**Paper for Consideration by S-100 WG**

**Gap analysis for S-100 Exchange set model**

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| *Executive Summary:* | This paper describes major results of gap analysis for S-100 Exchange set model and proposes to form a correspondence group to work on creating a new S-100 part of exchange and discovery metadata for S-100 Edition 6. |
| *Related Documents:* | S-100 4.0, S-101 1.0, S-122 1.0 etc. |
| *Related Projects:* | IHO S-100 testbed project, KHOA S-100 testbed project |

**Introduction / Background**

S-100 based product specifications have been under development for many years. Several have been completed into version 1, with some even being close to release as version 2. Most however, are still in development. The various product specifications have used different versions of S-100, with most being built according to S-100 Editions 3.0.0 and 4.0.0.

When the product specifications are ready for producing datasets by member states, the exchange set model will be an important component of the distribute process of the S-100 based products. For that reason, the exchange set model should be reviewed to ensure it meets the requirements of the various product specifications.

**Analysis/Discussion**

In order to conduct gap analysis for S-100 exchange set model, the following process was considered;
- Review of the implemented Metadata in available S-100 product specifications
- Create simple usage scenarios of S-100 based product specification exchange sets
- Record any limitations in the S-100 Edition 4.0.0 Exchange Set data model

Review of metadata in S-100 product specifications

All S-100 based product specifications available on s100.iho.int were investigated, see Annex A for complete lists. This investigation also looked at which version of S-100 was used and how closely the implementation had followed the relevant version of S-100. High level findings include;
- Due to the different usages of S-100 within the various product specifications developed to date, metadata inclusion is varied in the different specifications.
- Most of the various having implemented a version of the S-100 exchange set metadata, although a few have not done so. It is not clear if the product specifications that have omitted the exchange set concept will include it in a later version.
- All the cases of product specifications that have implemented the exchange set concept have done it from the individual product specification point of view.
- Most of the product specifications have some variation in terms of how the details have been implemented, and these differences may cause challenges for system implementors and users, as well as data producers that are responsible for more than one product. See Annex A for details.

Simple Usage scenarios of S-100 based product specification exchange sets

The S-100 Edition 4.0.0 exchange set model permits multiple types of exchanges. The table below list types of exchange sets that can be expected. The list is concerned with basic types, but notes that any combination of these are possible in the product specifications. No attempt has been made in creating and naming specific combinations of types.

Although new versions of a product specification are likely to be quite similar to previous version, it is unlikely that it can be guaranteed that new versions will immediately supersede previous version, at least not in an operational environment. It is therefore likely that two or more version of the same S-number will exist. In this exercise new versions are considered another product specification.

| Exchange set usage scenarios: | Explanation |
| --- | --- |
| New dataset(s) | Exchange set that includes one or more new edition datasets of the same product specification type. May include support files. |
| New update(s) | Exchange set that includes one or more updates to already issued datasets of the same product specification type. May include support files. |
| Re-issue dataset(s) | Exchange set with a re-issue of one or more dataset(s) of the same product specification type and with one or more updates constructed in a manner that includes the updates in the dataset(s) and permits the update(s) numbering to continue to increment and edition number remain unchanged. |
| New Edition dataset(s) | Exchange set that contains dataset(s) that terminates previous edition of the same dataset of the same product specification type, and adds a new edition. |
| Terminate dataset(s) | Exchange set that terminates one or more datasets of the same product specification type. |
| New support file(s) | Variation of exchange set that updates one or more datasets and/or adds new support file(s). |
| Replace support file(s) | Variation of exchange set that updates one or more datasets and replace support file(s). |
| Delete support file(s) | Variation of exchange set that updates one or more datasets and delete support file(s). |
| New FC/PC | Updates FC and/or PC of the same product specification type. |
| Replace FC/PC | Replaces FC and/or PC of the same product specification type. |
| Delete FC/PC | Deletes FC and/or PC of the same product specification type. |
| Multi type exchange set | Exchange set that contains a combination of one or more instances of any of the above scenarios. |
| Multi type and multi product specification exchange set | Exchange set that contains a combination of one or more instance of any of the above scenarios and exchange sets of different product specifications. |

Product specifications developed to date and available for review has been analyzed for their use of the S-100 exchange set concepts. Types that are applicable for the individual specification are listed. See Annex B for detailed listing of how each product specification used the basic types.

Limitations in the S-100 Edition 4.0.0 Exchange Set data model

Reviewing the scenarios envisioned within each product specification listed against the S-100 Edition 4.0.0 Exchange set model (S-100 Part 4a) some possible gaps has become apparent and should be investigated.

1) With more and more product specifications being developed it should be noted that not all have been created for a direct usage for navigation. It may therefore be useful to indicate which product specifications are intended for navigation. Metadata could be a good place for such information.
2) Some product specifications (S-122, S-123 and S-127) have defined metadata used for providing delta changes between new editions. There is a need for considering making these standardized within S-100 or alternative ways of harmonizing how metadata for delta changes are handled.

3) Considering the S-98 Interoperability Catalogue paradigm is expected to be combined with exchange set packages of combinations of products from multiple product specifications, should there also be an indication to say a set of products is the minimum safe set for a particular area.

4) S-124, and likely also S-412, makes use of a specialization for cancelling datasets. Should this method, once finalized, be included at the S-100 level to ensure machine readability?

5) Most if not all product specifications can expect updating of feature and/or portrayal and/or interoperability catalogues. The method of this process and metadata to support it should be considered for inclusion in S-100 to harmonize the functionality.

6) The Feature/Portrayal catalogues are specialised support files and do not have a means of updating an old version with a new version.

7) S-100 Part 4 currently contain an ambiguous naming convention for the product specific exchange set files and this convention is hidden in the Remarks column of the S100_ExchangeCatalogue class. Machine readability may be improved by a standardized naming convention.

8) The remarks column of the S100_ExchangeCatalogue class mention only S-101, and it is unclear if it applies to all products.

9) The 'purpose' attribute in S100_DatasetDiscoveryMetadata has no standardized values, meaning each product specification must be hardcoded in any system expected to read the product. There could be benefits from standardizing the list.

10) Consider making a new data type for external resources, since there currently is no means of expressing this function in a feature catalogue and therefore increases the likelihood of meaning each product specification must be hardcoded in any system expected to read the product.

See Annex C for details [including indication of issues already addressed by other inputs to S-100WG.]

**Conclusions**

The ten gaps that have been discovered should be analysed and validated with proper means, and once validated should motivate change proposals towards the next version of S-100. The gaps were reported at the TSM7, which agreed that exchange and discovery metadata will be moved to a separate part in S-100.

**Recommendations**

It is recommended that a correspondence group should be formed to work on creating a new S-100 part of exchange and discovery metadata for S-100 Edition 6.

**Action Required of TSM**

The S-100WG5 is invited to:

      a. note this document

      b. discuss the gaps of exchange and discovery metadata raised in this document

      c. consider the need for a correspondence group to address any gaps

**Annex A**


Review of the inclusion of Metadata in available S-100 product specifications

An overview of the various specifications, their release dates and which edition of S-100 they were based on is available below. The specifications with unknown release date and S-100 version are not readily available and could not be obtained from known sources. These are therefore not reviewed.

*Table 1 - List of all S-100 based product specifications (source S-100 web page (s100.iho.int))*

| Designator | Name | Released | S-100 version |
|---|---|---|---|
| S-101 | Electronic Navigational Chart (ENC) | Edition 1.0.0 (December 2018) | 4.0.0 |
| S-102 | Bathymetric Surface | Draft Edition 2.0.0 (February 2019) | 4.0.0 |
| S-104 | Water Level Information for Surface Navigation | Not released, version 0.0.5 (Nov 2017) is latest version | 3.0.0 |
| S-111 | Surface Currents | Edition 1.0.0 (December 2018) | 4.0.0 |
| S-121 | Maritime Limits and Boundaries | Not released, draft of 28 Jan 19 is latest version | 3.0.0 |
| S-122 | Marine Protected Areas (MPAs) | Edition 1.0.0 (January 2019) | 3.0.0 |
| S-123 | Marine Radio Services | Edition 1.0.0 (January 2019) | 3.0.0 |
| S-124 | Navigational Warnings | Not released, draft-v2.0. dated 30 June 2019 is latest version | 4.0.0 |
| S-125 | Marine Navigational Services | On hold | - |
| S-126 | Marine Physical Environment | On hold | - |
| S-127 | Marine Traffic Management | Edition 1.0.0, December 2018 | 4.0.0 |
| S-128 | Catalogue of Nautical Products | 0.0.1 (28 Dec 2018) | 3.0.0 |
| S-129 | Under Keel Clearance Management (UKCM) | Edition 1.0.0 (June 2019) | 4.0.0 |
| | | | |
| S-201 | Aids to Navigation Information | Not released, draft 0.0.7 – July 2017 | 3.0.0 |
| S-211 | Port Call Message Format | Not released, draft 1.0.0 – March 2019 | 4.0.0 |
| S-240 | DGNSS Station Almanac | Draft 0.0.2 – 2017 | 2.0.0 |
| | | | |
| S-401 | Inland ENC | Unknown | Unknown |
| S-402 | Bathymetric Contour Overlay for Inland ENC | Unknown | Unknown |
| | | | |

| S-411 | Sea Ice Information | Edition 1.1.0, June 2014 | 1.0.0 |
|---|---|---|---|
| S-412 | Weather Overlay | unknown | Unknown |
| | | | |

Due to the different usages of S-100 within the various product specifications developed to date metadata inclusion is varied in the different specifications. An additional complication is the various versions of S-100 has had an evolution of the metadata sections through the versions. These changes between versions are due many influences such as new versions of the foundational ISO documents, most notable ISO 19115. Significant changes were introduced in version 4.0.0 of S-100 and were mainly due to changes in the ISO documents. Most of the various product specifications having implemented a version of the S-100 metadata, although a few have not done so. It is not clear if the ones that have omitted the exchange set concept will include it in a later version.

*Table 2 - Mapping of Metadata implementation in S-10x product specifications*

| Designator | Makes use of exchange set | S-100 version | Identical to S-100 |
|---|---|---|---|
| S-101 | Yes | 4.0.0 | Yes |
| S-102 | Yes | 4.0.0 | No, does not include support files and extends the S-100 dataset discovery metadata class. |
| S-104 | Yes | 3.0.0 | Unknown, draft is not sufficiently advanced to tell. |
| S-111 | Yes | 4.0.0 | No, does not include support files |
| S-121 | No | 3.0.0 | No, does not include exchange set |
| S-122 | Yes | 3.0.0 | No, extends the S-100 dataset discovery metadata class. |
| S-123 | Yes | 3.0.0 | Yes |
| S-124 | Yes | 4.0.0 | No, constrains the S-100 dataset discovery metadata class. |
| S-125 | - | - | - |
| S-126 | - | - | - |
| S-127 | Yes | 4.0.0 | No, extends the S-100 dataset discovery metadata class. |
| S-128 | Yes | 3.0.0 | Yes |
| S-129 | Yes | 4.0.0 | Yes |
| | | | |
| S-201 | Yes | 3.0.0 | No, constrains the S-100 dataset discovery metadata class. |
| S-211 | No | 4.0.0 | No, does not include exchange set |
| S-240 | Yes | 2.0.0 | Yes |
| | | | |
| S-401 | - | Unknown | - |
| S-402 | - | Unknown | - |
| | | | |
| S-411 | Yes | 1.0.0 | No, own variation |
| S-412 | - | Unknown | - |
| | | | |

# Annex B

Usage scenarios of S-100 based product specification exchange sets

This annex lists the specific usage scenario exchange sets functions implemented in the reviewed S-100 based product specification. The list has been created by reviewing each product specification and noting its metadata functions as described in the documentation. The review show that some common trends are visible, but that most S-100 based product specifications have subtle differences. These differences may cause challenges in a system intended to read most products in a machine-readable way to simplify data and portrayal updating.

*Table 3 – Usage scenarios implemented in S-10x product specifications*

| Designator | Name | Released | S-100 version |
|---|---|---|---|
| S-101 | **Electronic Navigational Chart (ENC)** | **Edition 1.0.0 (December 2018)** | **4.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New update(s) | | |
| | Re-issue dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New support file(s) | | |
| | Replace support file(s) | | |
| | Delete support file(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-102 | **Bathymetric Surface** | **1.0.0 (April 2012)** | **1.0.0** |
| | Exchange set not defined in specification. | | |
| S-102 | **Bathymetric Surface** | **Draft Edition 2.0.0 (February 2019)** | **4.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-104 | **Water Level Information for Surface Navigation** | **Not released, version 0.0.5 (Nov 2017) is latest version** | **3.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |

| | | | |
|---|---|---|---|
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-111 | **Surface Currents** | **Edition 1.0.0 (December 2018)** | **4.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-122 | **Marine Protected Areas (MPAs)** | **Edition 1.0.0 (January 2019)** | **3.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New update(s) | | |
| | Re-issue dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New support file(s) | | |
| | Replace support file(s) | | |
| | Delete support file(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-123 | **Marine Radio Services** | **Edition 1.0.0 (January 2019)** | **3.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New update(s) | | |
| | Re-issue dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New support file(s) | | |
| | Replace support file(s) | | |
| | Delete support file(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-124 | **Navigational Warnings** | **Not released, draft-v2.0. dated 30 June 2019 is latest version** | **4.0.0** |
| | Exchange set usage scenarios: | | |
| | New dataset(s), note: datasets are cancelled by new dataset | | |
| | New FC/PC | | |

| | | | |
|---|---|---|---|
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-127 | **Marine Traffic Management** | **Edition 1.0.0, December 2018** | **4.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New update(s) | | |
| | Re-issue dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New support file(s) | | |
| | Replace support file(s) | | |
| | Delete support file(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-128 | **Catalogue of Nautical Products** | **0.0.1 (28 Dec 2018)** | **3.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New update(s) | | |
| | Re-issue dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New support file(s) | | |
| | Replace support file(s) | | |
| | Delete support file(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-129 | **Under Keel Clearance Management (UKCM)** | **Edition 1.0.0 (June 2019)** | **4.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| | | | |
| S-201 | **Aids to Navigation Information** | **Not released, draft 0.0.7 – July 2017** | **3.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New Edition dataset(s) | | |

| | | | |
|---|---|---|---|
| | Terminate dataset(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-211 | **Port Call Message Format** | **Not released, draft 1.0.0 – March 2019** | **4.0.0** |
| | Does not make use of exchange sets | | |
| S-240 | **DGNSS Station Almanac** | **Draft 0.0.2 – 2017** | **2.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| | | | |
| S-401 | **Inland ENC[1]** | **Unknown** | **Unknown** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New update(s) | | |
| | Re-issue dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New support file(s) | | |
| | Replace support file(s) | | |
| | Delete support file(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| S-402 | **Bathymetric Contour Overlay for Inland ENC[2]** | **Unknown** | **Unknown** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New update(s) | | |
| | Re-issue dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New support file(s) | | |
| | Replace support file(s) | | |
| | Delete support file(s) | | |
| | New FC/PC | | |

[1] Product specification is not available but assumed to behave in the same manner as S-101.

[2] Product specification is not available but assumed to behave in the same manner as S-401.

| | | | |
|---|---|---|---|
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |
| | | | |
| S-411 | **Sea Ice Information** | **Edition 1.1.0, June 2014** | **1.0.0** |
| | Applicable exchange set usage scenarios: | | |
| | New dataset(s) | | |
| | New Edition dataset(s) | | |
| | Terminate dataset(s) | | |
| | New FC/PC | | |
| | Replace FC/PC | | |
| | Delete FC/PC | | |
| | Multi type exchange set | | |

## Annex C

Limitations in the S-100 Edition 4.0.0 Exchange Set data model

S-100 based product specifications in list given in the document 'Usage scenarios of S-100 based product specification exchange sets' were analysed according to the S-100 Edition 4.0.0 Exchange set model (S-100 Part 4a), and considering their usage in an envisioned common user system and an envisioned common data distribution process. This review found some possible gaps that have been summarised below with any proposed solutions and any open questions that remain.

1) With more and more product specifications being developed not all have a direct usage for navigation. It may therefore be useful to indicate which ones are intended for navigation. This can be done with a Boolean attribute to indicate yes/no. Alternatively an enumeration attribute could be developed for more detailed classifications, such as 'not for navigation', 'for navigation planning' and 'for navigation'. The most likely place for such an attribute is the S100_DatasetDiscoveryMetadata class.

2) Some product specifications have defined means for providing delta changes between new editions. These delta change or update files are not specifically covered by S-100 exchange set metadata model, but several product specifications (S-122, S-123 and S-127) have made special adoption of the S100_DatasetDiscoveryMetadata class for update files. It should be noted that S-101 does not follow this approach. This should be reviewed and considerations made for standardizing a metadata approach for update files. For example, S100_DatasetDiscoveryMetadata contains mandatory attributes for datums which is very unlikely that any update dataset would change. Rather this would be a new edition type change. Rules and guidelines for what could be an update versus what should be a new edition may be useful. An update file metadata class could be considerably smaller than the metadata class for the base dataset, thus saving data volume where data bandwidth is an issue.

3) Considering Interoperability Catalogue would be expected to be combined with exchange set packages of combinations of products from multiple product specifications perhaps as a set of minimum safe data for entering or leaving a port or constrained waterway. S-100 exchange set model probably supports multi products, but should include more guidance for how to do this specifically since product specifications would likely focus on self only.

4) S-124, and likely also S-412, makes use of a specialization for cancelling datasets. These two, and possibly others use a cancelling dataset or self-cancelling dataset to align with current MSI distribution logic. Can data products with such specialization be included in the same exchange set as products created from product specifications that adhere closer to S-100 Exchange Set model? The question should be analyzed from the perspective of the metadata schema, as there is a potential for having two or more metadata schemas and what this means for exchange sets. S-100 does not currently address the question of multi schema exchange sets, and may need to provide some overall guidance on this, e.g. should it be possible with multi schema exchange sets and how does the user system know which schema to use.

5) Most if not all product specifications can expect updating of feature and/or portrayal and/or interoperability catalogues. Since this function is likely assumed to be identical for all specifications, it may be advisable to define the FC/PC/IC updating process at the S-100 level and include guidance in the product specification template to recommend that product specifications should consider making use of the common methodology. If not, there is a risk that each specification may define separate methodologies for updating FC/PC/IC. A consequence of variations in updating methodologies is that user systems will most likely need to implement each method separately and thus increasing the implementation burden.

6) Support files referenced by datasets are managed via the S100_SupportFileDiscoveryMetadata class. Feature and Portrayal Catalogues are managed via the S100_CatalogueMetadata class. This class does not have a means of updating an old version with a new version. It is unclear if there is a needed for an attribute like Purpose for S100_DatasetDiscoveryMetadata, or if there is a need to specify a process which user systems should follow to ensure the latest version of a catalogue is used for any specific dataset. Earlier discussions at TSMAD/S-100WG suggested that version increases by clarifications (x.x.X) should still work with datasets within the same edition and correction number. Such processes are not yet defined in S-100 and are needed before it can be clarified if there is a need to amend the S-100 Exchange Set model.

    Example; a set of new FC/PC is sent out to a user that need support for new dataset types. A question to consider is if all amendments to FC/PC require a new version of the Product Specification? If so, there is likely no need to update existing FC/PC. A further question to consider is that there currently is no means beyond manual intervention to ever delete a PC/FC/IC already in a user system, should there be such a function in the Exchange Set model?

7) S-100 Part 4 currently contain an ambiguous naming convention for the product specific exchange set file, and this convention is hidden in the Remarks column of the S100_ExchangeCatalogue class, in the row for the exchangeCatalogueName attribute. It states 'In S-101 it would be CATLOG.101'. This means that there is no guidance given for exchange sets with multiple products. There is also no guidance given to what should be the naming convention for any of the other metadata files of an exchange set. Due to the construction of the exchange set model this part is less critical since the entry point for a system to read the exchange set is assumed to be the exchange set catalogue.

8) The remarks column of the S100_ExchangeCatalogue class, in the row for the exchangeCatalogueName attribute says what S-101 must name its catalogue. The wording is ambiguous and should be either changed into a rule for all products, or removed.

9) The 'purpose' attribute in S100_DatasetDiscoveryMetadata is defined as 'The purpose for which the dataset has been issued' and will tell the user system what should be done with the dataset that the metadata describes. The attribute is of characterString data type and therefore has no standardized values. This means that S-100 based product specifications are free to choose their own utilization of this attribute, meaning each specification must likely be implemented separately and cannot assume to use a common system function. The consequence is likely going to limit the machine readability concept of S-100. There could be

benefits to implementation in standardizing the purposes of datasets into an enumerated list and adding that to S-100.

10) Consider making a new data type for external resources. References to external resources are currently CharacterString or Text data types depending on where they are used. In a machine-readable environment, there is no standardized way to tell a system that a particular value in an attribute means a path to another resource/file. This increases the risk of new versions of product specifications having to be implemented specially in user systems, and reduce the likelihood of machine-readable new versions of product specifications, including how metadata is understood by systems.