Bridge Use of S-100 based Products

TSM7
23-26 September 2019

Raphael Malyankar

Eivind Mong

On behalf of S-100 WG Chair

Overview

- Initiate in-depth discussion of navigation uses of S-100-based data products.
  - The focus is on which (S-100) data products are suitable for front-of-bridge (FoB) use and hence should be covered by S-98 interoperability implementations.
- Systematic approach to classifying data products (or parts of them) as front or back of bridge.
  - Defines front-of-bridge/back-of-bridge systems.
  - Proposes criteria for selecting data products as FoB.
  - Describes (summarizes) the factors affecting the selection of a product as FoB.
  - Contains an initial list of data products suitable for FoB use – and thereby for initial implementation of S-98 interoperability.
- Recommendations:
  - Next steps for validating the designation of products as FoB.
  - Add support for interoperability to S-100 itself as well as S-100-based product specifications.

Definitions

- “Front-of-bridge” versus “back-of-bridge” is determined by the role being filled by a system, regardless of its location.

- Definition: A front-of-bridge (FoB) system is a system in use by the operator responsible for ship’s handling, usually at the main or relief workstation for ship’s handling.
- Definition: A back-of-bridge (BoB) system can be any system which is not being used as a front-of-bridge system, has a part in ensuring the ship complies with SOLAS Chapter V REGULATION 34, and is capable of loading S-100 based data products.

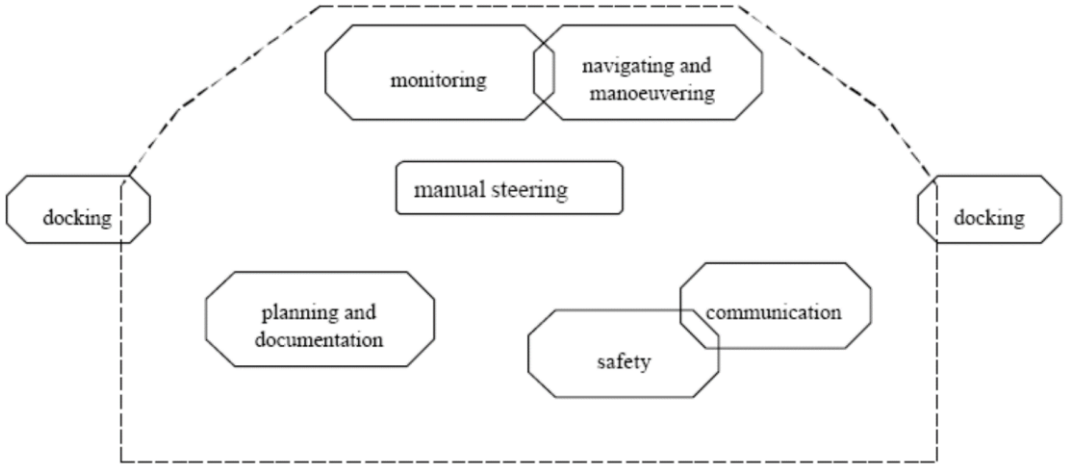


Fig. 1: Example of function areas – showing a possible location of workstations

From IMO MSC/Circ. 982

Definition – Front of Bridge system

- "Definition: A front-of-bridge (FoB) system is a system in use by the operator responsible for ship's handling, usually at the main or relief workstation for ship's handling.
  - It is normally the system at the "workstation for navigating and maneuvering" as described in IMO Circ. 982 (reproduced in Appendix B of this paper). The system (if any) at the "workstation for monitoring" is normally also included as front-of-bridge when it is shared with, or being used as a reliever for, the workstation for navigating and maneuvering. (Circ. 982 does not specify a separate ECDIS at the workstation for monitoring.) The front-of-bridge system can be one or more independent ECDIS systems (e.g., main and backup, according to the IMO ECDIS performance standards).
  - If a system in another location on the bridge (e.g. bridge wing) is temporarily playing the role of the main workstation for ship's handling, it must be treated as a front-of-bridge system for the time being.

Definition – Back-of-bridge system

- Definition: A back-of-bridge (BoB) system can be any system which is not being used as a front-of-bridge system, has a part in ensuring the ship complies with SOLAS Chapter V REGULATION 34, and is capable of loading S-100 based data products.
  - It is normally the system at the “workstation for planning and documentation”, as described in Circ. 982. It may be the same system as the backup ECDIS (but the same physical system cannot play both roles simultaneously).

Criteria for designating a data product as FoB

- The product contains geographic feature data that is critical or important for ship's handling and monitoring and which is capable of replacing, substituting for, or updating information in the ECDIS used by navigators for ship's handling and monitoring.
  - Definition: "Capable of replacing, substituting, or updating" means data that conveys equivalent knowledge within known, tolerable uncertainty.
  - "Information critical or important for ship's handling and monitoring" of ship movement on ECDIS would normally be ENC data.
- The product contains geographic feature data that is critical or important for ship's handling and monitoring and which enhances or supplements similar information in the systems used by the navigators responsible for ship's handling and monitoring.
  - Definition: "Enhances or supplements" means the product provides additional or more up-to-date information, e.g., additional features like weather hazards, additional attributes for existing features, or more accurate values for some attributes, but is not a complete replacement for a feature layer.
  - A data product which enhances ENC information with additional information meeting this criterion is qualified for front-of-bridge.
  - It does not have to be a replacement or substitute for ENC data, nor does it need to meet the same quality requirements as ENC data.

Factors

Human factors

- Information overload
- Symbol proliferation
- OEM variations
- Stress, fatigue
- Visibility
- Individual work styles

Regulatory

- Possible regulation of data products allowed FoB?
- Obscuring “SENC” information

Production

- Data product availability
- Frequency
- Timeliness
- Data degradation

Delivery

- Volumes
- Channels
- Data streaming
- Well-defined APIs and/or delivery processes.

Quality

- As compared to the updated or replaced product?
- Safety & urgency vs. quality.

General Requirement: Products satisfy the criteria for FoB and have suitable portrayal catalogues defined.

Summary classification of data products

Candidacy for FoB use	Data products	Inclusion in normative FoB interoperability catalogue (IC).
Certain or highly likely	S-101 (ENC) S-102 (Bathymetric surface) S-104 (Water Levels) S-111 (Surface Currents) S-124 (Nav. warnings – selected types) S-129 (UKCM – only go/no-go areas?)	All products should be Covered by the FoB IC. Inland navigation may need a different normative IC. S-401 and S-402 are not listed because they belong on Inland ECDIS.
Probable	S-412 Weather and Wave Hazards – features selected by proximity, timeliness. (Perhaps also the size of the area, e.g., warnings covering relatively large areas may be better communicated to navigators by other means.)	Covered.
Possible or conditional	S-411 (Ice Information – selected feature types) – depending on release frequency and timeliness of data S-413 (Weather and Wave Conditions) or S-414 (Weather and Wave Observations) – depending on localization and timeliness of data.	Covered/Not Covered TBD, pending discussions with the respective project teams.

Rules for replacement - 1

Product	Rule	Suggested implementation
S-102 Bathymetric surface	S-102 data must originate from an official source such as a hydrographic office.	Compare producer in metadata to IHO S-62 list of producer codes.
	S-102 data can only replace ENC depth information in dataset originating from the same source.	Compare producer in metadata of S-102 and ENC datasets.
S-104 Water levels	S-104 data must originate from an official source such as a hydrographic office.	Compare producer in metadata to IHO S-62 list of producer codes.
	S-104 data can only replace ENC depth information in dataset originating from the same source.	Compare producer in metadata of S-104 and ENC datasets.
S-111 Surface currents	S-111 data must originate from an official source such as a hydrographic office.	Compare producer in metadata to IHO S-62 list of producer codes.
	S-111 data can only replace surface current information in datasets originating from the same source.	Compare producer in metadata of datasets.

Rules for replacement - 2

Product	Rule	Suggested implementation
S-124 Nav. warnings	Must be valid according to most recently received in-force bulletin, or received afterwards.	Check list in the in-force bulletin. Check if warning date/time is after the most recent in-force bulletin.
	Must be within any filtering parameters	Spatial filter by proximity to planned route. Temporal filter by difference from time of planned passage. Filtering parameters may depend on type of event and be customizable on board.
	(Display)	Is an overlay and does not replace ENC data directly, rather provides navigational safety information that may impact the reliability of some ENC data.
S-129 UKCM	Must be an updated dataset from a UKCM service along route.	Check producer in metadata to IHO S-62 list of producer codes. Compare production or validity time to time of planned passage.
	Updates must be received at regular and/or prescribed intervals.	Compare production or validity time to time of planned passage.
	(Display)	Is an overlay, but may be created from more recent sources than ENC data and therefore be fit to replace depth information.

Rules for replacement - 3

Product	Rule	Suggested implementation
S-411 Ice	Must be an updated dataset from an Ice Service	Compare production or validity time to time of planned passage.
	(Display)	Temporary overlay to validate safety and efficiency of route execution.
S-412 Weather and wave hazards **S-413 Weather and wave conditions** **S-414 Weather and wave observations**	PS in development, rules tbd. (Similar to S-124 rules?)	Is an overlay product and do not replace ENC data.

Related observations

- Defining which products should be BoB would also be useful
  - To clarify the FoB list.
  - For voyage planning.
  - For developers of ECS and other non-ECDIS systems.
- Voyage plan may have to be annotated with additional information, or specific data layers transferred from BoB to FoB.

Conclusions

- Further stakeholder input to the list of FoB projects should be obtained.
- Mariners should have choices about displaying FoB products in the primary navigation window other than mandatory information.
  - Choice could be controlled by the vessel's master, at the start of the voyage. The master and navigation officers should get the information that helps them decide in an easily-digestible form.
- Data products may be partly FoB and partly BoB.
  - Defining the FoB and BoB parts should be supported in the product metadata, portrayal catalogues, etc., as well as in the PS development process.

Recommendations – Near term

- For the initial interoperability implementation, use:
  - S-101 (ENC); S-102 (Bathymetric surface); S-104 (Water levels); S-111 (Surface currents); S-124 (Navigational Warnings); S-129 (UKCM)
- Agree upon definitions and criteria proposed in this paper:
  - FoB and BoB
  - Criteria for designating a data product FoB.
- Obtain wider stakeholder input:
  - Circulate this paper as-is for stakeholder feedback;
  - Prepare and circulate a factorial matrix analyzing candidate products on the basis of each of the factors identified in this paper;
- Clarify what is expected of data producers for FoB products and when, e.g., phase in FoB data at different times in different places.
- Extend S-100 metadata (Part 4a) to specify FoB or BoB use (or both) for datasets.

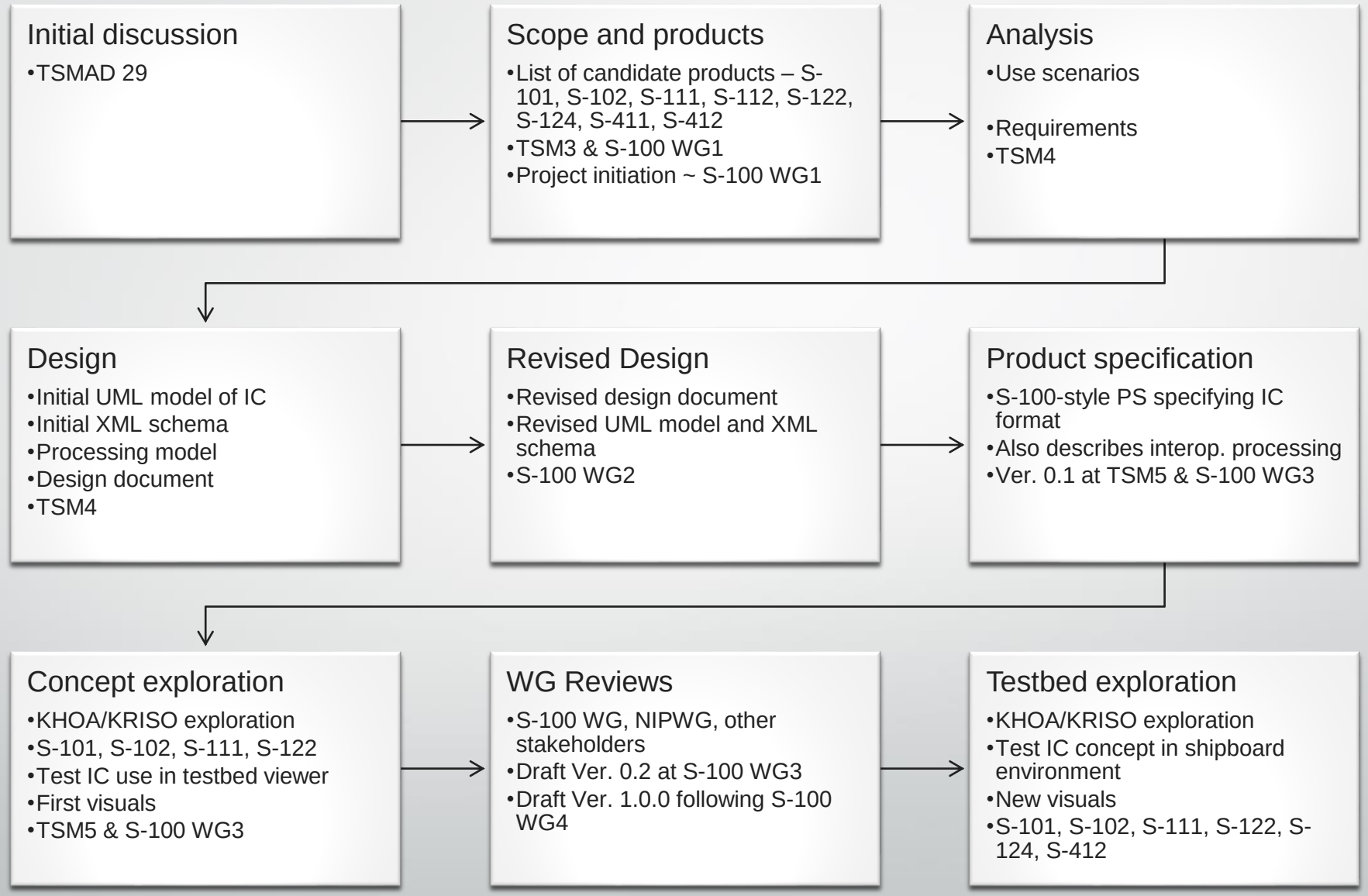
Recommendations – Medium term

- Review the FoB list as product specifications mature.
- Request product specification project teams to develop suitable descriptions of their data products as soon as possible.
  - Develop criteria for what constitutes an adequate description for the FoB/BoB designation.
- For products where only selected feature types are expected to be used front-of-bridge, request project teams to:
  - include specification scopes in the product specification, distinguishing FoB from BoB features (and potentially attributes too), and
  - define separate portrayal catalogues for Fob/BoB use.
- Extend S-100 metadata (Part 4a) with metadata attributes that allow indication of the specification scope(s) included in a dataset. (Similar recommendation in TSM7-4.7.)
- Develop a model of temporal validity for FoB use and extend S-100 metadata with (optional) temporal validity attributes.

Actions requested

- Endorse or revise the analysis of individual product specifications in Table 3, providing justifications.
- Based on the results of action 1, endorse or revise the summary classification in Table 1 including coverage/non-coverage by the initial normative interoperability catalogue.
- Further development of the rules for data replacement in Table 2.
- Discuss means for obtaining wider stakeholder input to classification of products as FoB.
- Endorse the recommendations set forth in the Recommendations section, as modified during the meeting.

S-98 PROGRESS



Appendix A. Detailed analysis of S-100 products respecting their use front-of-bridge

Key for Table 3: Y or N = definitely use / definitely do not use
? = undetermined
C = conditional use; the notes column elaborates on the conditions.

Undetermined or conditional classifications will change to Y or N as the relevant product specification is better defined and production issues arise and are clarified over time. Products classified as undetermined must not be used in front of bridge systems; products classified as conditional must not be used unless the conditions are satisfied and there is a well-defined process and product metadata for indicating that they are satisfied. In short, if this paper evolves into a specification or guideline, only the products classified as "Definitely Use" for front-of-bridge systems may be used on them.

The question "What is the timeframe for beginning production and dissemination of data?" applies to all products in this table.

Table 3. Candidacy of S-100 products for front-of-bridge use

Product	FoB	Notes
International Hydrographic Organization (IHO) (S-101 to S-199)		
S-101 Electronic Navigational Chart	Y	Base information
S-102 Bathymetric Surface	Y	Detailed gridded data about depths. It is reported that some HOs or defense agencies are of the opinion that S-102 is covered by S-101 (the reason should be determined – perhaps arguing that S-101 will make it easier to have higher intervals of depth areas than S-57?). Availability being likely especially given some producers' (NOAA; others TBD) plans to produce and distribute high-definition bathymetry, this is a likely candidate for FoB use. Delivery aspects (volume, etc.) may need to be addressed.
S-103 Sub-surface Navigation	?	Not enough information available for classification vis-à-vis FoB or BoB. Unlikely to be relevant to surface navigation – likely to be more relevant for military (submarines) which would generally use WECDIS. If this is also used for remotely operated submersibles or autonomous underwater vessels, "front-of-bridge" must be interpreted in that context.
S-104 Water Level Information for Surface Navigation	Y	Gridded data and localized data about water levels. Real-time or near real-time availability TBD, but expected to be available. Availability being likely especially given some producers' (NOAA; others TBD) plans to produce and distribute datasets, this is a likely candidate for FoB use. Delivery aspects (volume, etc.) may need to be addressed.
S-111 Surface Currents	Y	Gridded data and localized station data about surface currents. Real-time or near real-time availability TBD, but expected to be available. Availability being likely especially given some producers' (NOAA; others TBD) plans to produce and distribute surface current datasets, this is a likely candidate for FoB use. Delivery aspects (volume, etc.) may need to be addressed.
S-121 Maritime Limits and Boundaries	N	Format for encoding claims as to limits, boundaries, and claimed rights over maritime regions. The project team's intentions regarding use as FoB or BoB are TBD. May be FoB for military vessels.
S-122 Marine Protected Areas	N	BoB, under the assumption that all the navigation-critical information is in the ENC. That is, the MPAs with navigation or movement-related restrictions are coded in the ENC as restricted areas. Described on the NIPWG web site as "protected areas and related features, regulations, and similar information about protected areas." Provides additional information about MPAs which is useful for planning. May provide details useful for monitoring (rather than navigation or manoeuvring), e.g., regulations regarding overtaking or passing. Depends on whether the

Product	FoB	Notes
		monitoring workstation is classified as FoB or BoB (or being used in an FoB or BoB role).
S-123 Marine Radio Services	N	Radio information which may be immediately needed at FoB workstations, such as communication channels for radio calling points, should be in the ENC or provided by other means at the workstation. The NIPWG web site describes S-127 as "indicating the location, availability, type of radio communications, frequencies, and content of radio services for navigational information and other maritime radio communications." As such this is intended to be a BoB product rather than FoB.
S-124 Navigational Warnings	Y	Navigational Warnings (subset of MSI) is needed in FoB and BoB, but there are potential issues with information overload and screen clutter (reported during discussions with navigators and Sea Traffic Management test-bed participants). Also, S-124 covers one part of the whole global navigational warning provision system. WWNWS-SC currently considers S-124 an additional method to provide navigational warnings and not as a replacement of existing methods. S-124 is developed for ECDIS, and as an enhanced version of todays NAVTEX and recognized mobile satellite service. As noted in the 'S-124 Training manual for NAVAREA Coordinators draft'; 'Some ECDIS manufacturers may provide an interface into the ECDIS for information received over NAVTEX or recognized mobile satellite service. This interface will use a text convertor to interpret the received text in order to identify positions and facilitate the geo-location of the information using the symbols unique to the manufacturer'. Navigational warnings received via NAVTEX or recognized mobile satellite service are both of direct printing type, and interpreted by a system that attempt to geo locate this information. Errors can occur from a variety of causes such as receipt error, missing characters, misinterpretation by software etc. The draft Training manual further notes that 'Within S-124, the standardized format for conveying navigational warning information is facilitated by the data model and its encoding format. The risk of reception errors is eliminated since S-124 will make use of the integrity measures as defined by S-100'. Other integrity measures like data validation checks will further improve the quality of S-124 Navigational Warnings versus NAVTEX and recognized mobile satellite service. The human factors considerations suggest that only a carefully selected subset of feature types, filtered by timeliness and relevance to the vessel's route should be displayed FoB. Views differ at this time about what kinds of filtering should be applied. Wider review of this paper should endeavor to develop either a common view, or a strategy allowing on-board customization of filtering. The position of the S-124 CG is that navigation warning information should be filtered only by time and all other navigation warning information within the chart screen should be on all the time in route monitoring mode. The MSI report list would be used to tell the mariner about MSI outside the screen but with an area affected which intersects the screen
S-125 Marine Navigational Services	N	Probably will be intended only for voyage planning and therefore not FoB. The NIPWG Web site describes S-125 as "navigationally [significant] features including lights and other navigation aids, both physical and virtual, temporary and seasonal marks, and local AIS application-specific messages."
S-126 Marine Physical Environment	N	Expected to be climatic or oceanographic information, or notable information about the physical environment of significance to navigation. The NIPWG Web site describes S-126 as "marine and terrestrial topography, prevailing, seasonal, and hazardous currents, tides, weather, and other environmental conditions." Does not include real-time or near real-time data. Intended for voyage planning and therefore a BoB product rather than FoB. Navigationally

Product	FoB	Notes
		significant hazards or other significant features should be encoded as features in the ENC.
S-127 Marine Traffic Management	N	Intended for planning use rather than navigation or manoeuvring. The NIPWG Web site describes S-127 as "vessel traffic services, pilotage, routeing systems, and ship reporting systems." The actual specification also includes basic descriptions of underkeel clearance management areas.
S-128 Catalogue of Nautical Products	N	Catalogue of data products, intended for product lookup, online product catalogues, and preparations for voyage planning. The NIPWG Web site describes S-128 as containing "the product, coverage, and publication information of various products, ranging from paper publications such as paper charts and printed sailing directions to digital products such as ENCs and e-Navigation services."
S-129 Under Keel Clearance Management (UKCM)	Y	Go/no-go areas are potentially relevant to navigation. FoB use will require sufficient temporal detail and/or timeliness to be relevant to current or near-future water level conditions. Note that since ECDIS is assumed NOT to have direct internet access, dynamic UKCM information is not accessible directly from the ECDIS (unless it arrives over a different, allowed, comms medium). Perhaps it can be routed via an intermediate back-of-bridge system which can act as a firewall?
S-1xx Marine Services	N	Scope to be determined, but almost certainly for voyage planning.
S-1xx Digital Mariner Routeing Guide	N	Intended for voyage planning, as a digital equivalent of S-49.
S-1xx Harbour Infrastructure	N	Intended for voyage planning and planning in-harbor non-navigational activities. Harbor charts expected to be used for within-harbor ship movements.
S-1xx (Social/Political)	N	For voyage planning.
International Association of Light Authorities (IALA) (S-201 to S-299)		
S-201 Aids to Navigation Information	N	Focuses on management and maintenance of navigation aids. Potentially an input to S-101 and S-125, but not of use for navigation due to redundancy with S-101 features and potential incompatibility with navigational aid feature types in S-101.
S-210 Inter-VTS Exchange Format	N	Intended for shore to shore information exchange.
S-211 Port Call Message Format	N	BoB use for notifications, scheduling port calls and services, and service management with port authorities. No effect on ship handling or manoeuvring and therefore not for FoB. May need an interface to voyage planning (BoB).
S-230 Application Specific Messages	?	Need more information on what this covers, presumably AIS ASM but its utility for voyage planning and criticality for navigation depends on what information is conveyed. As of August 2019, work on S-230 appears not to have begun.
S-240 DGNSS Station Almanac	N	Input to HO products, e.g., S-101 and S-125. Navigationally useful information will presumably be added in S-125 datasets.
S-245 eLoran ASF Data	N	Presumably eLoran signal propagation Additional Secondary Factors, and therefore potentially relevant for planning? Navigationally useful information will presumably be added in S-125 datasets. Need more information. As of August 2019, work on S-245 appears not to have begun.
S-246 eLoran Station Almanac	N	Need more information. Presumably the same role as the DGNSS station almanac, but for eLoran stations. Navigationally useful information will presumably be added in S-125 datasets. As of August 2019, work on S-246 appears not to have begun.

Product	FoB	Notes
S-247 Differential eLoran Reference Station Almanac	N	Need more information. Presumably the same role as the DGNSS station almanac, but for differential eLoran stations. As of August 2019, work on S-230 appears not to have begun.
Intergovernmental Oceanographic Commission (IOC) (S-301 to S-399)		
(unknown)	N	Presumably intended for scientific use, not navigation or voyage planning applications.
Inland ENC Harmonization Group (IEHG) (S-401 to S-402)		
S-401 IEHG Inland ENC	Y	FoB, but for Inland ECDIS.
S-402 IEHG Bathymetric Inland ENC	Y	FoB, but for Inland ECDIS.
Joint Technical Commission for Oceanography and Marine Meteorology (WMO/IOC JCOMM) (S-411 to S414)		
S-411 JCOMM Ice Information	C	FoB use depends on timeliness. If datasets are produced frequently enough (daily?), they may be useful in FoB to indicate hazardous "open water" areas with drift or pack ice, or variation of the nominal shoreline or sea floor depth due to fast ice or pack ice lodged against the shore. Or possibly only some types ice features may be suitable for FoB. (To do: check what features S-411 includes; and refer to JCOMM for advice.)
S-412 Weather and Wave Hazards	?	Part of Maritime Safety Information. Weather messages (watches, warnings, advisories, outlooks, synopses). Weather systems (cyclones, thunderstorms, tracks, cone of uncertainty). Spatial representations hazard and warning polygons, curves & splines for weather systems. Probably GML datasets. Timely information about localized hazards near the route may be useful FoB. Longer-term and larger warning areas and text forecasts are probably more suited for BoB use.
S-413 Weather and Wave Conditions	?	Conditions charts, grids, forecasts, nowcasts(?). Precipitation, wind, temperatures, etc. Probable formats HDF5, GML.
S-414 Weather and Wave Observations	?	Ship and buoy observations, satellite data. Source data is point-based data. Probable formats HDF5, GML. In principle timely observational data would be useful FoB, but may not be in a form suitable for direct use FoB by navigators. Filtered spot observations especially concerning anomalies are potentially useful, but should probably be ingested and analyzed on BoB systems before passing to FoB systems.
International Electrotechnical Commission - Technical Committee 80 (IEC-TC80) Numbers (S-421 to S-430		
S-421	Y	Route exchange information is important for both FoB and BoB operations.
NATO Geospatial Maritime Working Group (GMWG) for Additional Military Layers (AML) Numbers (S-501 to 525		
Additional Military Layers	N	Intended for WECDIS. Out of the scope of this analysis.