Paper for Consideration by S-100 WG TSM7

S-98 Interoperability Scopes

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Executive Summary:	Describes how the draft S-98 interoperability specification can be revised to facilitate a limited and phased introduction of interoperability.
Related Documents:	--
Related Projects:	S-98

Introduction / Background

The May 2019 draft S-98 specification for data product interoperability describes four levels[1] of interoperability between S-100-based data products, of successively increasing implementation complexity. This paper defines potential approaches to revise the S-98 specification to distinguish interoperability levels of increasing complexity and separate them into well-defined, successive scopes. This will facilitate phasing in interoperability with pauses between phases to evaluate the results and update the S-98 specification and implementation plan if necessary.

References

S-98 – Data Product Interoperability in S-100 Navigation Systems (Draft – HSSC11, May 2019). HSSC11-05.1A. At HSSC11 documents page (<https://www.iho.int/mtg_docs/com_wg/HSSC/HSSC11/HSSC11Docs.html>).

S-100 – Universal Hydrographic Data Model. Edition 4.0.0 (December 2018).

Discussion

This paper has been put together to address some of the concerns raised by Member States regarding how S-98 will work in practicality. In addition, since S-98 was first conceived and the initial analysis that defined the different levels of interoperability, it has been determined that S-98 potentially should be "de-scoped" to concentrate on the initial implementation of the S-98 concepts.

It should be noted that the concept of interoperability applies in both "front-of-bridge" and "back-of-bridge" systems. Front-of-bridge is obviously critical and support of safe navigation and smooth functioning in front-of-bridge systems is more important.

The phased implementation of interoperability catalogue scopes may face delays in the current ECDIS maintenance paradigm. All stakeholders should be made aware that a staggered implementation of interoperability is likely to require software updates in user systems already at sea.

The interoperability levels are described below.

- In **Level 1**, feature types from different products, including S-101, are interleaved as specified by display plane and drawing priority information contained in the Interoperability Catalogue. Feature layers from other products may be interleaved with ENC feature layers to prevent ENC data from being obscured.
- **Level 2** allows suppression of all features of a specified feature type in a specified product by a feature type from a different product. Filtering by attribute values and geometry type is also possible. Predefined combinations (PDCs) are introduced, so that the display can be customized for different sets of loaded products.
- **Level 3** allows feature hybridization – enhancement or combination of thematic attributes using rules specified in the Interoperability Catalogue, and treatment of the result as a notionally unified feature for display. Only thematic attributes can be combined in Level 3. For example, re-calculation of values of a numeric attribute or addition of listed values to an enumeration attribute.
- Levels 1-3 assume exact spatial coincidence of interacting features (within system tolerances). **Level 4** drops the requirement for exact coincidence and defines spatially-aware interoperability. Complex spatial queries (INTERSECT, etc.) can be defined to determine related subsets of features, and interoperation

[1] Technically 5 levels are described, Level 0 (no interoperability) is also a level.

results are defined using an adequate set of spatially-capable rules. This means that the interacting feature(s) need not be spatially equal, they need only be related to one another by the spatial query. For hybridization, in addition to thematic attributes, feature geometry can also be combined using spatial operations.

- Formally, there is also a **Level 0** interoperability, defined as turning off all interoperability processing. Layers are allowed, but are treated as whole units and may conceal the features in overlapped sections of lower layers.

Options for Re-scoping S-98

The following options are proposed to reorganize or supplement the May 2019 draft. These options are not all mutually exclusive, any combination can be adopted.

1) Incorporate the abstract specification part of S-98 into a new part of S-100 and S-98 stands as an implementation specification

The current iteration of S-98 is a mixture of an abstract specification defining interoperability – such as the structure of an interoperability catalogue and guidance on portrayal for interoperability. At the recent sea trial hosted by KHOA, there was a indepth discussion on how S-98 should be structured and one of the proposals was to split S-98 and absorb the abstract specification and mechanisms into a new part of S-100 and that S-98 itself could be a multipart implementation. For example, there would be one implementation for Front of Bridge Products and a second for Back of Bridge. This would also allow S-98 to become a specification which contains the guidance to tie the various parts of ECDIS (FoB) operation together. It has been pointed out that current elements that are contained within S-52 required for ECDIS do not have a home within the S-100 framework. For example, status report, portrayal framework, loading/unloading (this is in S-101), messages, and others. These elements make up part of the operation of the ECDIS (in the S-57 context) and facilitate the use of the ENC data for navigation while not necessarily being concered purely with its display.

2) Use specification scopes to distinguish levels and separate them in the specification

S-100 Part 11 allows product specifications to define “specification scopes”. This concept can be applied to interoperability catalogues, which are the “data products” defined by S-98. Successive levels described in S-98 introduce additional classes and attributes to the interoperability model and correspondingly, additional elements in the XML format for interoperability catalogues.

The tentative proposal is to define successive scopes as just the additional part, so for example, the L2 scope would consist of the S100_IC_PredefinedCombination and S100_IC_SuppressedFeatureLayer from S-98 draft Figure 4.8 (reproduced in Appendix A to this document).

The introduction of specification scopes will facilitate reorganization of the document to describe different levels in clearly distinguishable parts of the document, labelled with the appropriate scope identifier. This separation may also make it easier to add interoperability levels later.

Clauses describing to Levels 3 and 4 can be declared informative in Edition 1.0.

Specification scope information (S-100 Table 11-3) for the various levels is shown in Appendix A.

3) Divide the specification to have a distinct Part for each level

In addition to (or instead of) introducing scopes the document can be reorganized into Parts A-D, either in the same file or separate files. There would be a separate Part for each level, labelled with the scope identifier, and containing all the information specific to that level, including the additional UML classes and attributes, XML schema, portrayal interoperation rules, etc.

This option is similar to item (2) but makes the separation of different levels of interoperability clearer. It separates levels into distinct compartments which can be implemented when the S-100 ecosystem, including the human participants, is ready for each level.

As for item 2 above, Parts C and D corresponding to Levels 3 and 4 can be declared informative in Edition 1.0.0.

4) Scope conformance clause

Add a conformance section in S-98 with a table specifying which clauses (or Parts) of the revised S-98 belong in each scope. This would be largely redundant with the “different Parts” idea in item (3), but useful for item (2). ISO 19115-3 is using a similar idea in defining conformance classes for various content modules defined by ISO 19115-1 and ISO 19115-2, to allow these to be used as components in other interchange document implementations.

5) Move levels 3 and 4 into an informative annex or white paper.

Remove levels 3 and 4 from the S-98 document altogether (either conceptually or in practice). A separate white paper or informative Annex describing Levels 3 and 4 would be prepared as an adjunct to the actual specification.

Information pertaining to Levels 3 and 4 should be published even if these levels are not part of the initial implementation, because Levels 3 and 4 address potential problems which are not resolved in Levels 1 and 2. Decisions as to whether and when Levels 3 and 4 come into effect can be made later based on experience with Levels 1 and 2.

6) Supporting documents

The draft interoperability functional overview document should be revised to address feedback received and to conform to the final structure of the S-98 1.0.0.

An implementation roadmap needs to be prepared. Some or all dates and intervals can be notional, and fixed as implementation progresses. E.g., in the initial version planned dates for Levels 2 and higher can be notional.

7) Change S-98 into a guideline for interoperability and leave technical details to each OEM

S-98 in its current form is a highly technical and prescriptive document that outlines in detail how to go about making interoperability work in S-100 ECDIS. This nature of the document requires deep technical insight to maintain and implement. Changing S-98 into a guideline of visuals for how interoperability should work on the screen, and leaving the technical implementation details to each OEM can simplify the management of S-98. This significant change would make S-98 a cartographic document that elaborates the priorities for each data object in the described scenarios. The guideline would also have to describe if scenarios not described are permissible and how much freedom to arrange the navigational chart the OEMs and users would have. With this option, type approval would work in the same way as S-64, with IHO supplying test data and reference screen shots and the type approver comparing the image with reference screen shot.

Related Matters

The XML schemas can be split into XSD files corresponding to different scopes, though this would be somewhat more complex than maintaining them in one XSD file.

The scoping idea applies not just to the UML application schema, but also to related components such as portrayal rules.

It should also be possible to separate each level into a separate dataset, so an S-98 “exchange set” that implements level 2 would have two separate catalogue XML files – one for Level 1 and the second for Level 2. However, processing may be more complex with different IC files for different levels. These separate schemas would have to be developed as part of a re-structuring of S-98.

The classes and attributes of S-98 metadata should be the same for all levels. An additional metadata attribute is needed in S100_CatalogueMetadata to indicate the scope(s) of an interoperability “catalogue” (XML file). This attribute should be added at the S-100 level (and also to S100_DatasetDiscoveryMetadata) in S-100 Part 4a, since other data products which use specification scopes may have the same need in the future.

Implications of Implementing only Level 1 vs. Levels 1 and 2

In **Level 1** processing, feature types from different products, including S-101, are interleaved as specified by display plane and drawing priority information contained in the interoperability catalogue. The output of interoperability processing is either the original feature data (processing option 1) or drawing instructions (processing option 2), accompanied by display plane and drawing priority information, which is passed through to the portrayal processor.

In **Level 2** processing, it is possible to suppress all features of a specified feature type in a specified product, with another feature type from a different product being displayed instead. Filtering by attribute values and geometry type is also possible. The output of interoperability processing is the same as Level 1 with certain feature types suppressed. Level 2 also adds the concept of predefined combinations which allow IHO to define what products should be combined and in which order.

The analysis in this section takes into account that interoperability catalogues are for both “front-of-bridge” and “back-of-bridge” systems. The actual products on the system will of course differ between the two scenarios. Also, there may be different interoperability catalogues in use in the two different scenarios.

If only Level 1 interoperability is allowed, in case of similar feature layers from different products, both layers will be on-screen and both can be potentially presented to the mariner. Interleaving may permit the system to place the layer with the more detailed or more recent feature on top, but both are potentially visible depending on their geometry. Pick reports will produce data from both, and the mariner will have to review both and make a decision of how to use them.

Layers are either on or off, meaning that specific feature classes or feature class with specific attribute combinations cannot be filtered out since filtering is possible only in Level 2.

EXAMPLE 1: Features with date-referenced depth measurements in different layers cannot be compared by date. For example S-101 Dredged Area has depth range attributes as well as a “dredged date” attribute. The absence of attribute-based filtering means that S-102 high-definition bathymetry cannot replace only Dredged Area features with a “dredged date” preceding the date of the bathymetry observation.

EXAMPLE 2: A predefined combination suppresses S-101 restricted areas of category 4 (nature reserve) in favour of S-122 Marine Protected Area (MPA) features. With only Level 1, either S-122 MPA features or S-101 restricted areas (of any category) are always of higher display priority and in the latter case the presence or boundaries of an MPA may not be visually apparent. Alternatively, all types of restricted areas will be overlaid by an MPA when there is an overlap between an S-122 MPA and an S-101 restricted area. In short, either MPAs override every kind of restricted area or all types of restricted areas override all MPA – fine-tuning based on categories is not possible.

EXAMPLE 3: S-102 high-definition bathymetry interleaved in S-101 depth areas can overlap all S-101 depth areas, and be overlapped by all S-101 depth contours, including those that are deeper or shallower than S-102 data shows.

EXAMPLE 4: S-111 surface current data can overlap S-101 current information, or S-101 current information can overlap S-111 surface current data, but system cannot filter on type of currents.

Predefined combinations are definable only in Level 2. Their absence in Level 1 means that interleaving of display priorities is always fixed and cannot be customized depending on which products are on-screen.

EXAMPLE: Current feature types from S-111 are in one instance of S100_IC_DisplayPlane and the Current – non-gravitational and Tidal stream – flood/ebb feature type from S-101 is in a different instance with a lower priority. The display priority for all S-111 current feature instances is always higher than all S-101 current feature instances.

Without filtering, different compilation scale of data may cause minor differences in geometry which increases the risk of users seeing two instances of the same thing when features are duplicated between layers.

EXAMPLE: Different rounding of geometry between S-101 ENC and S-122 MPA restricted area can cause a ‘ghosting’ effect where the user will see double boundaries if the coordinates of the two instance of a restricted area are not perfectly identical.

If augmented geometry (e.g. safety contour and light sectors) is created based on a feature that is present in more than one layer both instances may be visible to the user since filtering one out is not possible in Level 1.

EXAMPLE: Safety contours generated by S-101 ENC and S-102 high definition bathymetry will both be visible since there is no means of filtering one out. This may make S-102 useless since the mariner will probably choose the most conservative safety contour which is likely to come from S-101 always.

Recommendations

1) Combine items (2) and (3) from the Options for rescoping S-98, i.e., introduce specification scopes, define one scope for each of Levels 1-4, and describe each scope in a distinct Part of the S-98 document. Whether they should be in one file or physically separate files should be determined after all Parts are ready.
2) Prepare the following supporting documents as white papers:
   a) Functional overview
   b) Implementation roadmap.
3) Develop an S-100 change proposal adding attributes to S-100 metadata for indicating the specification scope(s) to which a dataset or catalogue conforms.
4) Develop an S-98 Roadmap describing the S-98 implementation timelines – or at a minimum include it as part of the S-100 Implementation Strategy.

Action Requested of the TSM

The TSM meeting is invited to:

1) Discuss the proposed approaches to revising the S-98 specification.
2) Endorse the plan in the Recommendations section of this paper, or define an alternative plan.
3) Make a recommendation as to whether initial implementation should be limited to only Level 1 capabilities or include Level 2 capabilities.

Appendix A - Specification Scopes

Figure 1 below shows the levels defined in the S-98 draft of May 2019. Each level can be defined as a specification scope. Whether successive scopes are defined as consisting of just the additional parts, or as including earlier (and narrower) scopes remains to be decided. The tentative proposal is to define successive scopes as just the additional part, so for example, the L2 scope would consist of the S100_IC_PredefinedCombination and S100_IC_SuppressedFeatureLayer elements from Figure 1.

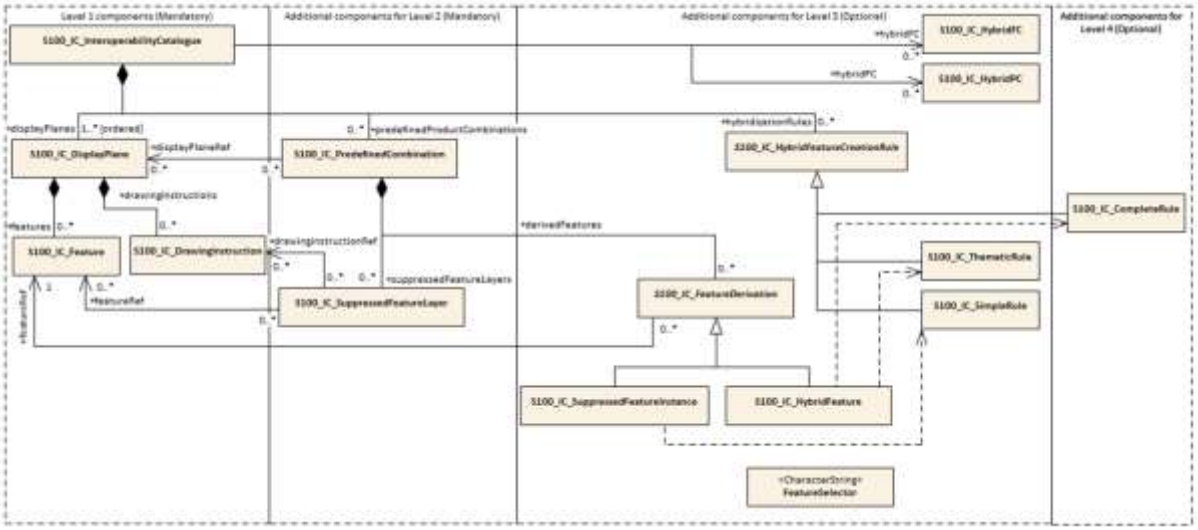

Figure 1. Interoperability catalogue levels as currently defined in the S-98 draft (HSSC 11, May 2019).

Table 1 below shows the scope description attributes in S-100 Part 11 Table 11-3 and their proposed values for S-98.

Table 1. Proposed specification scopes

Name	Description	Type	Mult.	Value in S-98
scopeIdentification	Specific identification of the scope	CharacterString	1	S98LX (X = 1, 2, 3, or 4)
level	Hierarchical level of the data specified by the scope	MD_ScopeCode (ISO 19115-1)	0..1	"software"
levelName	Name of the hierarchy level	CharacterString	0..1	Interoperability Level X
levelDescription	Detailed description about the level of the data specified by the scope	CharacterString	0..1	(see Note below)
coverage	Subtype of a feature that represents real world phenomena as a set of attributes	CharacterString	0..1	(not used)
extent	Spatial, vertical and temporal extent of the data	EX_Extent (ISO 19115-1)	0..1	EX_Extent.description = "worldwide" EX_GeographicBoundingBox = [-180, +180, -90, +90]

Note: The level description will be a short summary of capabilities for the level:

- L1: Interleaving of feature types
- L2: Type-based selectivity and feature class replacement
- L3: Feature hybridization
- L4: Spatial operations