The Next Edition of IHO S-57 (4.0)
-- A Primer [1] --

Introduction

The International Hydrographic Organization (IHO) is an intergovernmental consultative and technical organization that was established in 1921 to support the safety of navigation and 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 (HOs), and for the distribution of hydrographic data to manufacturers, mariners and other data users (e.g., GIS). It was developed so that the transfer all forms of hydrographic data would take place in a consistent and uniform manner. To date, S-57 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 Edition 3.1 needs to expand in order to accommodate new requirements.

This "Primer" explains what is planned in regard to the next edition of IHO S-57 (Edition 4). In particular, it provides a brief description about process required to align with ISO geospatial standards and the benefits to be gained. Included is an explanation about the scope of activity of the TSMAD S-57 Edition 4 Sub-WG, and how others may contribute to the process.

Background

S-57 was formally adopted as the official IHO standard at the XIV 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 or format that is used to implement the data model
- General rules for encoding data into the DX-90 format

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

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 ENC.

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[1] Prepared by the IHO TSMAD S-57 Edition 4 Sub-Working Group.

Edition 3.0 was released in November 1996, with an Edition 3.1 containing minor revisions/additional attributes being issued in November 2000. S-57 3.1 is currently "frozen" and will not be changed prior to the future publication of Edition 4.0. Currently, this is planned for late 2005.

Limitations of S-57 Ed. 3.1

S-57 Ed. 4 will not be simply a "revision of Ed. 3.1". It will be an entirely new standard in terms of content and format. Although S-57 3.1 has many good aspects, there are several limitations:
    - It was primarily developed to meet the ENC requirements called for in an IMO-compliant ECDIS.
    - It has an inflexible maintenance regime. Freezing standards for lengthy periods is counter-productive.
    - As presently structured, it cannot support future requirements.
    - Embedding the data with the encapsulation restricts the flexibility and capability of using a wider range of transfer mechanisms.
    - It is regarded by some as a limited standard that only deals with how to produce ENC data.

Goal/Objectives

The primary goal for the next edition of S-57 is to be able to deal with a greater variety of hydrographic-related digital data. This includes matrix and raster data, 3-D and time-varying data (x,y,z & time), and new applications that go beyond the scope of traditional hydrography (e.g., high-density bathymetry, seafloor classification, marine GIS, etc.). It will also enable the use of web-based services for data discovery and transfer.
Other objectives include:
    - Separate the content from the carrier. 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 inclusive instead of exclusive. Further, the core standard and feature/attributes can be changed without the need for new versions of unaffected product specs
    - An ISO-conforming registry on the IHO web site, containing feature data dictionaries, product feature catalogues, etc.
    - Separate registers for new requirements. This includes new S-57 features/attributes and additional product specifications that others will create (e.g., Inland ENC Product Specification).

ISO Geo-spatial Standards

The International Standards Organization (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 objects or phenomena that are directly or indirectly associated with a location relative to the earth.

IHO, together with many other geographic standards development organizations, is a Class A Liaison Organization to ISO/TC211. Currently, there are over 22 members, including:

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

A more complete listing is contained in Appendix A.

ISO 19100 Standards

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

- Data management (including definition and description)
- Acquiring, processing analyzing, accessing, and presenting
- 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, etc. A current listing of all ISO 19100 series standards is provided in Appendix B.

Alignment with ISO/TC211

It is one thing to agree, in principle, to align standards. However, it is far more difficult to actually undergo the process. Given the prominence of ISO standards and their worldwide recognition and use, it makes sense for IHO to adapt to the "ISO/TC211 way" of standards development for the next edition of S-57. However, the devil is in the details.

In 1999, ISO/TC211 invited both IHO and the NATO Digital Geographic Information Working Group (DGIWG) to enter into a cooperative agreement in regard to future standards development. Rather than work at cross-purposes, it was considered prudent to harmonize the data content contained in IHO S-57 (e.g., Object Catalogue) with that of NATO DIGEST (e.g., Feature Attribute Coding Catalogue or FACC). Further, the intent was developing 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 significant roles in the harmonization process.

Future S-57 Edition 4 alignment with ISO 19100 series of geo-spatial standards will require a new way or organizing and defining S-57. More specifically, it will require a new framework or structure, and a different set of terms used to describe the standard.

Registers and Registry

Perhaps the most significant aspect in terms of alignment with the ISO TC/211 standards is the employment of "registers." As defined by ISO, a "register" is set of files containing identifiers assigned to items with descriptions of the associated items. In turn, a "registry" is the entire information system (or location) on which a register(s) is located. In regard to the future S-57 Edition 4, IHO will host a registry which will provide a facility to store v various registers of hydrographic-related information. This will include feature data dictionaries, product feature catalogues, meta data and code lists (e.g., sounding datums). The main users will likely consist of IHO (S-57), WMO (ice and weather), NATO (AML), and Inland ENC producing organizations. Other types of information (i.e., proposed new features and attributes) can be registered on the Open ECDIS Forum (OEF). An important aspect is that each organization provides a register manager for their particular section of the registry.

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)
    - invalid (proposed but not accepted, or no longer acceptable).
In this way product feature catalogues can reference an entry that will remain legitimate even if a newer version is registered at a later date. Therefore, if a new or change entry is registered, a new version of current product specification is not required. Invalid entries will remain public in order to ensure that any future proposals for similar items have not been previously rejected. It is planned to develop a sample version of registry available for comment on the IHO website by December 2004. Ideally, a full implementation would take place in 2005.

New Terminology (IHO S-57 → "ISO-ese")

Like it or not, some of the current terms and definitions used in S-57 Ed. 3.1 will no longer be used. A number of terms 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 painful at first, in the longer term it will be beneficial since IHO S-57 Edition 4 will be using the same language as ISO TC/211 series of standards.

Some examples of this change in terminology include:

S-57 Ed. 3.1	→	ISO 19100 series
[none] *		a *registry* for a standard contains a number of *registers*
object		*feature*
attribute		*feature attribute*
object catalogue		a *feature data dictionary* will contain features and attributes but without any bindings. Using this, a specific *feature catalogues*

can be produced for a variety of requirements (e.g., a product specification).

| product specification | this will contain both a *spatial* and an *application schema* |
| [none] ** | a *profile* is specific tailoring of one of the I9100 standards (e.g., a hydrographic metadata profile for ISO 19115) |

*   The closest thing to a registry/registers that we presently have 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.

**   Presently, the idea of using a profile is not done at all in S-57 3.1.

<u>New Framework</u>

As shown in the following diagram, S-57 Edition 4 will be a multi-part standard consisting of a series of profiles (i.e., selected elements) of the ISO19100 series of standards. A major component will be the Application Schema Template. It provides the rules for how:

   - features, attributes and associations are configured

   - the various components are 'glued' together (i.e., a feature and its spatial component)

   - the use of 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.
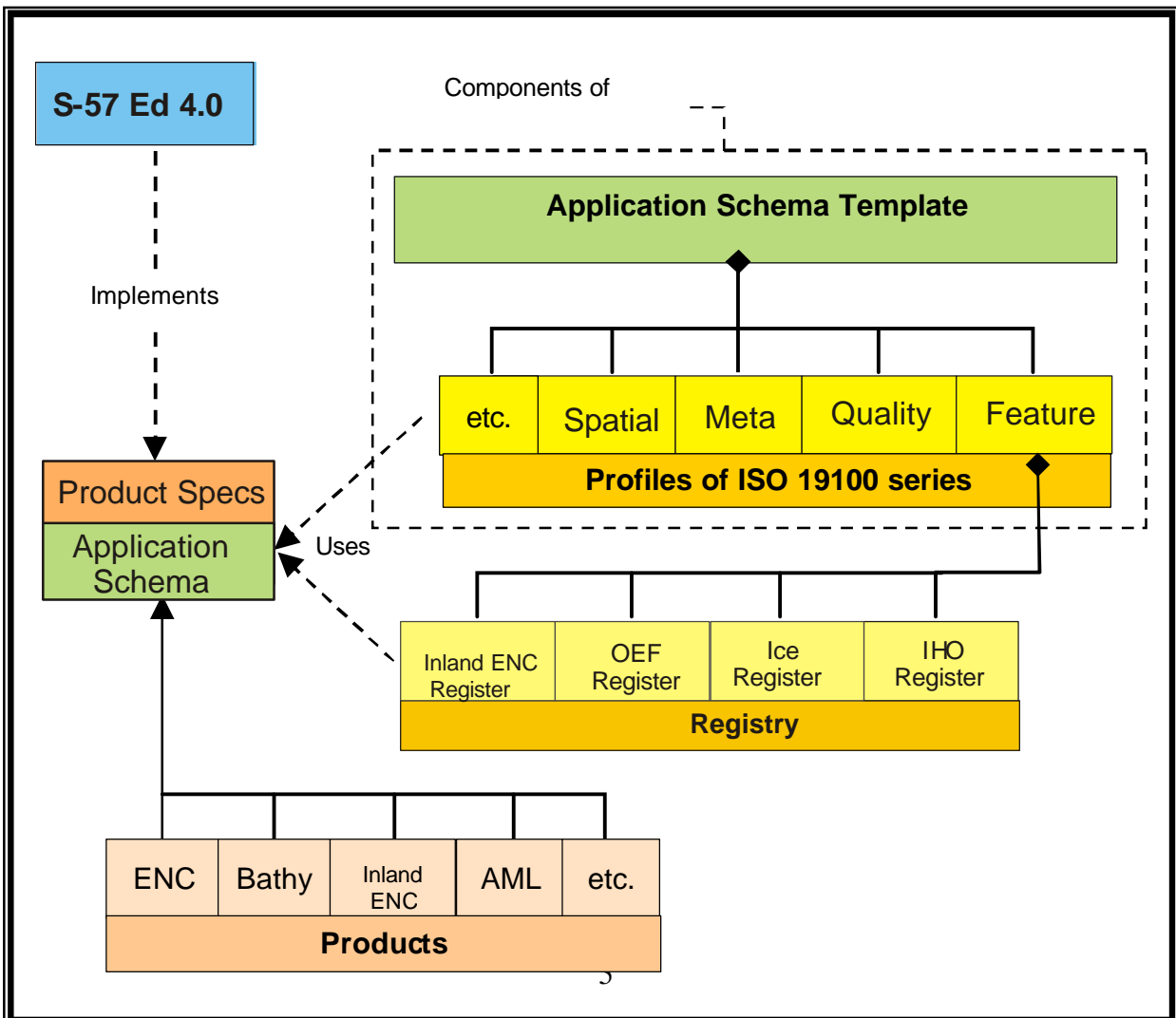
Benefits

There will be a number of benefits when S-57 Edition 4 becomes aligned with ISO standards.

- 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 compatibility with COTS (commercial-off-the-shelf) 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 base standards.
- Rather than being regarded as simply a standard for hydrography, S-57 Edition 4 will be interoperable with other ISO/TC211 standards and profiles (e.g., NATO DIGEST).
- S-57 will consist of a series of profiles based on the ISO/TC211 geo-spatial standards
- S-57 will be harmonized as closely as possible with DIGEST the mapping standard maintained by DGIWG, thus enabling better interoperability.
- 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 will be able to use hydrographic data.

Activity of TSMAD S-57 Ed.4 Sub-WG

In April 2001, TSMAD established a Sub-WG to begin work on S-57 Edition 4.0. The initial work plan was to deal with additional types of data that were not addressed in S-57 Edition 3.0 (e.g., raster, matrix, 3-D, time-varying, etc.), and to harmonize S-57 with the ISO 19100 series of geospatial standards. This in turn, led to the development of a work program to address the specific work items. Currently, there are 10 work items addressing such issues as:

- Revising the current S-57 Object Catalogue to become a Feature Data Dictionary
- A new Product Specification for "Next Generation ENC"
- Imagery and gridded data
- Time-varying and 3-D data
- Metadata
- Hydrographic Content Specification
- Portrayal
- Paper chart specification
- Non-HO applications

A more detailed description of the various work items is provided in Appendix C. An up-to-date status of the work progress can be found on the IHO website:
http://www.iho.shom.fr/COMMITTEES/CHRIS/TSMAD/S-57_Development/S57_Edition_4_Dev_Page.htm

Need for Testbeds

Prior to the adoption of any new component of S-57 Edition 4, it is intended that there be a meaningful period of test and evaluation (e.g., testbeds). In particular, before any new standards are adopted, there should be an adequate amount of testing and evaluation conducted to find what works, and what may need further refinement.

How others can submit new proposals
    - via OEF?
    - via IHO website?

Some Frequently Asked Questions (FAQ)

1. Q. Will S-57 Ed. 4 replace S-57 Ed. 3.1?
    A. No. Edition 4 will deal with new requirements/capabilities that were not addressed in Edition 3.

2. Q. Will the existing ENC Product Specification (S-57 3.1) become obsolete?
    A. No. Edition 4 will contain a "stand-alone" ENC product specification (i.e., for a type-approved IMO compliant ECDIS) that is a "reorganized" ENC product specification based on S-57 Edition 3.1.

3. Q. How or why will Ed.4 be better than Ed.3?
    A. flexible, can be modified; has more than one prod spec.

4. Need more…..

Appendix A

Class A Liaison Organizations to ISO/TC211

Committee on Earth Observation Satellites/Working Group on Information Systems and Services (CEOS/WGISS)
Digital Geographic Information Working Group (DGIWG)
European Commission Joint Research Centre (JRC)
European Petroleum Survey Group (EPSG)
Food and Agriculture Organization of the United Nations (FAO/UN)
Global Spatial Data Infrastructure (GSDI)
IEEE Geoscience and Remote Sensing Society
International Association of Geodesy (IAG)
International Cartographic Association (ICA)
International Civil Aviation Organization (ICAO)
International Federation of Surveyors (FIG)
International Hydrographic Organization (IHO)
International Society for Photogrammetry and Remote Sensing (ISPRS)
International Steering Committee for Global Mapping (ISCGM)
Open GIS Consortium, Incorporated (OGC)
Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)
Permanent Committee on Spatial Data Infrastructure for Americas (PC IDEA)
Scientific Committee on Antarctic Research (SCAR)
UN ECE Statistical Division
United Nations Geographic Information Working Group (UNGIWG)
United Nations Group of Experts on Geographical Names (UNGEGN)
World Meteorological Organization (WMO)

Appendix B

ISO 19100 Series (Geographic Information) Standards

International Standards
ISO 19101:2002 Geographic information — Reference model
ISO 19105:2000 Geographic information — Conformance and testing
ISO 19107:2003 Geographic information — Spatial schema
ISO 19108:2002 Geographic information — Temporal schema
ISO 19111:2003 Geographic information — Spatial referencing by coordinates
ISO 19112:2003 Geographic information — Spatial referencing by geographic identifiers
ISO 19113:2002 Geographic information — Quality principles
ISO 19114:2003 Geographic information — Quality evaluation procedures
ISO 19115:2003 Geographic information — Metadata
ISO/TR 19120:2001 Geographic information — Functional standards
ISO/TR 19121:2000 Geographic information — Imagery and gridded data

Final Draft International Standards
ISO/FDIS 19115 Geographic information — Methodology for feature cataloguing

Draft International Standards
ISO/DIS 19104 Geographic information — Terminology
ISO/DIS 19106 Geographic information — Profiles
ISO/DIS 19109 Geographic information — Rules for application schema
ISO/DIS 19116 Geographic information — Positioning services
ISO/DIS 19117 Geographic information — Portrayal
ISO/DIS 19118 Geographic information — Encoding
ISO/DIS 19119 Geographic information — Services
ISO/DIS 19123 Geographic information — Schema for coverage geometry and functions
ISO/DIS 19125-1 Geographic information — Simple feature access — Part 1: Common architecture
ISO/DIS 19125-2 Geographic information — Simple feature access — Part 2: SQL option
ISO/DIS 19128 Geographic information — Web Map Server interface
ISO/DIS 19133 Geographic information — Location based services tracking and navigation

Appendix C

IHO S-57 Edition 4 Development Forum – Work Item Sections

Work Item 2.1 – Object Catalogue → Feature Information Registry
The plan is to revise and restructure the current S-57 3.1 Object Catalogue to become a feature data dictionary. As explained above, IHO will host a registry for S-57 Edition 4 which will provide a facility to store different registers of hydrographic-related information.

Work Item 2.2 – ENC Product Specification
This work item cannot be progressed fully until the various profiles reach a more advanced state of completion. One possibility is to have the ENC Product Specification become a separate IHO Special Publication. One benefit of this approach would be to refute the myth that S-57 is only about ENCs.

Work Item 2.3 – Imagery and Gridded Data
Although "Raster and Matrix" data models were included in S-57, they were never full defined. In S-57 4.0 the capability to support this type of data will be explicitly included in the standard. "Raster and Matrix" data is a very common form of geographic data and there exist many external standards designed to handle such data. As such, there is no need to develop a unique capability in S-57 that would preclude compatibility. This new component of S-57 4.0 will be built upon the framework given in ISO TC211 Standard 19129 – *Geographic information – Imagery, Gridded and Coverage Data Framework.*

Work Item 2.4 – Time Varying and 3-D Data
This work item involves the extension of the S-57 object model to include time-varying (i.e., temporal) and 3-dimensional (3-D) data. This has the potential to be an exciting and useful addition to S-57 functionality. A 3-D spatial model is being developed which could be extended to 4-D with the addition of vector based temporal elements. Ideally, it will be possible to include capabilities to deal with both forecast and real-time tidal and current data. Coordination will need to occur with the IHO-IEC Harmonization Group on Marine Information Objects (HGMIO).

Work Item 2.5 – Metadata
In the paper chart world, metadata is displayed in the title block of charts, or may be recorded in various chart catalogues. In this form, metadata is readily apparent and easily transferred between chart producers and users. When chart data is provided in a digital format, metadata is equally as important, but its inclusion and maintenance often require a more conscious effort on the part of data producers and subsequent users. Increasingly, hydrographic organizations are collecting, storing and archiving large quantities of digital data. The complexity and diversity of these data have increased over the past decade. They are no longer confined to digital source and reproduction files, (e.g., used for paper chart generation). They now also include a variety of digital nautical products. Digital hydrographic data holdings are becoming an important national asset that must be managed and controlled. In order to achieve this, HOs will need to record

information about the data (i.e. metadata) and make it available for easy accesses. As hydrographic data holdings proliferate, a common metadata standard will facilitate the management, dissemination and reuse of digital data.

Work Item 2.6 – Base Documents → Core Modules
The goal of this work item will be to develop, improve and add to the existing standard - not to start over again or significantly change what is already being successfully used. However the contents need to be restructured to align with other geospatial standards under the ISO/TC211. There are several components to address:

    1 & 2D spatial profile - A final draft version has been published and is available for review on the IHO website. The existing vector models (e.g., spaghetti, chain node, etc.) will be carried forward into Edition 4.0 with the addition of two new ones – topology ready and chain node graph. The major difference is the separation of the geometry and topology. They will remain related but using different methods than earlier editions of S-57.

    Coordinate reference systems - A profile is being developed which will emulate the existing S-57 parameters. Horizontal datum will be based on ISO registered code lists and it is intended to register hydrographic sounding datum in a similar way.

    Application schema template - An initial draft version has been developed but this work depends on the completion of the series of profiles.

    Encoding - Although the existing ISO/IEC8211 encoding will probably be retained, the core encoding mechanism will be based on GML 3.0 (geographic markup language). This is quickly gaining wide acceptance in the GIS world (an ISO standard co-developed with OGC) and adds considerable flexibility in exchanging data -- particularly with the development of S-57 based Web Services. Both feature catalogues and portrayal (e.g., C&S Presentation Library) information can be transported within the file. This enables the use of freely available SVG (scalable vector graphics) viewers which can either be embedded in HTML web pages or as a plug-in for more sophisticated applications.

    Maintenance procedures - New procedures will be developed nearer the completion date of the main standard. This will reflect the increased flexibility of edition 4.0.

Work Item 2.7 – Hydrographic Content Specification
Originally to be Bathymetric Data Product Specification, it was later decided that a product specification would be too restrictive, and that this work item should focus on developing a Hydrographic Survey Content Specification. Initial steps in process will be:

    1) Compile a list of all known hydro/bathy standards
    2) Refine the list of products/applications from "all possible" down to "more reasonable"
    3) Review the relevant ISO TC211 standards required to produce a hydrographic survey application profile
    4) Determine what metadata items are necessary
Some of the products/applications that would benefit from a Hydro Survey Content Specification include: field/fair sheet, bathymetric maps, sea-floor classification, UNCLOS, and by products of multi-beam survey (e.g., backscatter imagery).

Work Item 2.8 – Portrayal
Although the portrayal of S-57 data is outside the scope of TSMAD, it needs to be considered for future product specifications (e.g., bathymetric charts/maps). Most likely, this will become a

profile of the ISO standard on Portrayal (ISO 19117). This work item will be performed in close coordination with the C&SMWG and HGMIO.

Work Item 2.9 - Paper Chart Product Specification
This Work Item is to investigate what is required to create paper charts using the S-57 format. Included in this effort is to determine what is needed for the exchange of digital chart repromat between the various producers of paper charts (e.g., for the exchange of INT charts between HOs).

Work Item 2.10 – Non-IHO Applications
This is a collective work item that seeks to coordinate other applications that go beyond the scope of IHO and the mission of most hydrographic offices. A tentative list includes:
    Inland ECDIS
    Additional Military Layers (AMLs)
    Digital Geographic Information Working Group (DGIWG)
    Industry
    Academia/Research