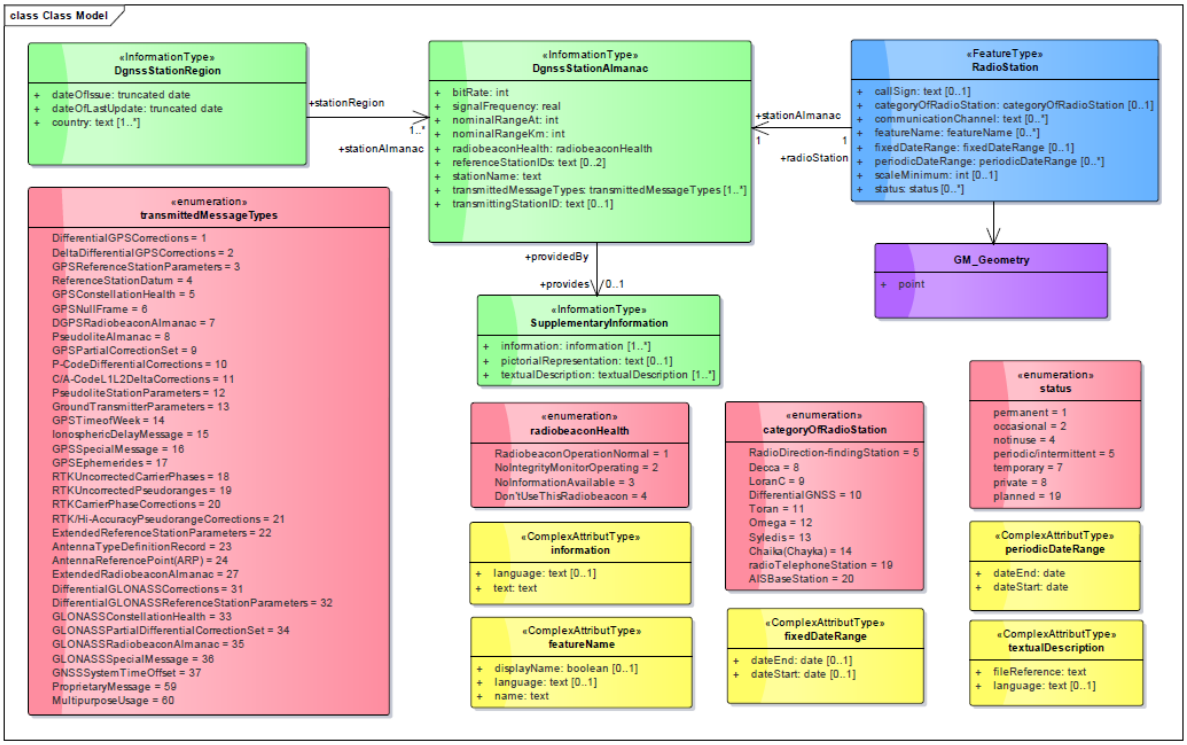
1.0 Definitions

1.1 Application Schema - An application schema is a fundamental element of any S-100 based product specification. The application schema serves two purposes:

- It achieves a common and correct understanding of the content and structure of data within a particular application field.
- Secondly, it may provide a computer readable schema for applying automated mechanisms for data management.

Note: *For the creation of an application schema several software tools can be used. Enterprise Architect is one of the tools that can be used.*



Example Application Schema from S-240 – DGNSS Almanac

1.2 Attribute – characteristics of a feature

1.3 Coordinate Reference System - coordinate system which is related to the real world by a datum

1.4 Coverage geometry – configuration of the domain of a coverage describe in terms of coordinates

1.5 Domain – within the feature concept dictionary, each entry is assigned to a recognised domain. The purpose of designating domains and a related control body is to ensure that key stakeholders are consulted in any subsequent proposals to adjust items contained in a Register. Domain control bodies include IHO, IALA and WMO.

1.6 Enumerant – An enumerant is a selectable value of an attribute. For example the attribute colour may have an enumerated value of red, blue, orange, black or white.

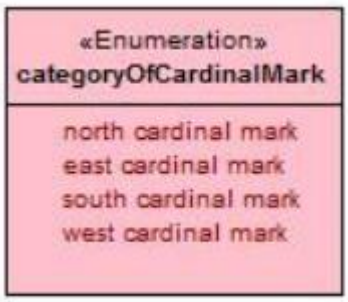
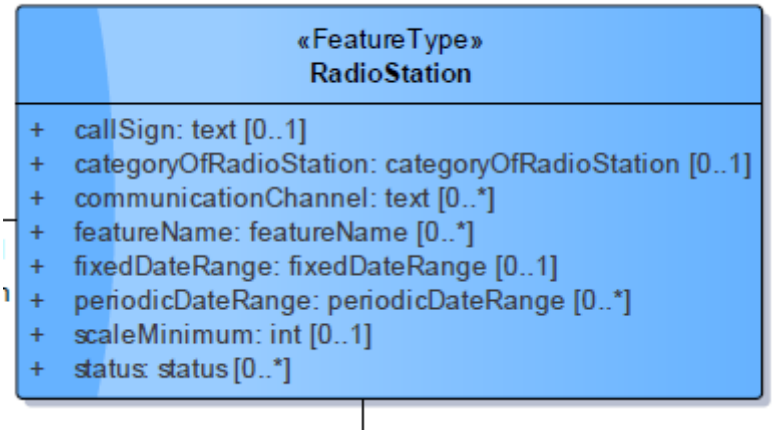


Image from draft S201 Product Specification

1.7 Extensible Markup Language (XML) - is a markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable.

1.8 Features - A feature is an abstract representation of real world phenomenon. Features have two aspects – feature type and feature instance. A feature type is class and is defined in a Feature Catalogue. A feature instance is a single occurrence of the feature type and represented as an object in a data set.



Example feature from draft S-240

1.9 Feature Catalogue – provides a full description of each feature type including attributes, attribute values and relationships in the data product. The feature catalogue shall be available in both 'machine readable' and 'human readable' forms (e.g. XML).

1.10 Feature Concept Dictionary (Register) – is a managed lists or dictionary of features. Selections from the Feature Concept Dictionary are used to define Feature Catalogues used in individual Product Specifications.

1.11 Information Types – An information type is a class of object that is defined in a Feature Catalogue. An instance of an information type is an identifiable unit of information in a data set. Information types have only thematic attribute properties. An instance of an information type may be associated with one or more feature instances or other instances of information type.

An example of a feature could be a buoy and an example of an information type could be a maintenance report for a buoy.

1.12 Portrayal Catalogue - The data product specification may provide information on how the data is to be presented as graphic output,

Example: *as a plot or as an image.*

This is an optional section; however it is strongly recommended that it is included where a product specification defines an IHO navigational product. Where included, this shall take the form of a reference to a portrayal library that contains a set of portrayal rules and a set of portrayal specifications.

The portrayal library shall be defined in accordance with S-100 Part 9.

Front	FRONTS	Cold Front, Developing	Curve		
Front	FRONTS	Cold Front, Dissipating	Curve		
Front	FRONTS	Cold Front, Surface	Curve		
Front	FRONTS	Cold Front, Above Surface	Curve		

Example of Feature Portrayal from draft S-412

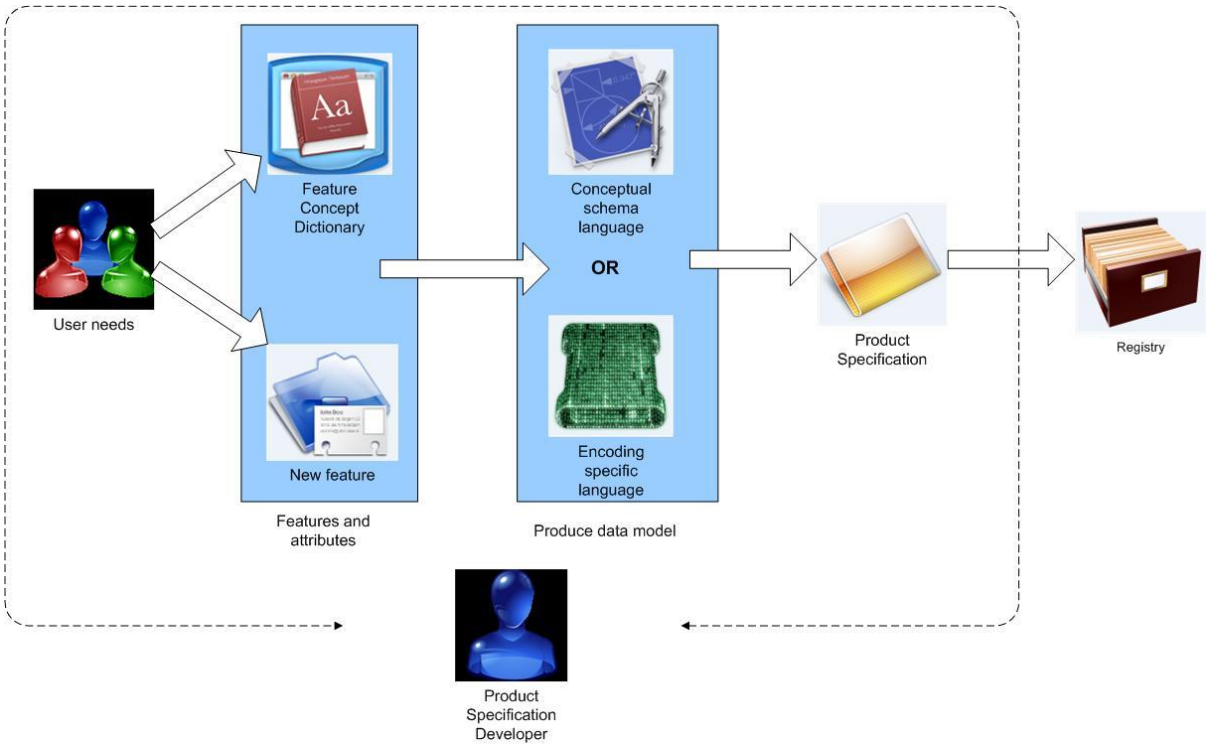
1.13 Unified Modelling Language (UML) - UML is used as the modelling language in S-100. An understanding of UML class diagrams is needed to produce a product specification. Wikipedia provides an overview via: http://en.wikipedia.org/wiki/Unified_Modeling_Language

2.0 From user need to a product specification – A basic overview

2.1 User needs, which are high level and functionally specified have to be transformed to product requirements in order to realize the needed functionality. The development of product requirements drives the data model, which in turn generates into a product specification and the items to be registered. This is the task of the product specification developer (UKCM PT). In the image below the idea of the route from user need to product specification is shown.

2.2 In order to develop a product specification it has to be clear what the product should be. The authority responsible for the relevant service creates a description of the desired product and the applicable user needs. Then it is up to the product specification developer to check the registry and investigate if the needed features already exist. In cases where the feature does not exist, a new feature has to be added to the feature concept dictionary (FCD).

2.3 Next a data-model has to be produced, either by means of a conceptual schema language (UML) or by means of an encoding specific language (XML). Finally the previous and other information is captured in a document called a product specification. This document will then be registered, after an approval process, in the product specification register of the GI Registry.



Above taken from IALA guideline 1106 - Section 2.3.

3.0 Product Specification

3.1 A product specification allows the standardization of a data product according to the S-100 framework, in order to specify, implement and exchange a data product. Product specifications may be created and used on different occasions, by different parties and for different reasons.

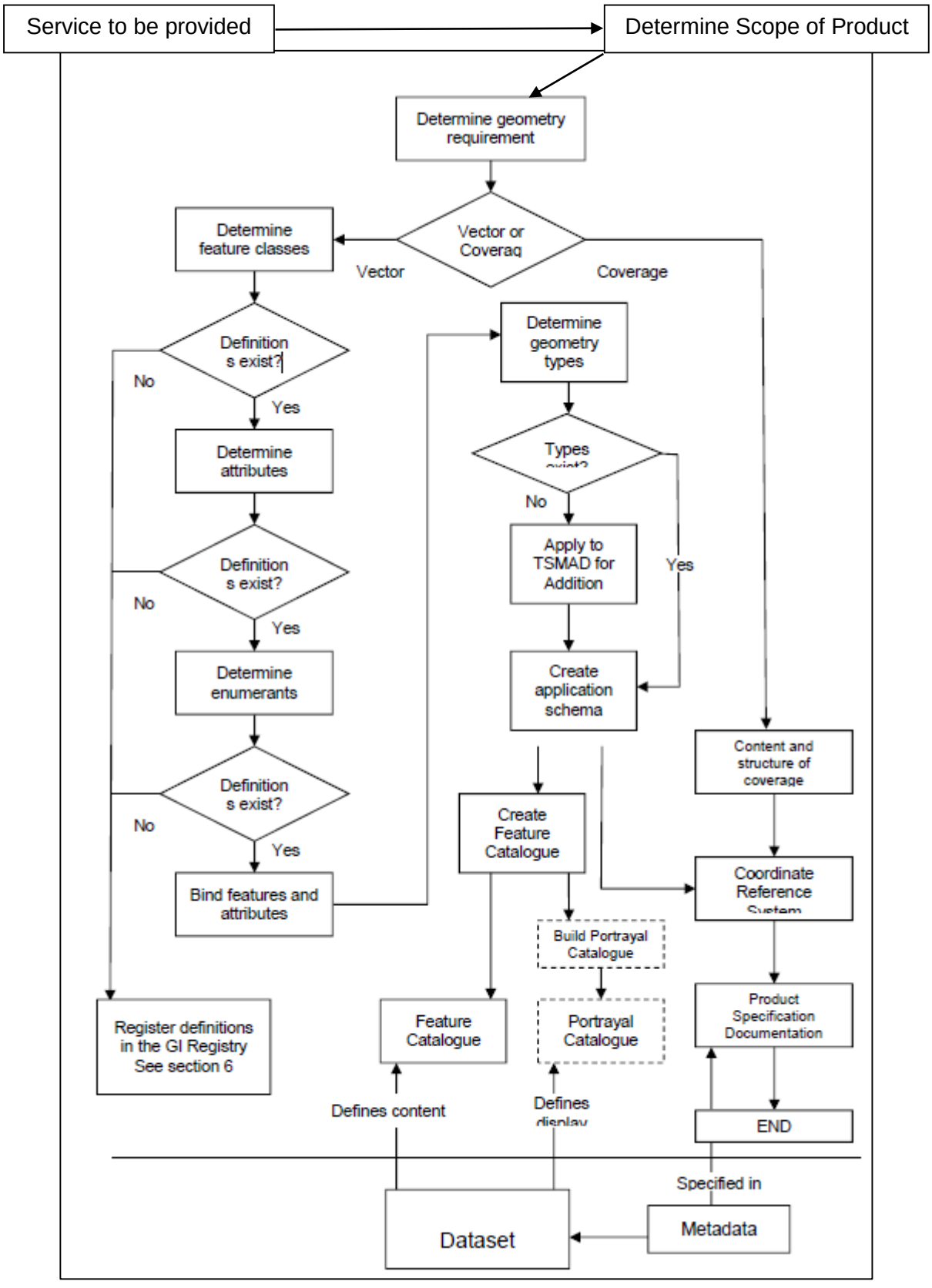
3.2 A product specification can be summarized as a precise technical description, defining a data product within the S-100 framework. It describes the features, attributes and relationships of a given application and their mapping to a means of data exchange.

3.3 For this purpose it includes general information for data identification as well as information for data content and structure, reference system, data quality aspects, data capture, maintenance, delivery and metadata.

3.4 The applied methodology for product specifications is derived from the IHO profile of ISO 19131 and ensures a clear and consistent structure for data product specifications being consistent with the other standards that have been developed as part of the IHO S-100 framework.

Above taken from IALA guideline 1106 - Section 4.3.

4.0 Product Specification Process



5.0 Key Steps in Producing a Product Specification

5.1 Service to be provided

The entry point assumes there has been the necessary discussion within the IHO organization, which has endorsed the action to create an S-100 product specification. This action includes setting up the task group that will develop the product specification.

5.2 Determine Scope of Product

The task group refines the scope into the product specification, utilizing the Product Specification Template. Procedures, item types etc. are a part of the scoping. What is the product supposed to do, is it for regional use or global use etc.

5.3 Determine Geometry Requirement

The first step in developing the specification is to determine whether the data will be discrete or continuous. A product specification may include both discrete and continuous data and these can be scoped separately.

- Vector Geometry or Coverage-based - Geographic phenomena fall into two broad categories — discrete and continuous.
- Discrete phenomena are recognizable objects that have relatively well-defined boundaries or spatial extent. Examples could include buildings, or aids to navigation.
- Continuous phenomena vary over space and have no specific extent. Examples could include radio signal strength or ground elevation.
- A value or description of a continuous phenomenon is only meaningful at a particular position in space (and possibly time). Signal strength, for example, takes on specific values only at defined locations, whether measured or interpolated from other locations.

5.4 Determine Feature Classes

The next step is to identify groups or classes into which the data objects fall. The data object and classes may have already been defined for another application and those existing definitions should be used. If not, then new definitions will need to be created. S-100 uses two specific object types, the feature type for objects that have attributes and geometric properties and the information type which is an object with no geometric properties.

5.5 Determine Attributes

With the features determined, the appropriate attributes need to be determined. This is also requires checking to see if they have already been defined. Attributes other than geometric properties are considered thematic attributes these can be simple or complex. A simple attribute carries a descriptive characteristic usually a value of a given type e.g. text, date, Boolean, integer. A complex attribute is a property composed of one or more simple attributes known as sub attributes.

5.6 Determine Enumerants

Determine if any attribute needs selectable enumerant values.

> ***Example:*** *If the attribute is simple attribute a data type of Enumeration, then only a list of permitted values needs to be specified.*
>
> ***Example from draft S-112:***
>
> *camelCase:* *airPressureTendency*
>
> *Data Type:* *Enumeration*
>
> *Values:* *1: steady*
>
> *2: decreasing*
>
> *3: increasing*
>
> *4: not available = default*

5.7 Bind Features and Attributes

Feature Bindings

The feature binding describes the association between two feature types. Both the feature association and the association role are specified together with the target feature type. Furthermore the Multiplicity and the role type are defined. The latter describes the nature of the role.

> ***Example:*** *The role 'Lane' used by a traffic separation scheme to associate its lane parts will have the role type Aggregation, whereas the role "Scheme" used from the lane part to the TSS has the role type Association*

5.9 Attribute Bindings

Attribute bindings are used to bind attributes to feature or information types. Additionally, they are used for defining the aggregation of attributes for a complex attribute. The binding specifies the target attribute and the Multiplicity of the attribute. The Multiplicity indicates how many instances of an attribute can be used. Bindings are used to define whether an attribute is mandatory (1..n) or optional (0..n). If the Multiplicity allows more than one instance of an attribute a Boolean flag indicates if the sequence of attributes has a meaning.

If the attribute is a simple attribute with a data type of Enumeration, a list of permitted values can be specified. An empty list indicates that all values defined for the attribute in the feature catalogue are valid.

5.10 Determine Geometry Types

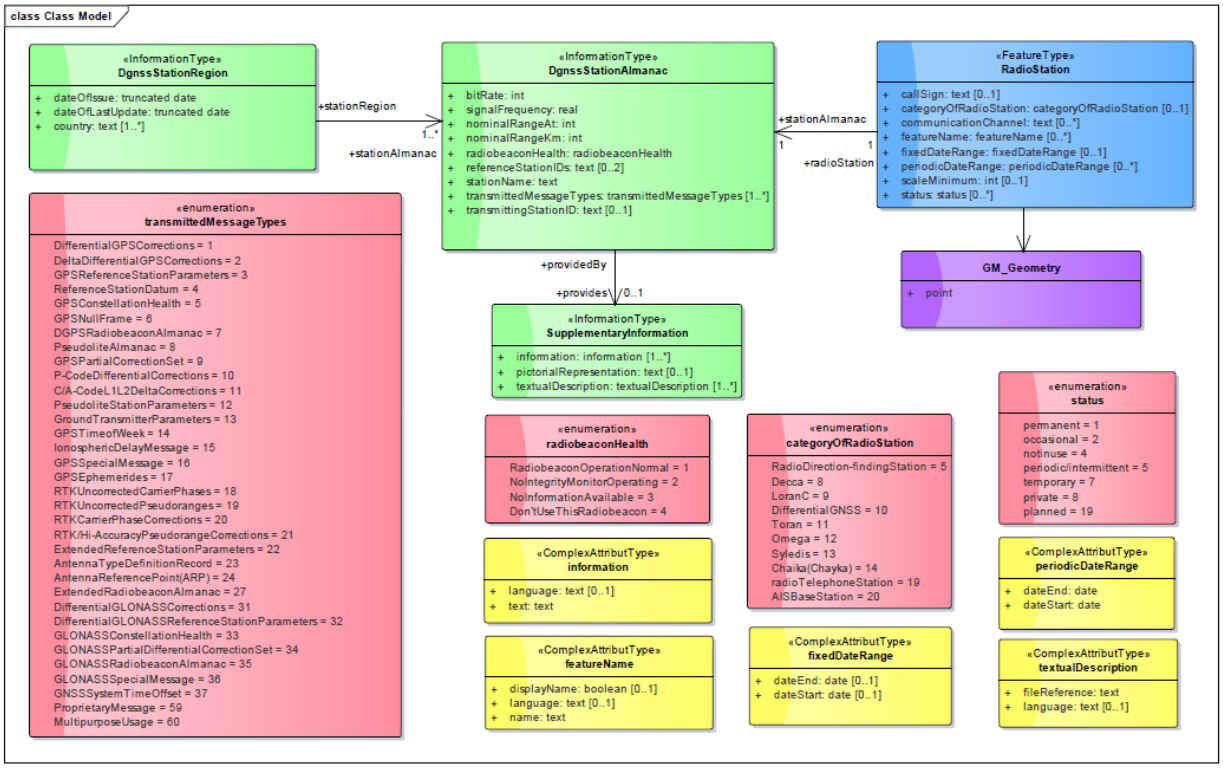
Determine the spatial component of geographic features through points, lines, and surfaces.

5.11 Create Application Schema

The next step is to create a model (schema) of the application. This can either be a logical model or a physical model. In the S-100 application, schemas are realized in a Feature

Catalogue that is encoded in XML. This defines the features, information types and attributes used within a data product.

The task group develops the application schema using all required feature classes, attributes and enumerations. This process can lead to a revised list of needed feature classes, attributes and enumerations. Typically the development process includes a number of iterations as the group refines the application schema. The outcome is a consensus S-100 compliant application schema.



Example Application Schema from S-240 – DGNSS Almanac

5.12 Portrayal

Portrayal is optional in S-100, but if included, provides the rules for display and symbology, which apply to the data defined in this specification and should be described in a Portrayal Catalogue.

> ***Example:*** *Display and symbols should be in accordance with IMO SN Circ. 243.*

5.13 Coordinate Reference System

The appropriate Coordinate Reference System (CRS) must be determined for the data product. It could be horizontal and vertical coordinate reference systems.

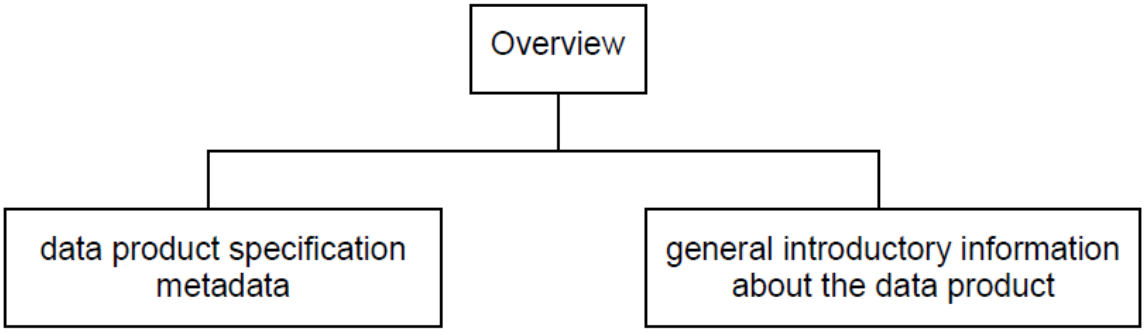
> ***Example:*** *WGS84 should be used for the horizontal reference system for spatial data.*

> ***Example from draft S-201:*** *Vertical datum shall be selected from the list in verticalDatum enumeration. If the local datum value is used, additional information must be provided using the comment attribute in the metadata, or information attribute on the feature instance.*

6.0 The IHO Product Specification Template

6.1 Section 1 - Overview

The overview section provides a reader of a data product specification with general introductory information about the data product together with product specification metadata.



The Overview shall include the following parts:

- information about the creation of the data product specification;

  Note: *This shall include the title, a reference date, the responsible party and the language. Information about the maintenance regime for the product specification should also be included.*

- terms and definitions;
- abbreviations;
- acronyms for the name of the data product;
- an informal description of the data product.

Example from draft S-112:

Title: *The International Hydrographic Organization Meteorological and Hydrographic Data AIS Application-Specific Message Dynamic Water Level Data Product Specification*

S-100 Version: *1.0.0 (Note: reference to 2.0.0)*

S-112 Version: *0.0.0*

Date: *November 2014*

Language: *English*

Maintenance: *Changes to the Product Specification S-112 are coordinated by Tidal and Water Level Working Group (TWLWG) of the IHO and must be made available via the IHO web site. Maintenance of the Product*

Specification must conform to IHO Technical Resolution 2/2007 (revised 2010).

6.2 Section 2 – Specification Scopes

Some parts of a product specification may apply to the whole product whereas other parts of the product specification may apply to only parts of the product.

Coordinate reference system will generally apply to the complete product; whereas maintenance regimes may be different for navigational features and contextual features.

If a specification is consistent across the whole data product it is only necessary to define a general scope to which each section of the data product specification applies.

The data product specification may specify a partitioning of the data content of the product on the basis of one or more criteria. Such partitioning may be different for different parts of the data product specification. Each such part of the data content shall be described by a specification scope that may inherit or override the general scope specification.

> ***Example:*** *Data products to support navigation often contain two sets of feature types: those that provide navigation information that changes rapidly and is essential for safety of navigation, and those that provide background reference information. Maintenance and delivery information would be partitioned on the basis of these groupings; reference system information would not.*

6.3 Section 3 – Dataset Identification

This section describes how to identify data sets that conform to the specification. The information identifying the data product may include:

Title	The title of the data product
Alternate Title	Short name or other name by which the data product is known
Abstract	Brief narrative summary of the content of the data product

> ***Example from draft S-112*** *- Abstract: Encodes information and parameters for use in making Dynamic Water Level Data and other tidal and meteorological data available for transmission in Meteorological and Hydrographic Data AIS Application-Specific Messages.*

Topic Category	The main theme(s) of the data product
Geographic Description	Description of the geographic area covered by the data product using identifiers
Spatial Resolution	Factor which provides a general understanding of the density of spatial data in the data product

Purpose	Summary of the intention with which the data product is developed
Language	Language(s) of the dataset. If language is not applicable, e.g. for raster data, use “not applicable” as value for the element
Classification	Security classification code on the data product
Spatial Representation Type	Form of the spatial representation
Point Of Contact	Identification of, and means of communication with, person(s) and organization(s) associated with the data
Use Limitation	Limitation affecting the fitness for use of the data product

6.4 Section 4 - Data Content and Structure (Application Schema)

This mandates different requirements for data product specifications, whether the data is feature or coverage-based or imagery data. The product specification shall include this information for each identified scope.

Feature Based Data

The content information of a feature-based data product is described in terms of a general feature model and a feature catalogue.

The data product specification shall contain an application schema. For all data product specifications in the realm of S-100, the application schema shall be expressed in UML. If the application schema is a separate document, then the product specification shall include a narrative summary.

The data product specification shall include a feature catalogue, which provides a full description of each feature type including attributes, attribute values and relationships in the data product. The feature catalogue shall be available in both ‘machine readable’ and ‘human readable’ forms (XML).

All the feature types, their attributes and attribute value domains, and the association types between feature types expressed in the application schema shall be described in a feature catalogue.

> ***Example from draft S-201:*** *An AtoN Information dataset is a feature-based product. The following sub-sections contain the product application schema expressed in UML and an associated feature catalogue. The feature catalogue provides a full description of each feature type including its attributes and attribute values in the data product.*
>
> ***Example from draft S-112:*** *An S-112 Meteorological and Hydrographic Data AIS Application-Specific Message is a feature-based product. This section contains a feature catalogue and an application schema which is expressed in UML.*

Coverage Based Data

A data product specification shall identify each coverage type and each image type that is included within the specification scope and shall provide a narrative description for each.

6.5 Section 5 – Coordinate Reference System

The product specification shall include information that defines the reference systems used in the data product. The application schema will show how CRS references are carried in the data sets; this may be by reference to a register of CRS parameters, such as the EPSG Geodetic Parameter Dataset.

> ***Example from draft S-112:*** *All geographical positions and coordinate points (latitude and longitude) must be based on the WGS 84 datum (EPSG: 4326). The full reference to EPSG: 4326 can be found at www.epsg-registry.org.*
>
> ***Example from draft S-240:*** *Time is measured by reference to Calendar dates and Clock time in accordance with ISO 19108:2002 Temporal Schema clause 5.4.4.*

6.6 Section 6 – Data Quality

The data product specification shall identify the data quality requirements for each scope within the data product. Each product specification shall describe the data quality requirements. One aspect is the “data quality overview element” which should allow a user to decide whether this dataset is the one they want. The other aspect is the metadata allowed for specific feature collections, features and attributes within the dataset.

The data quality overview element should include at least the intended purpose and statement of quality or lineage. Other data quality elements cover: completeness, logical consistency, positional accuracy, temporal accuracy, thematic accuracy, and anything specifically required for the product being specified. The product specification should comment on which of these are to be used and how, including a description of (or reference to) conformance tests.

> ***Example:*** *should data only be published if it passes a particular test, or is it allowable to publish the data with a quality statement which indicates non-conformance? The product specification shall describe how each quality element is to be populated, for example, stating the mechanism to reference the quality evaluation procedure, and allowable values for the quality results.*
>
> ***Example from Draft S-102:*** *As defined in IHO S-100 Part 4c the data quality for the elevation coverage is also defined as a co-located coverage, uncertainty. Uncertainty is defined as the vertical uncertainty at each node location. The uncertainty coverage supports multiple definitions of vertical uncertainty.*
>
> ***Example from draft S-112:*** *The Meteorological and Hydrographic Data AIS Application- Specific Message Dynamic Water Level Data transmitted via an AIS VDL must conform to the requirements for data structure and transmission specified in ITU-R M.1371.*

6.7 Section 7 – Data Capture and Classification

The data product specification shall provide information on how the data is to be captured. This should be as detailed and specific as necessary. The product specification shall include this information for each identified scope.

> ***Example from draft S-102:*** *There are a number of sounding techniques, including SONAR and LIDAR that are used to capture bathymetric data. It is permitted, but not required, to include data acquisition information in the metadata of an S-102 Bathymetric Surface product. The metadata class S102_AcquisitionMetadata has been defined, but the information elements to populate this metadata class should be identified in a national profile of S-102.*

The product specification includes the collection criteria for mapping real world objects to the conceptual objects of the dataset. Data products can carry information about their data sources. The product specification and application schema will show whether this is expected, and how it is to be done.

Any organization performing data capture for the data product defined by the data product specification shall provide references to any more detailed encoding guide used in addition to that indicated in the product specification for the capturing process.

> ***Example from draft S-240:***
>
> *Data Product Delivery Information: This data product specification defines GML as the primary format in which S-240 data products are delivered. The delivery format information should include the following items (from ISO 19131:2005 with some changes of obligation): format name, version, specification, language, character set. File structure and units of delivery can also be included if required.*
>
> *Exchange Set: An exchange set will consist of one or more S-240 datasets. An exchange set may also include one or more support files containing supplementary information encoded in separate files. These are linked to the S-240 dataset features, using the attributes described below. Each exchange set will include a single (XML) catalogue file containing discovery metadata for each S-240 dataset as well as support files.*

6.8 Section 8 – Maintenance

The data product specification shall provide information on how the data is maintained. It should describe the principles and criteria applied in maintenance decisions, as well as the expected frequency of updates. The product specification shall include this information for each identified scope.

Maintenance information shall also provide procedures regarding how known errors in the data shall be handled. Any organisation performing data maintenance for the data product defined by the data product specification shall provide a reference to the detailed maintenance guide used for the maintenance process. (See also Metadata / Maintenance Information). Information about maintaining the data product specification itself is included in the Overview.

6.9 Section 9 – Portrayal

The data product specification may provide information on how the data is to be presented as graphic output (e.g. as a plot or as an image). This is an optional section; however it is strongly recommended that it is included where a product specification defines an IHO navigational product. Where included, this shall take the form of a reference to a portrayal library that contains a set of portrayal rules and a set of portrayal specifications. The product specification shall include this information for each identified scope.

> ***Example from draft S-112:*** Currently there are no specific display standards for AIS ASMs on shipborne or ship-based systems

Example from draft S-101: General Colour Assignment for ECDIS features

Colour	Comment
black/white	(black by day / white by night) is used for critical navigation features which need highlighting by contrast against their background to give them adequate prominence. Examples are the own-ship symbol, dangerous soundings less than the safety depth, buoys, conspicuous objects on land etc. It is also used for text, which is less clear in any other colour.
white/black	(white by day / black by night) as a **background area shade** is used for deep, safe, water.
magenta	is used to highlight critically important features such as isolated dangers, traffic routes, anchorages; and for restricted areas, submarine cables, gas pipelines etc. It is also used for aids to navigation and services such as daymarks, racons, and pilot stations.
grey	is used for many features which are black on the paper chart. It is used with thick lines for critical physical objects such as bridges and overhead cables, and with thin lines for important but less critical physical features such as non-dangerous soundings, sandwaves, overfalls, water pipelines and fish farms. It is similarly used for chart features such as fairways, harbour areas, tidal information and for information about the chart such as quality of chart data, overscale areas, etc.
grey	as a **background area shade** is used with a prominent pattern for no-data areas.
blue	as a **background area shade** is used to distinguish depth zones.
blue	as **foreground colour** for AIS and VTS information; also reserved for future requirements.
green	is used for the radar image and synthetics, and for buoy and lights colours
blue-green	is used for transferred ARPA.
yellow-green	('moss-green') as a **background area shade** is used for the intertidal area between high and low waterlines,
yellow	is used as the manufacturer's colour; for the mariner's transparent colour fill; and for buoy and lights colours.
red	is used for the important planned route, for the mariner's danger highlight, and for buoy and lights colours.
orange	is the mariner's colour, for notes, chartwork, chart corrections. The scale bar, north arrow, and mariner's navigation objects such as EBLs and VRMs are also orange.

brown	as a **background area shade** is used for the land, and dark brown is used for features on land and in the intertidal area that do not have any strong significance for navigation.

6.10 Section 10 – Data Product Format

The data product specification shall define the format (encoding) in which each scope within the data product is delivered.

This section includes a description of file structures and format. The file structure (encoding) could be specified completely here, or by reference to a separate profile or standard. For example, S-100 gives guidance on GML (ISO 19136) encoding; a given product would have a specific GML application schema, expressed in one or more XML Schema Definition Language files.

6.11 Section 11 – Data Product Delivery

The data product specification may define the delivery medium for each identified scope. This is an optional section. If a data product can be delivered in different formats then the appropriate information for each shall be given. Data product delivery and medium information are:

Units of Delivery	Description of the units of delivery
Transfer Size	Estimated size of a unit in the specified format (expressed in Mbytes)
Medium Name	Name of the date medium

6.12 Section 12 – Metadata

The core metadata elements as defined in ISO 19115 and S-100 Part 4 shall be included with the data product. Discovery and Quality metadata shall be structured as per S-100 Parts 4a and 4c, respectively. Any additional metadata items required for a particular product specification shall be documented in the data product specification. These should be defined using ISO 19115 and ISO 19139, with extensions or restrictions if required. The application schema shall show how metadata is carried in the datasets. This information shall be specified for each identified scope.