 7 April 2016).

[3] International Hydrographic Organization (IHO): RESOLUTIONS of the INTERNATIONAL HYDROGRAPHIC ORGANIZATION, Publication M-3, 2nd Edition – 2010, Updated to July 2015, International Hydrographic Bureau, Monaco, July 2015. URL: http://www.iho.int/iho_pubs/misc/M3-E-JULY15.pdf (retrieved 8 April 2016).