Integrated Data as backbone of e-Navigation

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ABSTRACT: e-Navigation, a theme introduced but IMO to improve safety of navigation at sea, is starting to gain traction in various organizations. As the concept develops, the importance of data, both static as well as dynamic, is more and more realized. IALA and IHO, in their efforts to help making e-Navigation a reality, have agreed to propose the IHO GI Register (often known as S-100 Register) as the conceptual basis for the Common Maritime Data Structure (CMDS). Utilizing this common understanding of key players in e-Navigation arena, the IMO e-Navigation Correspondence Group has firmed up the overarching architecture, enabling a series to test beds proving the concept of integration of various data streams to enable improved communication between the stakeholders on shore or at sea.

The integration of pre-composed, expert generated navigational data with real time and semi real-time data like Virtual AtoNs, Tide Gages Data or MSI transmission from VTS into a single e-Navigation display, if correctly developed, implemented and executed, will be the enabler of increased situational awareness.

1 CURRENT DEVELOPMENT ON DATA IN E-NAVIGATION

Data is a central part of the e-Navigation concept: *"e-navigation is the harmonised collection, integration, exchange, presentation and analysis of maritime 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" (IMO MSC 85/26 Annex 20)*

Based on this IMO e-Navigation definition the relevant bodies are working on a harmonized data model. Consequently the discussions in the related e-Navigation Committee of the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) and the International Hydrographic Organization (IHO) have resulted in a more consolidated view on data architecture. The various working groups have come to the conclusion that a common data structure is necessary to harmonizing the different data streams within the e-Navigation concept. While IALA was originally looking at a new "Universal Marine Data Model", after further review and consultation with experts and the IHO it was agreed that the already established IHO concept of an "Universal Hydrographic Data Model", known as S-100, will be the basis of the "Common Maritime Data Structure". S-100 is based on the ISO 19100 series of geographic standards, well established in the GIS world.

Figure 1. S-100 Universal Hydrographic Data Model
Barry Greenslade

With that S-100 based data is compatible with data created according to the relevant ISO standards, not only within the maritime domain, but also with other GIS areas and is in support of the Spatial Data Infrastructure (SDI) initiatives in various regions of the world. This development provides the necessary harmonized platform for integrated systems. By agreeing on this common GI Registry concept the maritime community prepared the ground for harmonization and interoperability of the different data streams necessary to make e-Navigation a success.

An additional dominant argument unifying all stakeholders to move towards common structures and towards the IHO originated model is the fact that the implementation of S-100 and its related standards is well underway and will materialize shortly. As a consequence ENCs will follow this data structure, same as associated data streams, like "Inland ENCs" or "Marine Information Overlays".
The IHO has already created and approved S-100 in January 2010 and the first Product specification S-102 (Bathymetric Surface Product Specification) in April 2012. IALA has registered for an own domain in the IHO "GI-Registry" and has conduct a workshop in June 2013 to start the development of IALA product specifications for e-navigation. As all stakeholders agree that the ENC layer will build the foundation of any kind of advanced navigational systems, it was a natural development to try to align other data stream with this foundation. At the same time this development again verifies that ENCs, or better Hydrographic Vector Chart Data Layers, are the necessary ingredients for any navigational display now and in the foreseeable future.

This development on the data side is accompanied by the necessary review of the regulatory conditions. The concept of e-Navigation is evolving the understanding that future navigation will need constant innovation, and as such will need to change how performance standards are handled. It is widely understood that the current ECDIS performance standard is restricting innovation. Its update and certification concept is not geared up to meet the needs of e-Navigation.

The currently being promoted new concept defines a framework in which a growing number of data streams are integrated and harmonized to allow the creation of the necessary information for increased Situational Awareness in an environment of growing complexity.
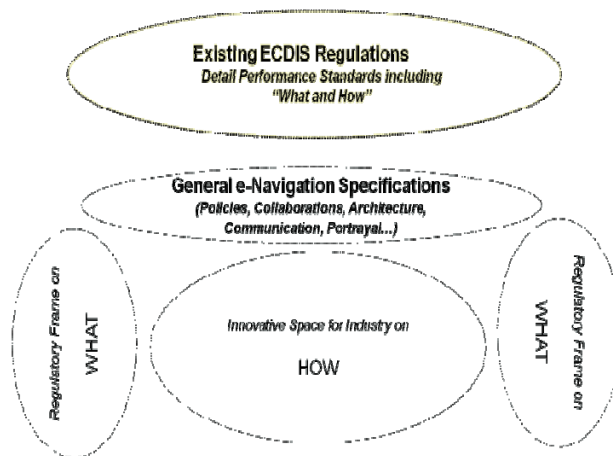

Figure 2. The regulatory Framework – Michael Bergmann

The on board and ashore systems to be developed within this framework will have to create a compelling need for their usage by increasing safety and security of navigation (compelling need for coastal administration) and improved efficiency of voyage (compelling need for ship owners and operators).

As outlined, the e-Navigation framework in development through IMO, IHO and IALA is changing the concept in how systems are managed, type approved and more importantly how they handle and render cartographic data. This will change how hydrography and cartography will play together.

While the changes in the regulatory framework will need to be developed over time in IMO, the discussion clearly moves towards a concept defining the conditions and regulatory requirements while allowing room for innovation by avoiding over-specification.

2 STATIC DATA STREAM COMPOSITION AND COMPONENTS

As ships where sailing the world the communication with shore until recently was very limited, if possible at all. Navigators relayed therefore on pre-composed, static data to support their navigation.
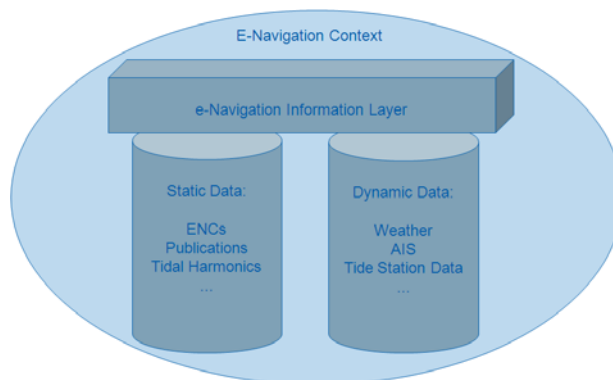

Figure 3. The two data pillars for e-Navigation - Michael Bergmann

The dominant products to provide a mariner with this necessary static data are and had been navigational charts and nautical publications. The

HOs around the world are compiling those products using the guidelines of IHO.

Input for those products are often generated by HOs themselves or associated organizations by conducting surveys, which provide bathymetric data layers. Together with information about navigational aids they are building the foundation of navigational data. These basic data sets are enriched by information collecting from organizations like coastal administrations or port masters on navigational relevant objects but also procedural and regulatory information needed for a safe passage.

The cartographers then are combining all of this static data, selecting the necessary data for the intended use of the chart or publication they build. They also compose the data to archive full level of deconfliction and ease of use of their products. The resulting charts and publication are products are stand alone products with no interoperability as such.

This concept was also adapted in the chart centric paradigm of current ECDIS concept with associated ENCs. HOs are preparing pre-composed ENCs of certain scale bands, which have an intended use and appropriate zoom factors. The With the different IHO specifications and their composition of ENCs HOs are defining the look and feel as well as the appropriate rendering of ENCs in a type approved ECDIS. Any so call "Value Added Data" may form an "Overlay" but cannot integrate with the ENC data.

3 DYNAMIC DATA STREAMS IN E-NAVIGATION

Just in recent years the communication between ships and shore has drastically changed. Satellite communications at high seas as well as other communication means like 3G or WIFI when closer to shore are increasingly enabling ships to receive real time data. The e-Navigation concept builds on these growing capabilities.

Figure 4. e-Navigation Prototype - Jeppesen

Real time transmissions of tidal information are already reality in some areas. In addition the establishment of AIS AtoNs is under development and is adding another real time data stream to the mix.

These are only two examples of dynamic data streams already available or in development. The general concept of dynamic data is that it allows a view on current reality rather than a generalized

composition. In the same category are falling situation centric data like traffic situation information, on board ship sensors like motion sensors for ship movement or propulsion sensors.

e-Navigation as envisioned by IMO and under development at IMO, IALA, IHO and others is including dynamic data sets as part of the concept to improve situational awareness. With this the safety of navigation and environmental protection is intended to be increased, which is the underlying goal of e-Navigation.

Dynamic data streams are essential components of the e-Navigation concept. They are not only "overlays" to support static data sets but integral part of the idea behind e-Navigation.

It is envisioned that in addition to real time data for chart display enhancement, additional real time or semi real time data will be available on demand to further increase the knowledge of the navigators. Communication currently transmitted via voice communication equipment to the bridges can be supplemented sending key messages in writing rather than only via voice communication. It allows the navigator to review important notes on the situation ahead as needed, especially if voice communication is suboptimal or language barriers are reducing communication efficiency.

4 INTEGRATED DATA FOR IMPROVED SITUATIONAL AWARENESS

Both static as well as dynamic data is, as described, intended to support the mariner on the task of safe navigation. It is important to highlight that, while data is important for situational awareness and as such as an aid to navigation, data by itself is not providing any benefit. Only if the data is received by the navigator as information it is reaching the intent. Information brought to the mariner will enable the expansion of knowledge, which creates the necessary situational awareness to make the right decisions, or in other words create the wisdom which enables the navigator to master the situation on hand. We all integrate data with our existing experience. We bring it in context if possible and use this combination as information.
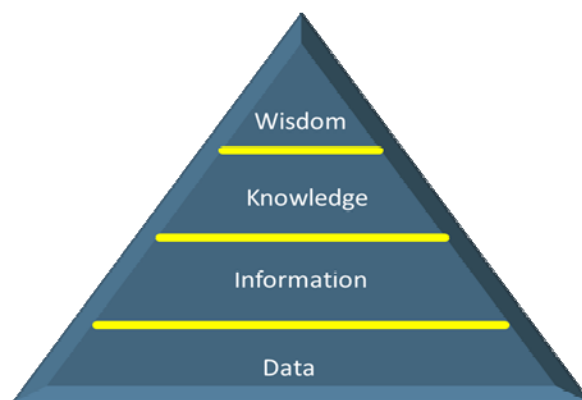

Figure 5. Data-Wisdom Pyramid – Michael Bergmann

In the classic chart paradigm, the hydrographers and cartographers integrated the various raw data

they received in a pre composed static data set as described earlier. As we are now providing both static as well as dynamic data sets, the different data streams are not necessarily integrated as they may come from different sources. The growth of data streams are not by default leading to more information, better knowledge and as such wisdom, there is a risk of "data overload". The "data overload" actually results in less information available to the mariner and not in more. When looking at the current view on data as static data sets with dynamic overlays, the mentioned risk of data overload can at least be envisioned, in quite a few cases already been experienced.
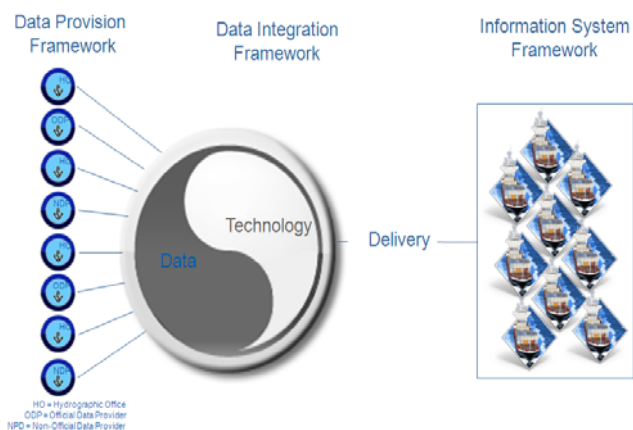

Figure 6. Data Integration Framework - Michael Bergmann

To solve this issue the different data streams need to be integrated and prepared for use to ensure they reach the mariner as meaningful information. For example real time water level information will need to be combined with static shore information, static navigational aid information need to be combined with AIS AtoN information and so on. With this concept the different incoming data streams will be integrated in as a "nautical data collection".

The concept of data integration requires technology to group data into meaningful sets and select data sets as needed. Rendering rules and presentation guidelines will allow displaying the selected and grouped data of the "nautical data collection" needed at a certain situation to better inform the navigator while the traditional "overlay" concept would lead to a less and less informative patchwork. In the integrated data concept the different available data layer will be rendered based on situational needs, i.e. zooming level as desired by the mariner, and as such will result in a situational centric display.

All of this will not reduce the importance of hydrographic data. It is quite the opposite.

Hydrographic data will become the base data set and foundation of a situational centric e-Navigation display of an integrated navigational system. But it needs to be integrated and enriched by all the other data streams, even those which will be available in future and which are not yet envisioned.

5 CONCLUSION

The current development of usage of electronic cartography in the maritime world has taken a step towards situational awareness and as such has matured away from simple chart display. This development will intensify and as such will require in future a change in how electronic maritime information are developed, composed and stored. The future will focus on a variety of static and dynamic data streams to support data integration and situational centric rendering.

With this development the mariner on board will receive the necessary information, which helps to build up the knowledge needed for the wisdom to ensure a safe and efficient journey at sea.

The Hydrographic datasets are the foundation on which this data and information concept is built on.

While all of that is technically possible and well underway, e-Navigation needs to be supported by a change from a regulatory concept defining the detail implementation aspects to a regulatory framework defining the "What", but allowing innovation to specify the "How" based on state-of-the-art and ever evolving technology.

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