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The Next Edition of IHO S-57 (Edition 4): Much more than ENCs

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Abstract: The primary goal for the next edition of S-57 (Edition 4) is to support a greater variety of hydrographic-related digital data sources, products, and customers. This includes matrix and raster data, 3-D and time-varying data (x, y, z, and time), and new applications that go beyond the scope of traditional hydrography (e.g., high-density bathymetry, seafloor classification, marine GIS). It will also enable the use of web-based services for data discovery, browsing, query, analysis, and transfer. S-57 Edition 4.0 will not be an incremental revision of Edition 3.1. Edition 4 will be a new standard that includes both additional content and a new data exchange format. Due to the world-wide prominence of ISO standards, IHO S-57 will conform to the “ISO way” of standards development. However, alignment with the ISO 19100 series of geographic standards will require a re-structuring of S-57 Edition 4. More specifically, this requires a new framework, and a new (or revised) set of terms used to describe the components of S-57 Edition 4.0. The present intention is to release Edition 4.0 in late 2006. Edition 3.1 will continue to be valid for many years to come -- even after Edition 4.0 has been released. Since most ECDIS equipment use ENC data conforming to the ENC Product Specification contained in S-57 Edition 3.1, Hydrographic Offices should continue to produce Edition 3.1 ENC data in order to continue to improve world-wide ENC coverage. Current plans are to release a new ENC Product Specification approximately one year after publication of S-57 Edition 4.0.

Introduction

The International Hydrographic Organization (IHO) is an intergovernmental consultative and technical organization established in 1921 to support the safety of navigation, and to contribute to the protection of the marine environment. IHO Special Publication 57 (IHO S-57) is the *IHO Transfer Standard for Digital Hydrographic Data*. It is the standard to be used for the exchange of digital hydrographic data between hydrographic offices, and for the distribution of

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hydrographic data to manufacturers, mariners and other data users (e.g., environmental management organizations). It was developed so that the transfer of all forms of hydrographic data would take place in a consistent and uniform manner. To date, S-57 Edition 3.0/3.1 has been used almost exclusively for encoding Electronic Navigational Charts (ENCs) required for ECDIS. However, S-57 is intended to support all types of hydrographic data. In order to do so, S-57 needs to be expanded in order to accommodate new requirements, customers, and technology.

This paper is based on a “white paper” that was originally prepared in November 2004 by the IHO CHRIS (Committee on Hydrographic Requirements for Information Systems), TSMAD (Transfer Standard Maintenance and Development) S-57 Edition 4 Sub-Working Group. This information paper is posted on the IHO Website (www.iho.shom.fr), and was forwarded to IHO Member States as IHO CHRIS Circular Letter 83/2004 (7 Dec 04).

Background

IHO S-57 was formally adopted as the official IHO standard at the XIVth International Hydrographic Conference in May 1992. It includes:

- A general introduction with list of references and definitions
- A theoretical data model on which the standard is based
- The data structure and format that is used to implement the data model
- General rules for encoding data into the ISO 8211 encapsulation

In addition to the main document, there are two appendices:

Appendix A is the Object Catalogue. It provides the official, IHO-approved data schema that can be used within an exchange set to describe real-world entities.

Appendix B contains the IHO-approved Product Specifications. These contain additional sets of rules for specific applications. Currently, the only product specification in S-57 is for an Electronic Navigational Chart (ENC).

Edition 3.0 was released in November 1996. Edition 3.1 containing minor revisions/additional attribute values was issued in November 2000. There have been no changes made since that time, and no additional revisions to Edition 3.1 are planned that would result in another interim edition. The present intention is to release Edition 4.0 in late 2006.

Current Limitations of S-57 Edition 3.1

Although S-57 Edition 3.1 has many good aspects, it does have certain limitations:

- It was primarily developed to meet the ENC data requirement called for in the ECDIS Performance Standards adopted by the International Maritime Organization (IMO) in 1995.
- It has an inflexible maintenance regime. Freezing standards for lengthy periods is counter-productive.
- As presently structured, it cannot support future requirements (e.g., gridded bathymetry, time-varying information).
- Embedding the data model within the encapsulation (i.e., file format) restricts the flexibility and capability of using a wider range of transfer mechanisms.
- It is regarded by some as a limited standard focused exclusively for the production and exchange of ENC data.

S-57 Ed. 4.0 will not be an incremental revision of Edition 3.1. It will be a new standard that includes both additional content and support for new data exchange formats.

Goal/Objectives

The primary goal for the next edition of S-57 is to be able to support a greater variety of hydrographic-related digital data sources, products, and customers (see Figure 1).

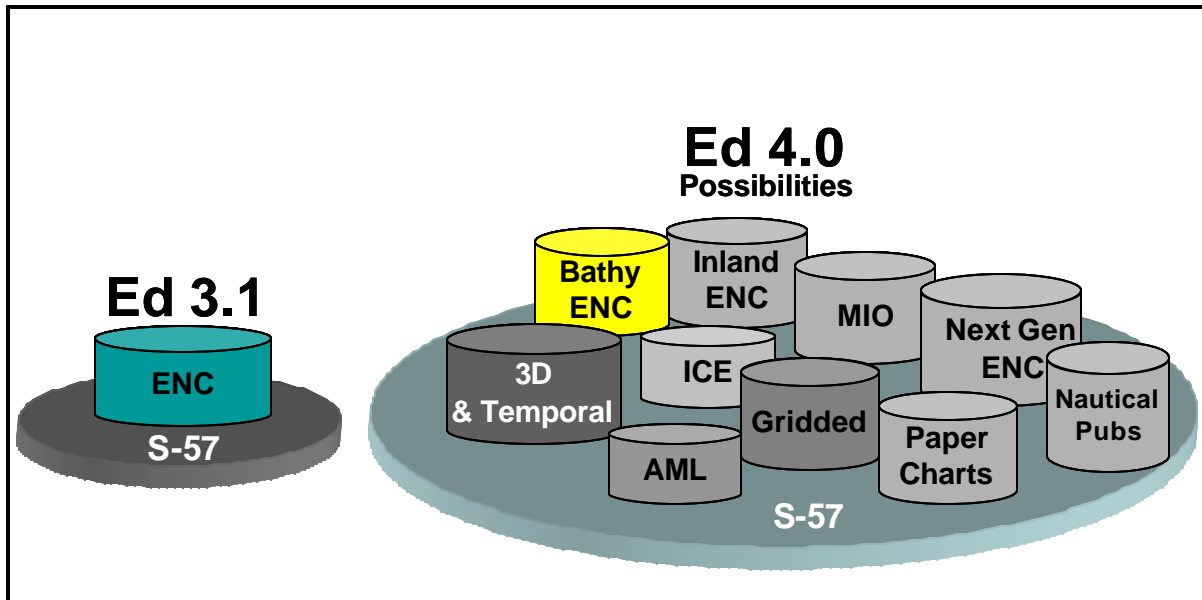


Figure 1 – S-57 Edition 4 will support a greater variety of data sources, products and services.

Unlike Edition 3.1, Edition 4.0 will include matrix and raster data, 3-D and time-varying data (x, y, z, and time), and new applications that go beyond the scope of traditional hydrography (e.g. high-density bathymetry, seafloor classification, and marine GIS). It will also enable the use of web-based services for data discovery, browsing, query, analysis, and transfer.

Other objectives include:

- Separate the data content from the carrier (i.e., 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. Future product specifications will be based on a core data model that may be extended to meet the needs of different hydrographic information communities. This will allow the core standard to evolve (e.g., through extension) without the need for new versions of existing product specifications.
- An ISO-conforming registry on the IHO web site containing feature data dictionaries (i.e., registers) and product feature catalogues that are more flexible and capable of being expanded.
- Separate registers for other user communities. These will include new features/attributes compatible with S-57, and additional product specifications that may be created (e.g., Inland ENC Product Specification).

ISO Geospatial Standards

The International Organization for Standardization (ISO) is a non-governmental international standards organization comprising a worldwide federation of national standards bodies from over 130 countries. In response to a growing demand for geo-spatial information standards, ISO established Technical Committee 211 (ISO/TC211) in 1994. The aim of ISO/TC211 is to establish a structured set of standards for information concerning geographic objects or phenomena. IHO, together with many other geographic standards development organizations, is a Class A Liaison Organization to ISO/TC211. Currently, there are over 22 Class A members, including:

- Digital Geographic Information Working Group (DGIWG)
- Global Spatial Data Infrastructure (GSDI)
- Open Geospatial Consortium (OGC)
- United Nations Geographic Information Working Group (UNGIWG)

ISO 19100 Standards

The standards developed by ISO/TC211 are contained in the ISO 19100 series of geographic information standards. For all forms of geographic data, these standards specify the methods, tools, and services for:

- Data management (including definition and description)
- Acquiring, processing, analyzing, accessing, and presenting data
- Transferring data in digital electronic form between different users, systems and locations

In the most general sense, they fall into one of the following categories:

- Framework and Reference Model
- Profiles and Functional Standards
- Data Models and Operators
- Data Administration
- Geographic Information Services

Currently, there are over 40 standards in the ISO 19100 series. These include both formally adopted and draft International Standards for spatial and temporal schema, metadata, imagery and gridded data, profiles, portrayal, encoding, and so forth.

Alignment with ISO/TC211

Given the prominence of ISO standards and their worldwide recognition and use, it makes sense for IHO to follow/adopt the “ISO/TC211 way” of standards development for the next edition of S-57.

In 1999, ISO/TC211 invited the IHO and the NATO Digital Geographic Information Working Group (DGIWG) to enter into a cooperative agreement for future standards development. Rather than work at cross-purposes, it was considered prudent to harmonize the data content contained in IHO S-57 (i.e., the Object Catalogue) with that of NATO DIGEST (i.e., DGIWG Feature Data Dictionary – formerly called FACC). Further, the intent was to develop hydrographic standards that were compatible with a broad range of other ISO Geospatial standards. This was agreed to

by IHO at the 12th CHRIS meeting in October 2000. Currently members of both organizations attend each other’s meetings and have played important roles in the harmonization process.

New Framework

Alignment with the ISO 19100 series of geographic standards will require a new way of organizing and defining S-57 Edition 4. More specifically, it will require a new framework or structure, and a new (or revised) set of terms used to describe the components of S-57 Edition 4.0.

Registry and Registers

Perhaps the most significant aspect in terms of alignment with the ISO TC/211 standards is the employment of a “registry” containing one or more “registers” (see Figure 2).

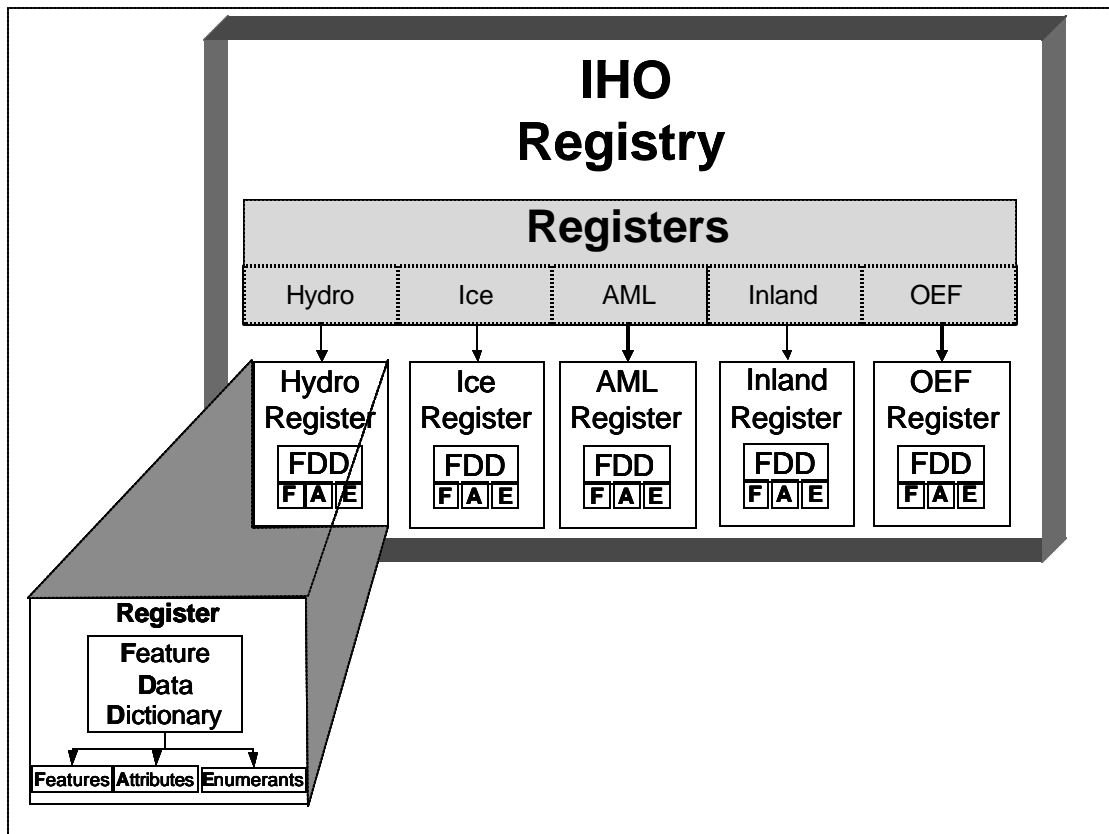


Figure 2 – The IHO Registry for S-57 Edition 4 data will be comprised of a collection of registers.

A “registry” is the entire information system (or location) in which a collection of registers is located. In the case of the future S-57 Edition 4.0, IHO will host a registry that will provide a facility to store various registers of hydrographic-related information. This will include feature data dictionaries, metadata and code lists (e.g., sounding datums). There will be registers for Hydrographic Information, Dynamic Ice Coverage, Additional Military Layers (AMLs), Inland ENCs, and possibly others. Other types of information that do not fit into these categories can be

included in the Open ECDIS Forum (OEF) register. For each register there is an organization that will be responsible for its content and management.

A major benefit of the registry concept is its flexibility. Multiple versions of similar entries in a data dictionary can be maintained using unique identification and classification. For instance, an entry can be classified as being either:

- valid (latest version)
- superseded (previous version/s)
- retired (no longer recommended for use)
- not valid (proposed but not accepted, or no longer acceptable).

In this way product feature catalogues can reference an item that will remain in the register even if a newer version is registered at a later date. In this way, if a new item is registered, a new version of a current product specification is not required. Not valid items will remain public in order to ensure that any future proposals for similar items have not been previously rejected. A prototype registry will be available for comment at the IHO website in December 2004. An operational registry is planned for 2005.

Application Schema Template

An application schema template (see Figure 3) specifies the rules for how:

- features, attributes and associations are used to specify a data model
- the various components are 'glued' together (i.e. a feature and its spatial component)
- to use registers as part of an overall registry

These rules can then be applied to develop a product specific application schema that in turn forms the basis of the product specification.

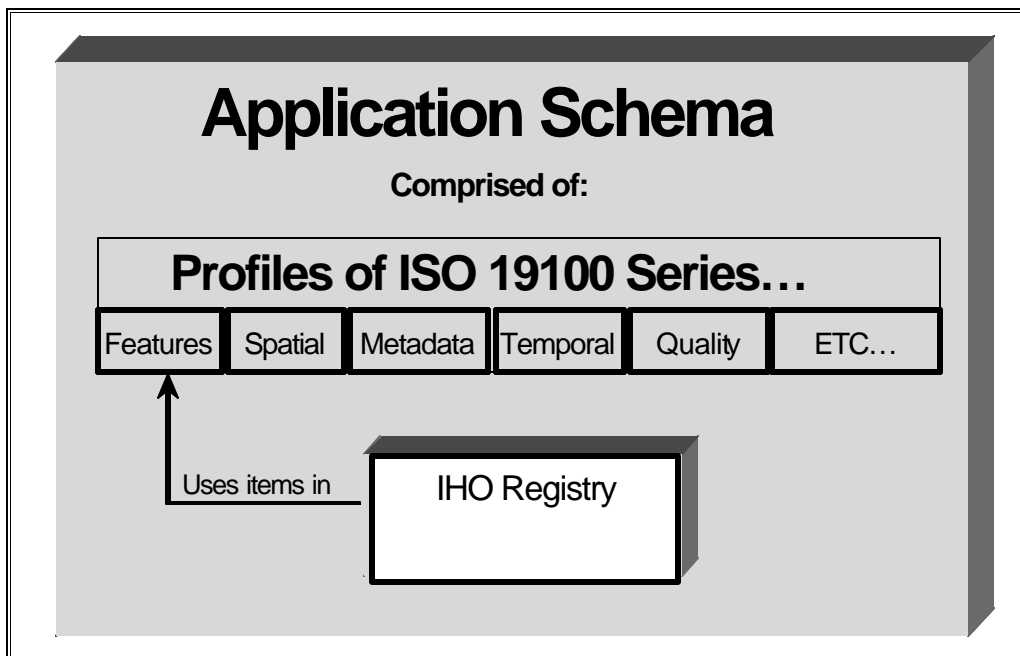


Figure 3 – Application schema template

Individual product specifications consist of a feature catalogue, an application schema, an encoding (e.g., Geographic Markup Language – GML), and so forth. (see Figure 4).

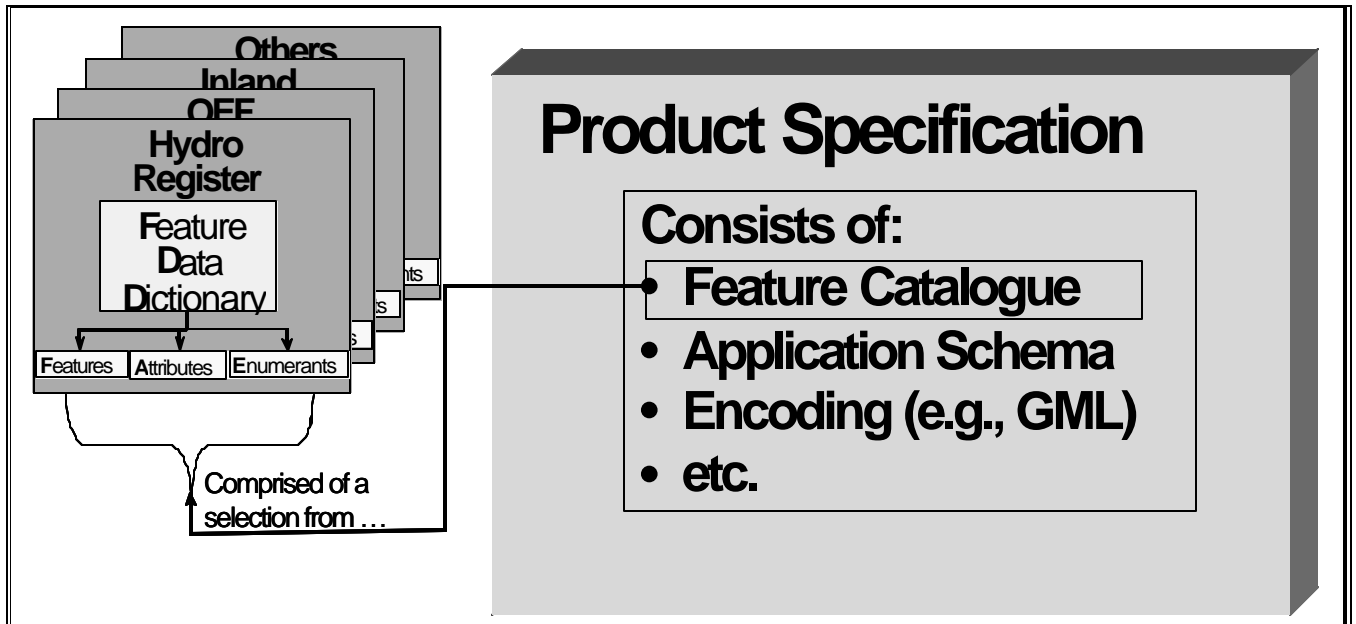


Figure 4 – Individual product specifications will be comprised of several components.

New Terminology (IHO S-57 → “ISO-ese”)

Some of the terms and definitions currently used in S-57 Ed. 3.1 will no longer be employed. They will be re-defined or will “evolve” into what some have described as a new language (i.e., “ISO-ese”). While this transition may be difficult at first, in the longer term it will be beneficial since IHO S-57 Edition 4.0 will be using the same language as the ISO TC/211 series of standards.

Some examples of this change in terminology include:

<p>S-57 Ed. 3.1</p> <p>[none] *</p> <p>object</p> <p>attribute</p> <p>attribute values</p> <p>object catalogue</p>	<p>→</p>	<p>ISO 19100 series</p> <p>a <i>registry</i> for a standard contains a number of <i>registers</i></p> <p><i>feature</i></p> <p><i>feature attribute</i></p> <p><i>enumerants</i></p> <p>a <i>feature data dictionary</i> contains features and attributes but without any mandatory relationship. Using this, a specific <i>feature catalogue</i> (mandating relationships between features and attributes) can be specified for a variety of requirements (e.g., a product specification).</p>
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* The closest thing to a registry/registers that currently exists for IHO S-57 is the Open ECDIS Forum (OEF). During the past four years, it has served as a useful mechanism/database for registering additional objects/attributes that were not contained in S-57 Edition 3.0/3.1.

Benefits

There will be a number of benefits in adopting S-57 Edition 4.0:

- Using ISO-developed components and terminology will help ensure that S-57 and future extensions are in the mainstream of the geospatial information industry. This should also help to facilitate a greater use and lower cost implementation of S-57 for hydrographic and other types of geospatial applications (e.g., Marine GIS).
- Conformance with the ISO/TC211 standards will maximize the use of commercial-off-the-shelf (COTS) software applications and development.
- New components of S-57 will not be developed in isolation from the rest of the spatial information technology community.
- Any new requirements can be incorporated within the established framework of ISO/TC211 based standards.
- Rather than being regarded as simply a standard for hydrography, S-57 Edition 4.0 will be interoperable with other ISO/TC211 standards and profiles (e.g., NATO DIGEST).
- There are many national standards bodies that will take full advantage of S-57 being aligned with ISO/TC211 standards.
- More than just hydrographic offices and ECDIS equipment will be able to use S-57 based hydrographic data.
- It will facilitate the ability of HOs to use other sources of geospatial data (e.g., combining topography and hydrography to create a coastal zone map).

Another improvement will be the way in which ENC data will be encapsulated. In simple terms, encapsulation means deciding what data structure is used for the exchange of ENC data. The current edition of S-57 uses an ISO standard referred to as ISO/IEC 8211, "*Specification for a data descriptive file for information interchange.*" First published in 1985, ISO/IEC 8211 was developed when the state-of-the-art was the 3.5" floppy disk. ISO/IEC 8211 is no longer widely used, and it would not be possible to efficiently encapsulate some of the new data functionality using this outdated standard. The GIS industry has provided a standards-based format that should be a good replacement for 8211. The Geography Markup Language (GML) has been developed by the Open Geospatial Consortium. The current version is going through the process of becoming an ISO standard. Using GML as one method of encapsulating S-57 Edition 4.0 data fits in well with the overall strategy of using existing standards in order to facilitate acceptance.

S-57 Edition 3.1 → 4.0

Edition 3.1 will continue to be used for many years to come -- even after Edition 4.0 has been released. Since most ECDIS equipment use ENC data conforming to the ENC Product Specification contained in S-57 Edition 3.1, Hydrographic Offices should continue to produce Edition 3.1 ENC data in order to continue to improve world-wide ENC coverage. When a new ENC Product Specification is eventually published based on S-57 Edition 4.0, it is expected that mariners will want to upgrade their systems in order to take advantage of the new functionality. It is anticipated that any future ENC Product Specification would take approximately two years to develop after publication of the S-57 Edition 4.0 base standard. Ideally, this effort will involve the active participation of all "stakeholders", including Hydrographic Offices, ENC software producers, ECDIS manufacturers, and maritime users.

Implications for ENC Product Specification

There are some deficiencies in a future ENC Product Specification that have been identified since the release of S-57 Editions 3.0 and 3.1. Currently, these are published in the S-57 Maintenance Document. Once the work on the main parts of the new Edition 4.0 standard has been completed, any future ENC Product Specification will address all of these accumulated corrections and additions. There are some other decisions to be made regarding the future ENC Product Specification such as “backwards compatibility”. Although it sounds good, this term is somewhat misleading since any change made to the existing ENC Product Specification will result in an ENC that will not be completely compatible with an existing ECDIS. However, this can be overcome as ECDIS equipment is upgraded to be able to take advantage of new ENC data that has increased functionality. This situation should not be a surprise to anyone who has upgraded their office suite of computer software and sent files in a new word processing format to their colleagues who, using older software, reply ‘I can’t open the file that you sent me!’

Another issue to be decided is what new functionalities of Edition 4.0 should be included in the future ENC Product Specification. For new features and attributes, this could include archipelagic sea-lanes (ASL) and Environmentally Sensitive Sea Areas (ESSA) that have recently been mandated by the IMO to be included on paper and electronic charts. Another capability could be the incorporation of gridded data. This would provide the capability for ENCs to show detailed bathymetric information and to create three-dimensional views of the detailed bathymetry. Finally, allowing for time-varying data to be part of a new ENC Product Specification will enable the incorporation of tide and current data, weather, oceanographic and dynamic ice coverage.

In Summary

The primary goal for S-57 Edition 4 is to support a greater variety of hydrographic-related digital data sources, products, and customers. This includes matrix and raster data, 3-D and time-varying data (x, y, z, and time), and new applications that go beyond the scope of traditional hydrography (e.g. high-density bathymetry, seafloor classification, marine GIS). It will also enable the use of web-based services for data discovery, browsing, query, analysis, and transfer. S-57 Edition 4.0 will not be an incremental revision of Edition 3.1. Edition 4 will be a new standard that includes both additional content and support of a new data exchange formats.

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