# Harmonizing Survey Deliverables – Emerging Standards and Smart Data Exchange

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## Introduction

When a survey company plans a project the deliverables are analyzed and the relevant equipment is identified. This is true for both the hardware and software requirements. A survey for charting for safety of navigation has traditionally had a different set of requirements than those stipulated for a survey to support Exploration and Production (E&P) purposes, yet importantly the project may be undertaken by the same survey company.

The International Hydrographic Organization (IHO) data standards are utilized for surveys for safety of navigation, whereas organizations like the OGP are driving the use of data standards for the E&P sector. The difference in survey purpose results in different processing flow lines, which adds to the cost of the survey, as different skillsets and equipment are needed for the desired result to be achieved. This has forced survey companies to have access to a wide range of equipment making standard operating practice challenging. It also makes the reuse of survey data for other purposes more difficult.

It is clear that smarter survey deliverables would benefit the industry as a whole, but does this mean that surveys for safety of navigation should be delivered in OGP SSDM? Or should high resolution source data collected in an E&P survey be delivered in IHO S-102? It is perhaps more important to focus on how both OGP and IHO data standards can co-exist and facilitate each other through data interoperability. This interoperability is possible because the International Organization for Standardization (ISO) TC211 geospatial data standards are the foundation of both the SSDM and S-100 standards and this in turn means that data exchange is possible through the use of Open Geospatial Consortium (OGC) standard file formats like Geography Markup Language (GML).

## Data Models for Survey Data

SSDM and S-57/S-100 are examples of different data models that are used for similar survey data capture purposes. These data models have some common content.

*OGP SSDM for Oil and Gas Surveys*

The SSDM is a standard GIS data model for seabed survey information. It is intended for use in the E&P industry for the exchange of survey data [1]. The conceptual model groups objects into survey measurements, seabed features, shallow/intermediate geology features and environmental sample features. The feature types of the model are defined with vector geometries which means that feature type, such as bathymetry, are represented as contours rather than coverages. Coverages, such as a bathymetric DEM, are included in the conceptual model and they can be included with a survey deliverable but are optional. The main feature types used in the SSDM are in the group named Seabed Features. Almost every seabed survey requires the interpretation of synthetic or natural features. Often some of these features will pose a risk to safe navigation and will eventually be charted.

The SSDM is implemented using the ESRI Geodatabase which is the data storage and data exchange framework for ESRI ArcGIS. Data exchange is supported by the File and Personal Geodatabase and an SSDM template is provided in this format. The constraint that this imposed was recognized early on by the SSDM task force which noted that the SSDM can, in principle, be implemented on any GIS and transferred by means of open GIS data exchange formats. SeabedML is a formal definition of an open GIS data format.

SeabedML arose from the need to provide an encoding for the SSDM that is open and not tied to a proprietary system. SeabedML is an application schema that is developed using GML which is an XML grammar for encoding a wide range of geographic information concepts. GML is both a standard of OGC and of ISO. XML is in turn a specification of the World Wide Web Consortium (W3C). There are many software libraries that have been developed for processing XML and there is a growing number of GML aware applications for processing geographic information. These open standards and wide range of choice in terms of applications are beneficial to organizations wishing to implement flows where geographic data are exchanged.

*IHO Standards for Safety of Navigation Surveys*

Specifications are in place for the distribution of hydrographic data for navigation and the protection of the marine environment as established and maintained by the IHO [2]. A number of specifications have guided the charting process and products with IHO S-57 in place since 1992 as the current Transfer Standard for Digital Hydrographic Data. A new set of standards called the S-100 Universal Hydrographic Data Model was devised and became active in January 2010. The S-100 standards are meant to embrace opportunities for new exchange formats, products, content and, perhaps, most importantly, new users.

S-100 aims to support the wider hydrographic community. With that goal in mind, S-100 provides a framework for products comprising of vector data, coverage data, and time-varying data. A richer set of content definitions supports the creation of product specifications that meet the needs a many different domains and users in the future. One of these domains could be the E&P industry.

Along with providing definitions for many types of data, S-100 has several concepts that enable it to meet the needs of the community into the future including:

- Separation of the content from the carrier so new file formats can be used as they become available. Appropriate encodings are defined at the product level.

- Having content in product specifications be a subset of S-100 allowing the core standards to be extended over time without adversely affecting any existing product specification.

- Conformance with ISO/TC211 standards, components and terminology to facilitate integration with other geospatial data sources.

A number of products [3] have already been or are in the process of being defined under S-100 including product specifications for marine protected areas, sub-surface navigation, currents, tides, and ocean forecasts. Most of these products have relevance to data collected and derived from surveys for oil and gas exploration and infrastructure management. Three of the more relevant IHO specification are:

- The S-101 Electronic Nautical Chart product is for the exchange and presentation of information relevant to navigation using an electronic navigation system. Most existing features defined under S-57 will be retained but there is support for flexible, product definable metadata and new data types for feature properties such as complex attributes, information types and more flexible feature relations.

- The S-102 Bathymetric Surface Product for the exchange and presentation of gridded bathymetry as a product unto itself and integrated with other S-100 products for use within an electronic navigation system. This product offers an alternative to contours and sounding features to depict the seafloor and is expected to be used for navigation in sensitive high traffic areas where the high resolution data can facilitate advance planning and offer enhanced real-time situational awareness.

- The S-121 Maritime Limits and Boundaries product for the exchange of digital maritime boundaries described under the United Nations Convention on the Law of the Sea.

## Harmonized Processes and Models

The differing sets of requirements based on the type of survey can drive a survey company to use different hardware and software for each (Figure 1). If the survey deliverables were more closely harmonized this would add value to the data or at least save time reformatting later. It would also provide efficiencies increasing survey company competitiveness (Figure 2).

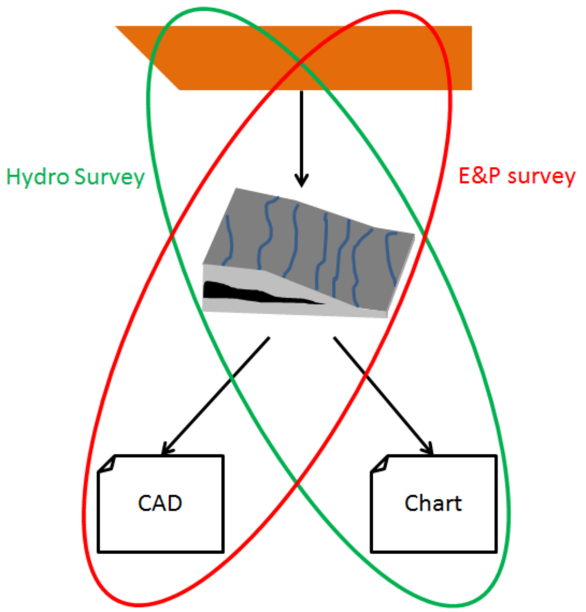


*Figure 1: Traditional approach based on survey type*

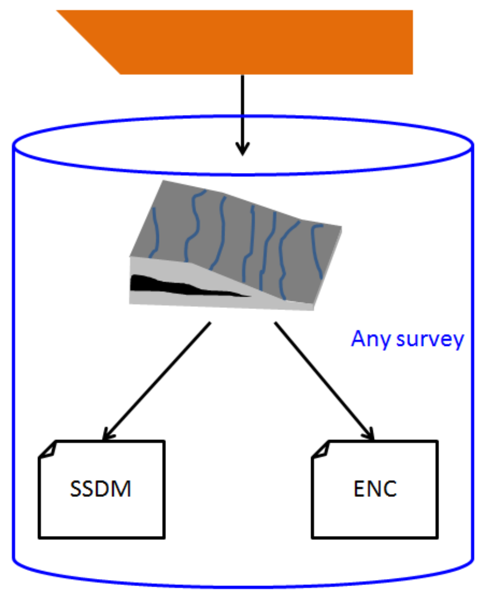


*Figure 2: Suggested approach independent of survey type*

The question of harmonized deliverables is amplified by the recognition that the data should be the key deliverable from a survey not a paper representation; charts and alignment sheets should be a report on a database not the deliverable. Much of the data collected is common to both types of survey project and it is now technically feasible to re-purpose the relevant elements of the data by simply changing the presentation or mapping it to a different data model (Figures 3 and 4). By stipulating digital survey deliverables rather than analogue ones, we can solve this problem through the use of interoperability and smart data exchange which is a pre-requisite for today's GIS and mapping software. We can also add value to the survey deliverable by providing richer data that supports better decision making.

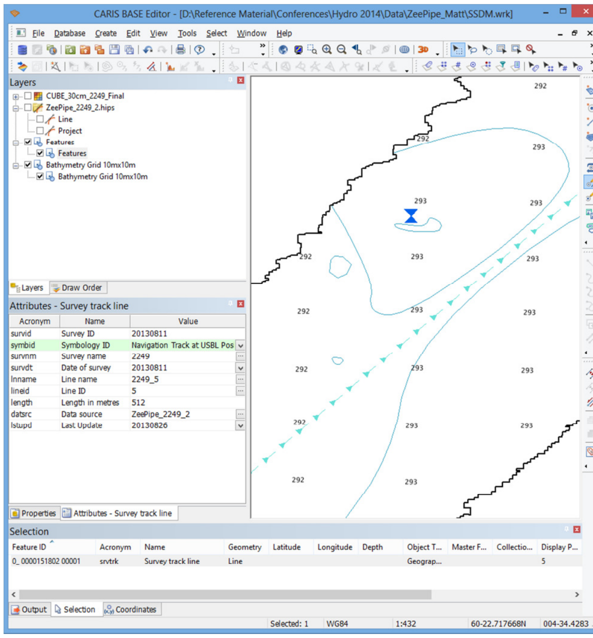


Figure 3: SSDM feature portrayal

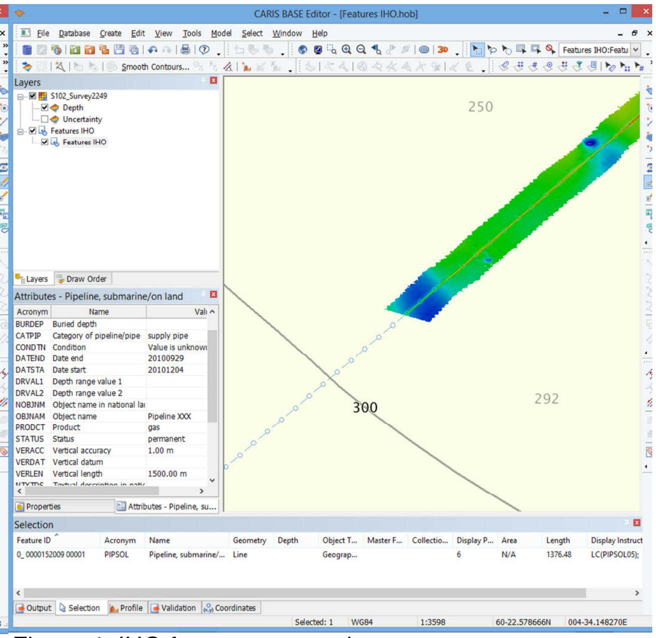


Figure 4: IHO feature portrayal

When thinking about collecting fit for purpose data that can meet the needs of different stakeholders, data accuracy and geodetic control also needs to be considered. Surveys that are conducted for the purpose of charting typically adhere to IHO S-44 standards, this defines the accuracy that the survey must meet e.g. Special Order. Surveys conducted for E&P purposes usually meet the specifications of the company contracting the work, organizations like the International Marine Contractors Association (IMCA) and the OGP influence these specifications but ultimately the survey accuracy needs to meet the purpose of the project. The differences in geodetic requirements between survey projects can be handled by defining the Coordinate Reference System (CRS) used in a survey for both the horizontal and vertical components. By capturing the CRS information in the project metadata it should be straight forward to transform the data effectively for different purposes giving the required output.

In UK waters the Maritime Coastguard Agency coordinates survey operations for the purpose of charting. The survey data is delivered to the Hydrographic Office as full resolution bathymetry datasets that can be interacted with and quality controlled on receipt and databased with corresponding metadata. Contours and other features are derived from the bathymetry and used in electronic and paper chart products.

Deliverables from E&P surveys are typically a series of CAD drawings and an accompanying report. The CAD drawings are effectively the mechanism where relevant survey derived data is captured, e.g. sediment thickness or debris location. The full density data exists but the primary deliverable is the interpreted results rather than the source. The full density data likely only exists on a hard disk archive and is rarely revisited. The increasing use of the SSDM for E&P survey deliverables provides rich and consistently encoded information that can be further interrogated following delivery. An E&P survey that delivered SSDM features along with high resolution source survey data e.g. bathymetry, seafloor imagery, and shallow geology would seem to provide an optimal deliverable reinforcing the quality especially when managed in a spatial database and visualized and queried through GIS tools.

Both types of survey also have a concept of a report of survey, which is another area that would benefit from a digital approach rather than the current analogue one. The majority of information captured in a survey report is location based which raises the possibility of capturing it digitally and having it co-exist alongside the survey deliverable.

In the case of the hydrographic office it is normal for the survey company to pass the survey data to hydrographic office for interpretation by its personnel, whereas in the case of the E&P company the interpretation is typical done by the survey company itself. It would seem that both types of survey owner can benefit from the practice of the other through the delivery of rich source and infield interpreted feature level data also.

The establishment of a survey database to manage and query the source and feature level data together would seem to be an essential system in an E&P company's or Hydrographic Office's data centre. Being able to view derived features alongside the full density data would provide a level of assurance and allow for rapid regeneration of features if required. It would also support easier extraction of information for use in other projects or for transfer to other stakeholders (Figure 5). The concept of a survey database also raises the potential for the pipeline infrastructure itself to also exist in the same database further adding to situational picture for E&P companies.

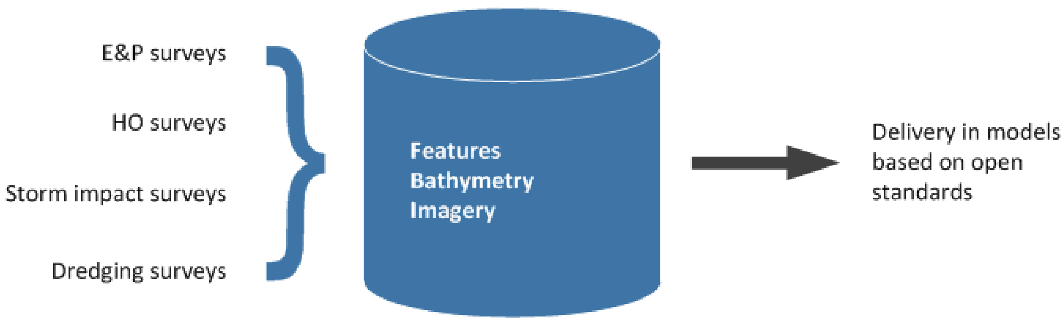


*Figure 5: Survey data collected for different purposes should be stored in a single system*

Another driver for harmonized and standards based deliverables is the upwards trend in autonomous surveys using AUVs and USVs. "The volume of data collected is too large to transfer through the vehicle's communication system whilst underway; the data has to be downloaded on its return. This currently results in a data processing bottleneck as many hours of data needs to be processed at once. The solution to this will likely involve more real time data processing so that what comes off the AUV is ready to be incorporated into the survey deliverable with far less human interaction" [4]. Therefore it will be important that, as processing flow lines are automated, the downstream deliverables are digital and data centric as the quality control and interpretation tasks will happen increasingly on a database of survey data rather than on files fueling paper products.

## Conclusion

Digital deliverables based on the OGP and IHO data standards provide an excellent opportunity for smarter data exchange. In addition they facilitate better data management practices as these standards lend themselves to the use of spatial databases and GIS software which should lead to a departure from the traditional product centric workflows under-pinned by paper.

By taking a database approach it should be possible to manage and view the high resolution source data alongside the feature level data providing the best information for quality control and decision making. This should also reduce the time it takes to submit the deliverable after a survey project as making paper charts is far more time consuming than delivering a database of intelligent features, mosaics and terrain models.

It should be possible to map directly between the different data models using Extract, Transform and Load (ETL) software, or through the use of OGC standard file formats. Ideally spatial database technology or GIS software should allow both types of data to co-exist or at least facilitate the transformation from one data model to the other. The differences in symbology to ensure a fit for purpose view should also be user selectable and definable.

E&P companies and Hydrographic Offices should consider incoming survey data as source to their spatial data infrastructure, whose content evolves over time on the completion of each new survey project. The database approach allows for beneficial analysis such as changes to the seafloor, project planning and could support a Common Operating Picture should an emergency arise. Survey companies who manage client data in this way can speed up operations by delivering survey databases rather than files and paper and can more easily defend the quality of their work.

The marine geomatics community can benefit greatly by using the latest geospatial software. By adopting data standards we ensure interoperability between systems avoiding vendor lock-in which in turn safe guard's accuracy and efficiency. At the same time this provides consistent data that can be used more widely. As surveys become more automated, this approach is even more important if data collectors and more importantly data holders want to leverage the value of "Big Data".

## References


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## Biographies

Andy Hoggarth has a BSc. in Mapping Science (1997) from the University of Bedfordshire, England. He started his career at Racal Survey as data processor specializing in Multibeam survey. In 2003 he joined CARIS where he leads the company's global sales and marketing efforts.

Karen Cove is a professional engineer and the Product Manager for the Bathy DataBASE suite of software applications at CARIS. She earned her BSc. Eng. (2003) and MSc. Eng. (2005) in the Department of Geodesy and Geomatics at the University of New Brunswick, Canada.