TSMAD 25-INF3

Paper for consideration by TSMAD
Feature relationships and coming challenges of e-Navigation

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Executive Summary:	Paper highlights envisioned challenges with e-Navigation and suggests a path forward stressing that unlike S-57, S-101 cannot be developed in isolation from the maritime community.
Related Documents:	(2) S-100 Ed. 1.0.0, S-101
Related Projects:	(2) S-100, S-101

1. Introduction

S-100 was developed using the experiences gained from the S-57 development and originally thought to be the new S-57 version (S-57 4.0). This has naturally led to S-100 having a strong ENC centric foundation. However, as a consequence following the IHO offering of S-100 to IMO as the base standard for e-Navigation as well as S-100 being the base standard for the organizations own digital navigation developments, some of the ENC centric elements of S-100 will be challenged. One such item is the ENC notion of trying to include all relevant data within one dataset and have few or no dependencies on other datasets (aka the paper chart in the digital area). In the e-Navigation paradigm multiple organizations will be making data for various uses and the ENC will represent the base chart, which at a minimum means other datasets will reference the ENC. This emerging reality will likely require a paradigm shift.

2. Anticipated Problem Areas

A. Duplication of information

With e-Navigation, data will be coming from multiple sources and in many different ways. For example, TSMAD is now tasked with investigating how virtual AtoNs can be encoded in ENCs, however, the same virtual AtoNs can be overlayed on the ECDIS from the AIS signals received. Thus, the mariner might get confronted with two or more instances of the same thing. What happens when instances are different? This may be solved relatively easy by having unique identifiers, and rules which says which has priority when. However, this solution might not be a good fix, when for example a coastline is present in two data streams, one being the ENCs and the other being a nautical publication (NP) here the navigation system might trigger an alarm in one dataset and not the other leaving the user to figure out why. The scope of this problem starts emerging when considering that within the S-101 ENC data stream one might have 13 different coastlines in one location and a few more in the NPs and this is only the challenge within one organization. Returning now to consider the situation where an aid to navigation (AtoN) originates at a coastguard or maritime administration, and is then shared with the hydrographic office and also broadcasted via AIS, the number of instances that must be kept up to date and in sync is a big challenge:

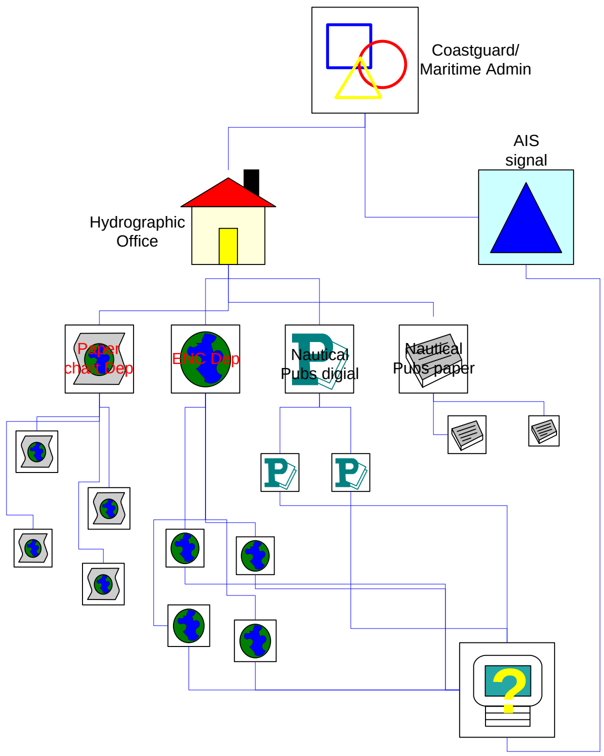

Figure 1 – Multiple instances of one navigation aid

B. Updating

Updating in the ENC (paper chart) paradigm requires the same feature to be updated in each scale band and thus potentially multiplying the work and the number of updates many times over, with the SI features a possible exception. Similarly, updates of different products may have different cycles, so a change in an ENC might be available quicker than say in an NP, thus if it's the same information, the mariner is faced with another factor to consider when having to pick the most relevant information. A change to a virtual AtoN over AIS is virtually instantaneous when in range of the AIS signal, but if the same feature is on the ENC, there may be several weeks lag. Similar scenarios can be expected in various data streams under e-Navigation, unless a more agile solution is developed.

If one data stream is dependant on another, the method of how that dependency is formalized will be critical. For example if one dataset reference features in another dataset, changes in the referenced dataset might force the need to also perform updating on the referencing dataset to maintain the links. If the datasets both come from the same organization, this might be manageable, however, in the e-Navigation era, it is more than likely that several organizations will be involved issuing datasets/data streams with cross dependencies and maybe without the knowledge of the data producer of the data referenced, which may inadvertently cause broken links and anomalous behaviour in systems.

Two agencies might issue AtoNs in the same area, for example physical buoys marking a channel and a virtual AtoN marking section of the channel with low air draft. Updating and normalizing the data in this case must take into consideration that the two items have similar characteristics (location, aids to navigation, etc), but are different items. Therefore a location based identifier is likely not enough to enable a link between data.

How the link between datasets is established, is of paramount importance in ensuring a functional and manageable e-Navigation future.

3. Common feature of problems areas

Common to both the updating issue and data duplication issue is the need to manage the dependencies back to source. Naturally the more instances there are of the same feature the more likely it is that something will be missed and one or more instances become out of sync with the others.

Moreover, as more and more data becomes digital, there will be a watershed moment where a decision need to be made whether each data stream should include all relevant information, and thus increase the number of instances of the same information, or to reduce the number of instances and manage the references between data streams better to support the principle “one feature, one instance, used many times”.

Jeppesen proposes to choose the “one instance used many times” approach and have started to sketch how such a solution can look like, below.

4. Solution Approach

A. Likely solution

With e-Navigation, data from different organizations need to be interlinked to combine the same information into a single item for the end user. Different and same attributes from different organizations need to be combined, and then the particular use of that data then affects which attributes are needed at any given time. This will likely require a more comprehensive solution.

Given the complexity of the problem, a solution is likely to require a few different components. It is also likely that the feature identifier will require improvements from the FOID used in the S-57 ENCs, as well as a redefinition of how datasets are defined. The latter is already taking shape with the Scale Independent and Scale Dependant separation in S-101.

B. Universally Unique Identifiers (UUID)

Unique Identifiers should be unique for the lifetime of the object to avoid breaking linkages. Nothing should be included in the UUID that can be changed on a regular basis. The UUID should be generated at the creation of the first instance of a feature; this UUID should then be broadcasted to all likely users (including re-broadcasters). The method of generation of a UUID should be stored in the GII registry to allow referencing and interpretation.

Artificial: Artificial ID, usually computer generated key, in a certain format, and usually does not relate to any physical characters of the object (e.g. Record Identifier in ENC). Usually used in systems when you want to ensure that any change to any attribute can be done in the system without any effect on the key. Rarely are artificial IDs used for identifying objects from other organizations. This is because it would be needed to have a register of the keys to ensure that both organizations know what the key is. The problem is that you cannot guarantee that the key is unique within the other organization.

Natural: Is a UUID that consists of attributes of an object, which means Germany Hamburg harbour as an identifier for the harbour in Hamburg. Risk of running out of natural attributes to identify a feature. E.g. USA Coastguard buoy – many buoys can have this id.

Fusion of artificial and natural: FOID is a combination of the two; producer code is natural, while the number is artificial. Updating can be difficult if organizations responsibility change, or name changes etc, as linkage would be broken. However, the number of combinations is infinite.

C. Data management under e-Navigation

In e-Navigation the goal should be to have data normalized in a way where the data is stored only once, linked together with other data in a way that allow the various e-Navigation uses, so the updating and maintenance is done only once.

One solution might be to revise the understanding of what a unit/dataset is under the e-Navigation paradigm. In the ENC paradigm the unit is the cell, a concept more or less inherited from the paper chart. But for reasons discussed earlier in this paper, this may be too coarse for e-Navigation. In AIS each feature is its own item/unit, this might be too granular for all types of data, particularly considering features like soundings and underwater rocks. Therefore a solution should probably be somewhere in the middle. Perhaps a concept that was discussed during SNPWG15 might be worthwhile exploring. The concept is still in its inception phase and the members of SNPWG have taken an action to discuss this concept within their organizations and report back at SNPWG16.

The basic idea is to break everything down into narrow themed products/data streams, keep everything at best scale available or scale independent and define functions (or publications/products as we know them today) as a stack of a few or many of the data streams along with rules for how the system using them aggregate them and interact with them. For example, the scenarios discussed for NPs is to have all regulations in one data stream, all lights in another, pilot information in another and so on. That way the regulations data stream is maintained and distributed only once, but used multiple times such as for example in sailing directions and in radio signals.

Similarly ENCs could be divided into narrow themed data streams, harmonized with NPs and other data streams. The function served by S-57 ENC could then be defined as a stack of the relevant data streams. Figure 2 below illustrates the concept. For example, a hypothetical VTS screen "function" in a S-100 compatible Vessel Traffic Service/Control might display all content from some data sets (coastline, VTS, TSS, etc.) and only particularly relevant parts of others (high-definition bathymetry and prominent soundings, dangerous wrecks and underwater rocks, etc), with the displayed features from the needed data streams being referenced by means of pointers to the relevant parts.

The rules for how interaction will work are still needed, but it is likely that a strict regime with universally unique identifiers is needed to facilitate any form of interaction between data streams to allow creation of stacks.

E-Navigation Data streams and functions

	Coastline	VTS	TSS	Sounding High-def bathy	Pilotage	Wrecks Obstructions	Underwater rocks	Radio signals	Light Marks	Harbour Facilities
Navigational Chart	Use	Reference	Use	Use	Referece	Use	Use	Reference	Use	Reference
Sailing Directions	Use	Use	Use		Use	Reference	Reference	Refernece	Reference	Use
List of Lights									Use	
Radio Signals		Use	Use		Reference			Use	Reference	Reference
VTS screen	Use	Use	Use	Reference	Use	Reference	Reference	Use	Use	Reference

Use means used fully
References means used partially

Figure 2 – Functional stacks. The horizontal axis shows data streams, the vertical axis functions/products. In the matrix use means to use fully and reference means to use partly.

5. Further development

A. Rules

As discussed above, it is unavoidable to develop some form of robust mechanism for referencing features across datasets. However, along with that come strict rules that are necessary to maintain integrity and robustness in the system being established. These rules must be developed for the data creation, distribution and use stages. For example, if one dataset references a lights feature in another dataset, and for whatever reason the target dataset is unavoidable, what happens? Ideally, the system using the data should do all this integrity checking while still in port where good communication systems are available. But if for some reason this even occurs during voyage, what should happen? For this scenario and others, rules and procedures must be developed.

B. S-100 impact

The suggested solution moves most of the scale concept from the creation of the data to the use of the data. Although this is not frequently discussed, this is already happening in ECDIS where it is possible to zoom in/out in the S-57 ENCs independently of the compilation scale set in the dataset. Work is also underway in S-101 to better define the rules that systems reading the S-101 data should follow when displaying the data. The suggested solution would be a natural extension of this work.

6. Actions for TSMAD

a. TSMAD is invited to note this paper

b. TSMAD is invited to establish a sub working group to further develop the proposal in this paper as a general guideline within S-100 and e-Navigation overall on how to solve the data duplication issue.