

# **IALA S-201 Product Specification**

**Edition 1.0.0 – October 2019**

IALA AtoN Product Specification

## Document Revisions

Revisions to the IALA Document are to be noted in the table prior to the issue of a revised document.

Date	Page / Section Revised	Requirement for Revision
03/03/2016	Various	See comments table 20160127
09/03/2016	Section 7.6 Geometry	Remove square brackets from S-201
09/03/2016	Section 8.2 Data Compliance	S-58 replaces Annex H for consistency
09/03/2016	Section 12.1 Encoding	Indicate conformity with S-100
09/03/2016	Section 11 Portrayal	Removed (not required)
04/07/2016	Various	FTA proposals
21/09/2016	Various	Reviewed at ENAV 19
26/11/2016	Various	Updated various sections and figures following data model update
31/01/2017	Various	Changed precision of lat/long, added units, various editorial changes
15/08/2017	Various	Partial implementation of TG1 July 2017 report. Aligned metadata and dataset identification with S-100 Edition 3.0.0, included AIS AtoN and base station (Radio Station), minor clarifications for file names and support files.
31/09/2019	Various	Updating specification to S-100 v4.0.0 and various edits following review at IALA ARM9.



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## **1 Overview**

### **1.1 Introduction**

The Aids to Navigation (AtoN) Information Product Specification provides a common structure for the exchange of information about AtoN. This includes buoys, beacons, racons, lights sound signals and AIS. The product contains the positions, properties, operational status and general comments related to an AtoN. The Product Specification can be used to exchange AtoN information in a consistent form between Lighthouse Authorities, Hydrographic Offices and other organizations (*including commercial and professional agencies*).

### **1.2 References**

#### **1.2.1 Normative references**

IHO S.100 IHO Universal Hydrographic Data Model, Edition 4.0.0, December 2018

IHO S.63 Data Protection Scheme, Edition 1.2.0, January 2015

ISO 8601:2004 Data elements and interchange formats \_ Information interchange \_ Representation of dates and times

ISO/TS 19103:2005 Geographic information – Conceptual schema language

ISO 19111:2003 Geographic information – Spatial referencing by coordinates

ISO 19115-1:2014 Geographic information – Metadata (Tech Corr. 1, 2006)

ISO 19131:2007 Geographic information – Data product specifications

ISO/IEC 19505-1:2012, Information technology — Open Distributed Processing - Unified Modelling Language Version 2.4.1

#### **1.2.2 Informative references**

ISO, 2006. ISO 19109 Geographic Information – Rules for Application Schema.

ISO, 2007. ISO 19135 Geographic Information – Procedures for Item Registration.

ISO, 2009. ISO 19136 Geographic Information – Geography Mark-up Language (GML).

IMO, 2008. Safety of Navigation Circular SN/Circ.243

IALA, 2012. Guideline 1088 on an Introduction to Preparing S-100 Product Specifications

### **1.3 Terms, definitions and abbreviations**

#### **1.3.1 Terms and definitions**

Terms and definitions have been taken from the normative references cited in clause 1.2.1 above.

#### **1.3.2 Acronyms**

AtoN            Aid to navigation

CRS            Coordinate Reference System

ECDIS          Electronic Chart Display and Information System

EPSG          European Petroleum Survey Group



ENC	Electronic Navigational Chart
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IHO	International Hydrographic Organization
IMO	International Maritime Organization
ISO	International Organization for Standardization
XML	Extensible Mark-up Language

#### **1.4 Product specification metadata**

<b>Title</b>	Aids to Navigation Product Specification
<b>Version</b>	1.0.0
<b>Identifier</b>	S-201
<b>S-100 version</b>	4.0.0
<b>Date</b>	31 March 2019
<b>Language</b>	English
<b>Classification:</b>	<b>001 - unclassified</b>
<b>Contact:</b>	IALA-AISM 10, rue des Gaudines 78100 Saint Germain en Laye, France Telephone: +33 1 34 51 70 01 Fax: +33 1 34 51 82 05
<b>URL:</b>	<a href="http://www.iala-aism.org">www.iala-aism.org</a>
<b>Maintenance:</b>	The product specification is maintained by IALA-AISM and amendments are performed on a needs base, up to maximum one new release per calendar year.

##### **1.4.1 IALA Product Specification Maintenance**

This section details the process of maintaining this document.

###### **1.4.1.1 Introduction**

Changes to this product specification will be released by IALA-AISM as a new edition, revision, or clarification.

#### 1.4.1.2 New Edition

New editions of this product specification introduce significant changes. *New editions* enable new concepts, such as the ability to support new functions or applications, or the introduction of new constructs or data types.

#### 1.4.1.3 Revisions

Revisions are defined as substantive semantic changes to a product specification. Typically, revisions will change a product specification to correct factual errors; introduce necessary changes that have become evident because of practical experience or changing circumstances. A *revision* must not be classified as a clarification. *Revisions* could have an impact on either existing users or future users of a product specification. All cumulative *clarifications* must be included with the release of approved corrections.

Changes in a revision are minor and ensure backward compatibility with the previous versions within the same edition. Newer revisions, for example, introduce new features and attributes. Within the same edition, a data product of one version could always be processed with a later version of the feature and portrayal catalogues.

#### 1.4.1.4 Clarification

Clarifications are non-substantive changes to this product specification. Typically, clarifications: remove ambiguity; correct grammatical and spelling errors; amend or update cross references; insert improved graphics, spelling, punctuation and grammar. A clarification must not cause any substantive semantic change to a product specification.

Changes in a clarification are minor and ensure backward compatibility with the previous versions within the same edition. Within the same edition, a data product of one clarification version could always be processed with a later version of the feature and portrayal catalogues, and a portrayal catalogue can always rely on earlier versions of the feature catalogues.

#### 1.4.1.5 Version Numbers

The associated version control numbering to identify changes (n) to this product specification will be as follows:

New editions denoted as **n.0.0**

Revisions denoted as **n.n.0**

Clarifications denoted as **n.n.n**

## 2 Specification Scope

This product specification describes one data product and therefore requires only one scope which is described below:

<b>Scope ID:</b>	Aids to Navigation datasets.
<b>Hierarchical level:</b>	MD_ScopeCode - 005
<b>Hierarchical level name:</b>	dataset.
<b>Level description:</b>	information applies to the dataset
<b>Extent:</b>	EX_Extent.description: Global coverage of maritime areas

## 3 Data Product Identification

This clause describes how to identify data sets that conform to the specification. A dataset that conforms to this Product Specification may be identified by its discovery metadata as defined in clause 13 of this specification. The information identifying the data product may include the following items from S-100 4.0.0 clause 11-6 (adapted from ISO 19115-1).

<b>Title</b>	Aids to Navigation
<b>Alternate Title</b>	AtoN
<b>Abstract</b>	An Aids to Navigation is a vector dataset containing all relevant information regarding the aids to navigation within a defined geographical area.
<b>Topic Category</b>	Environment, Oceans, Structure and Transportation
<b>Geographic Description</b>	CharacterString
<b>Spatial Extent</b>	Global
<b>Description</b>	Aids to navigation information, such as characteristics of the AtoN, its location and maintenance procedures that apply
<b>Spatial Resolution</b>	All scales
<b>Purpose</b>	Aids to Navigation datasets are produced to allow the producer to exchange AtoN information with interested stakeholders.
<b>Language</b>	EN

<b>Spatial Representation Type</b>	Vector
<b>Point of Contact</b>	IALA
<b>Use Limitation</b>	

## 4 Data Content and structure

### 4.1 Introduction

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.

### 4.2 Application Schema

The application schema conforms to the modelling conventions of UML as constrained in S-100 Part 1, and conforms to the General Feature Model described in Part 3.

An overview of the application schema is provided in the following figure (Figure 1). The subsequent figures provide details for feature types and their relationships. The allowed values for enumeration attributes are depicted in Figures 5 - 7. In conformance to S-57 and S-101, aids to navigation are described by combinations of structure and equipment features.

- The feature type AidsToNavigation is an abstract type from which the geographic feature types for aids to navigation are ultimately derived.
- StructureObject and Equipment are abstract types which collect the attributes and relationships common to structure and equipment features respectively. The relationship that exists between them is between structure and equipment features in the combining of structure and equipment object(s) to make up an individual aid to navigation.
- GenericBeacon and GenericBuoy are abstract types which collect attributes common to multiple types of beacon and buoy features respectively.
- Links to the geographic features for individual AtoN constituting the collection object are modelled by feature associations (the “Aggregations” and “Associations” links between Aggregation and Association classes and the common supertype for geographic AtoN features (AidsToNavigation). The type of the collection feature is indicated by the attribute categoryOfAggregation which can take the allowed values listed in the codelists of the same names.
- Structure-equipment associations are modelled by the association labelled StructureEquipment, between classes Structure and Equipment in Figure 1 below.

- Features participating in the same range system are indicated by the association labelled RangeSystem, between feature classes NavigationLine and RecommendedTrack.
- The model supports two types of AIS features, physical (real) and virtual (synthetic). The broadcasting station for virtual AIS is encoded as RadioStation, and may be associated with the virtual AIS it broadcasts by an association labelled VirtualAIS. AIS related items are shown in Figure 4.
- Only RadioStation that are AIS base stations can be included.
- The structure features are Lighthouse, Landmark, Pile, LightFloat, OffShorePlatform, LightVessel, and Silo/Tank features as well as buoys and beacons of different kinds. The detailed models of structure features are depicted in Figure 2.
- The equipment features are daymark, Fog Signal, Radar Reflector, Light, Retroreflector, Topmark, Radar Transponder Beacon, Environmental Observation Equipment, Physical AIS Aid to Navigation, and Radio Station. Daymark is allowed to act as either a structure or equipment feature in practice but this cannot at present be modelled in the application schema since S-100 discourages multiple inheritance. The detailed model of equipment features is depicted in Figure 3.
- The feature classes Navigation Line and Recommended Track are neither structure nor equipment objects, and are depicted in complete detail in the overview (Figure 1). Documentation tables for the application schema are in ANNEX F.

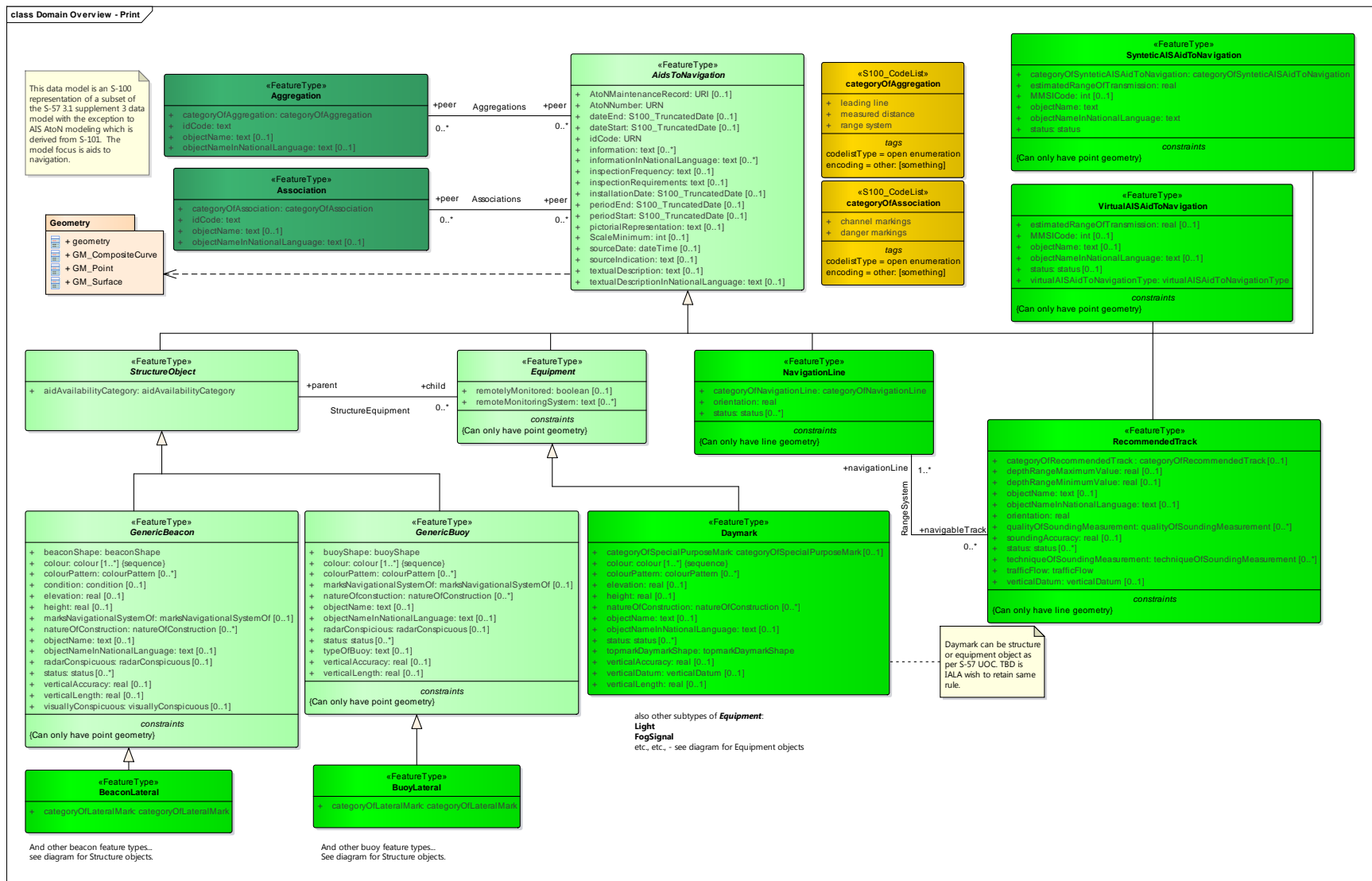


Figure 1. Overview

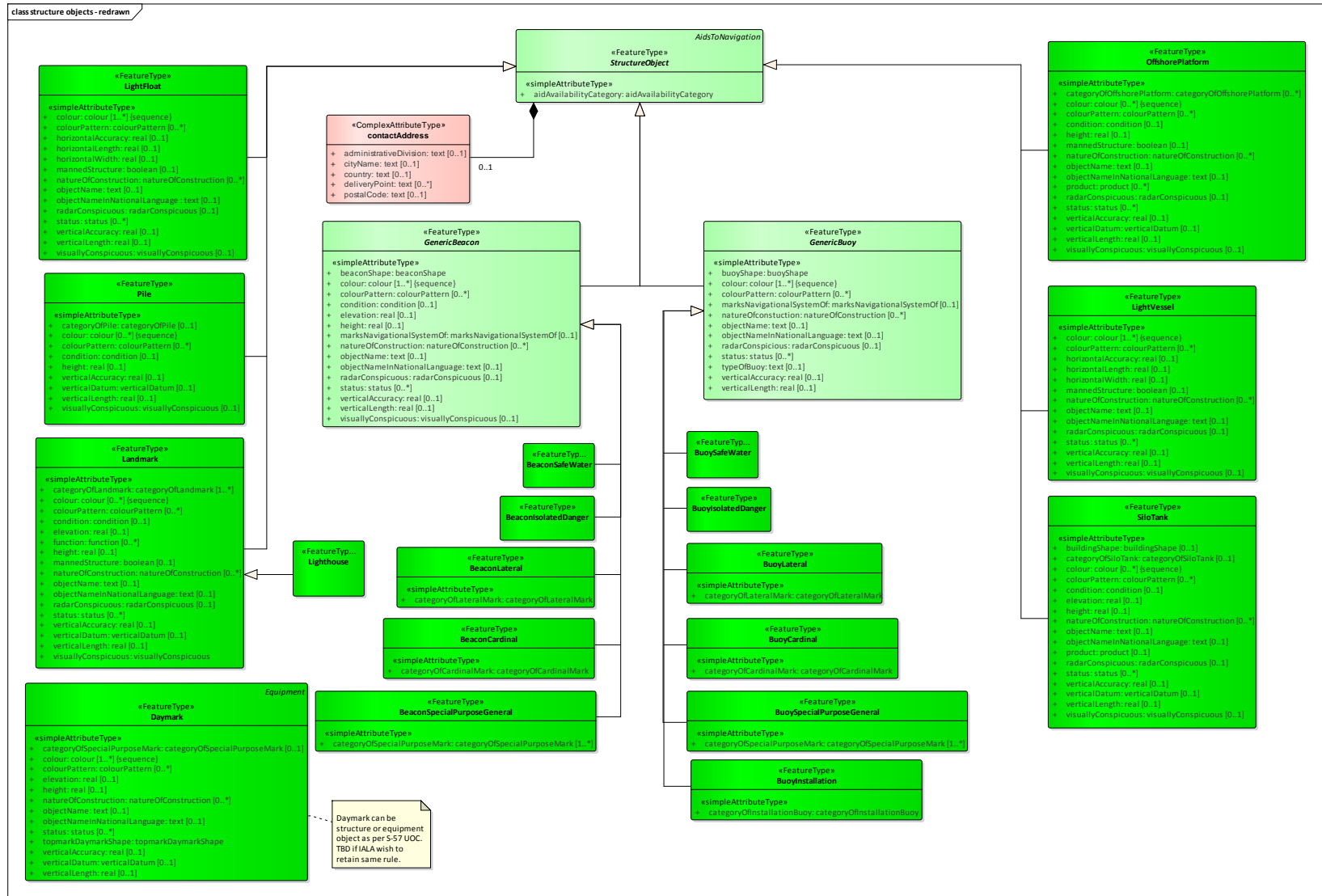


Figure 2. Structure Objects

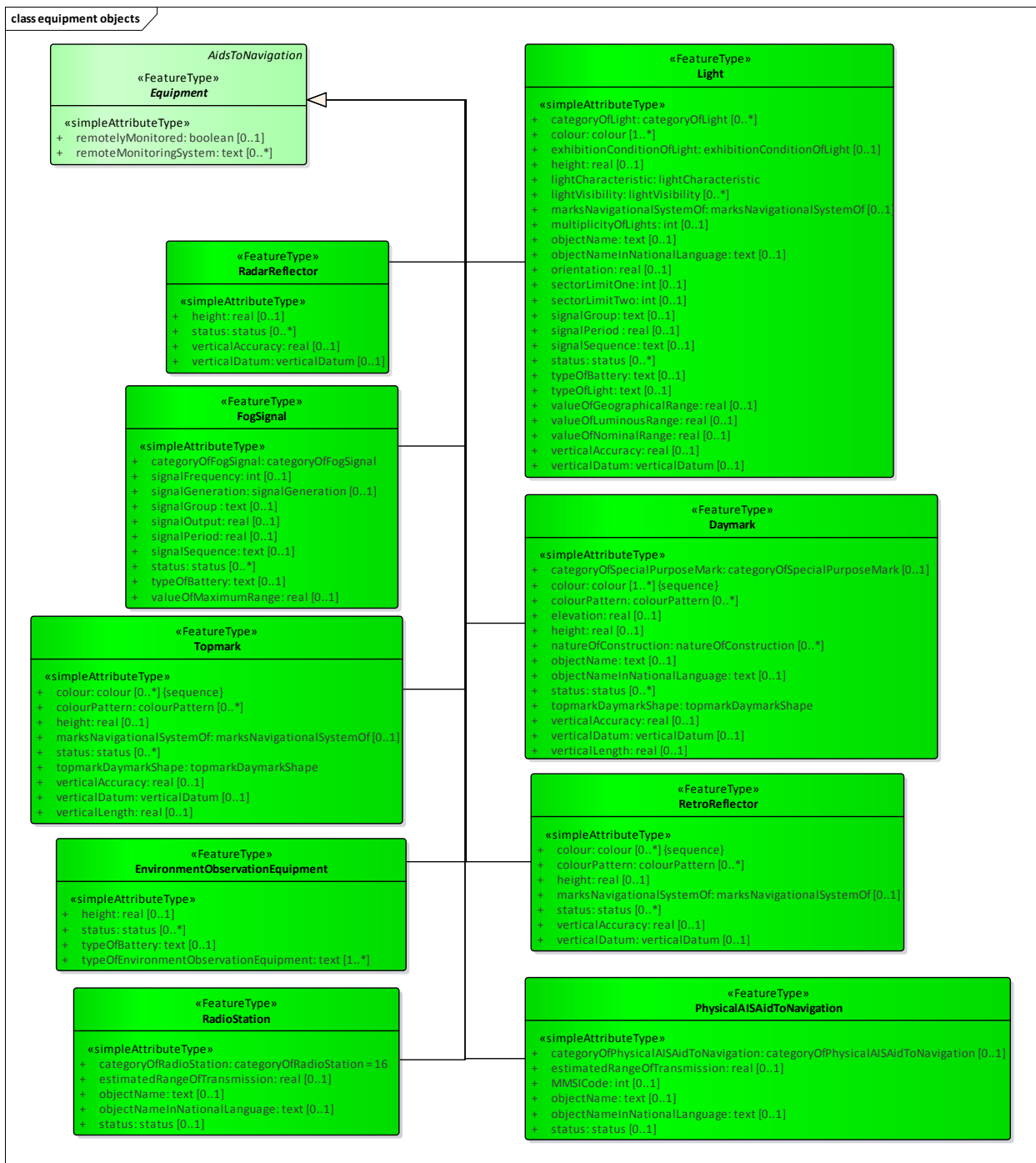


Figure 3. Equipment Objects



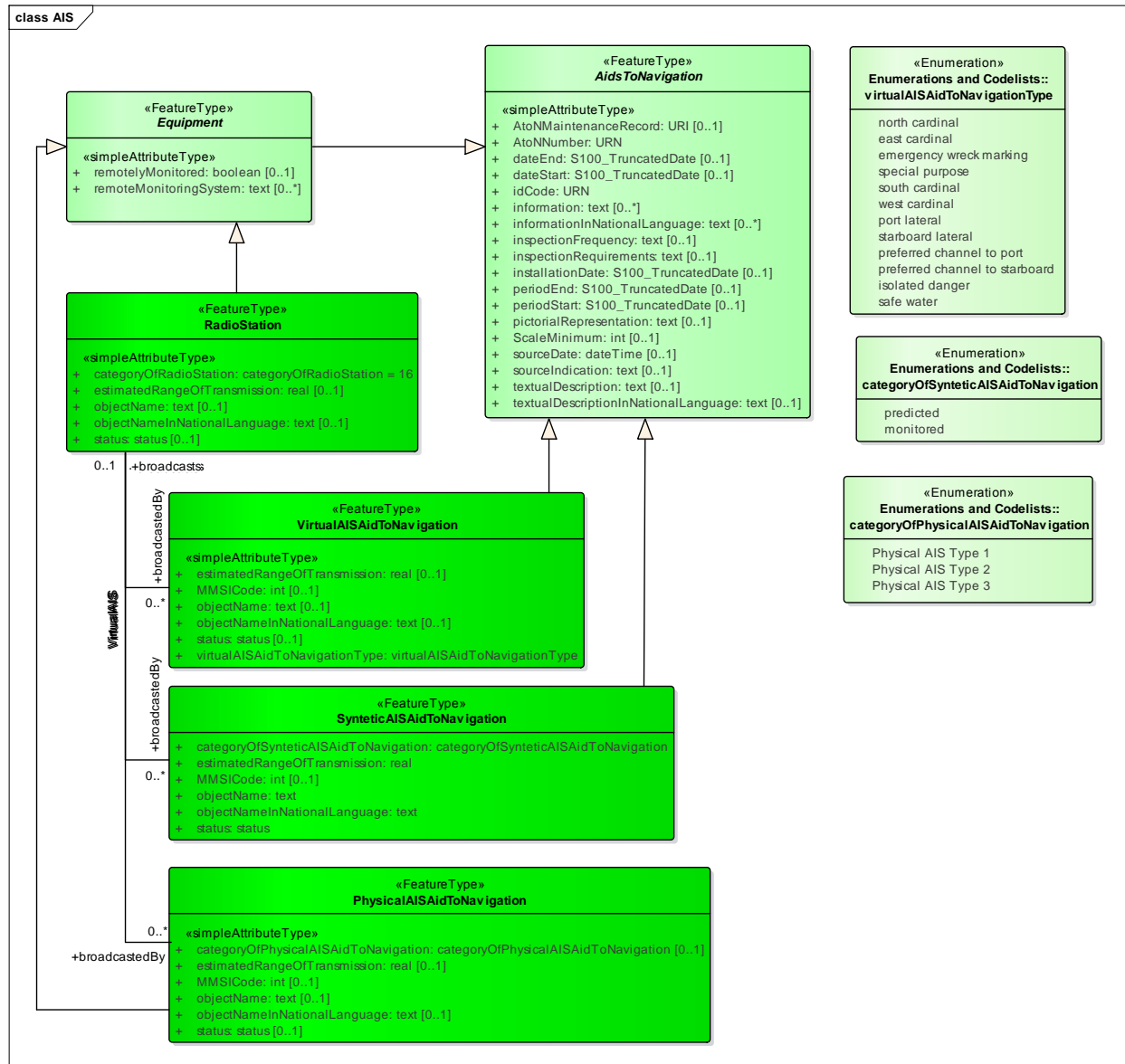


Figure 4. AIS Aids to Navigation

## class Enumerations - Categories

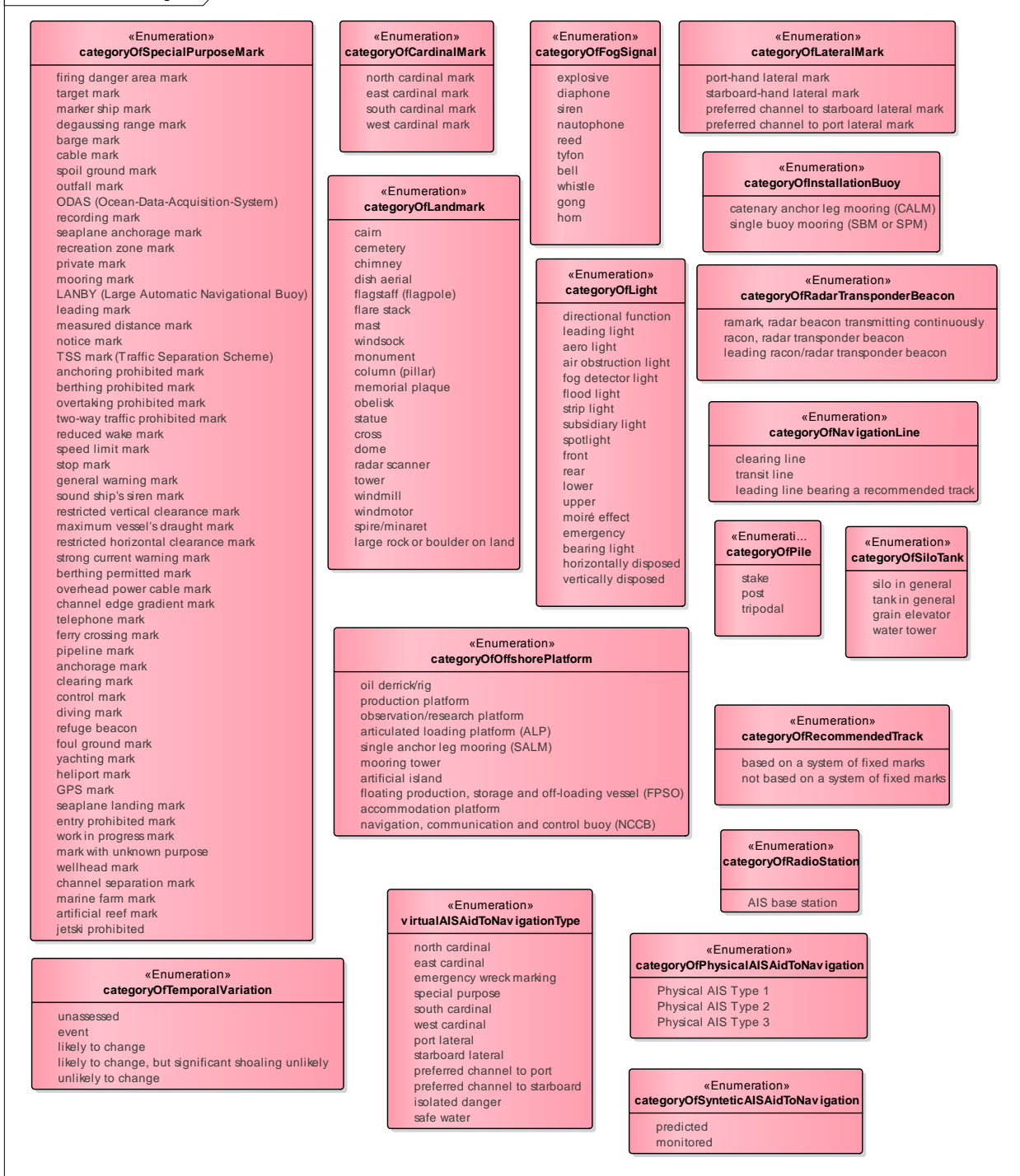


Figure 5. Enumerations – categories

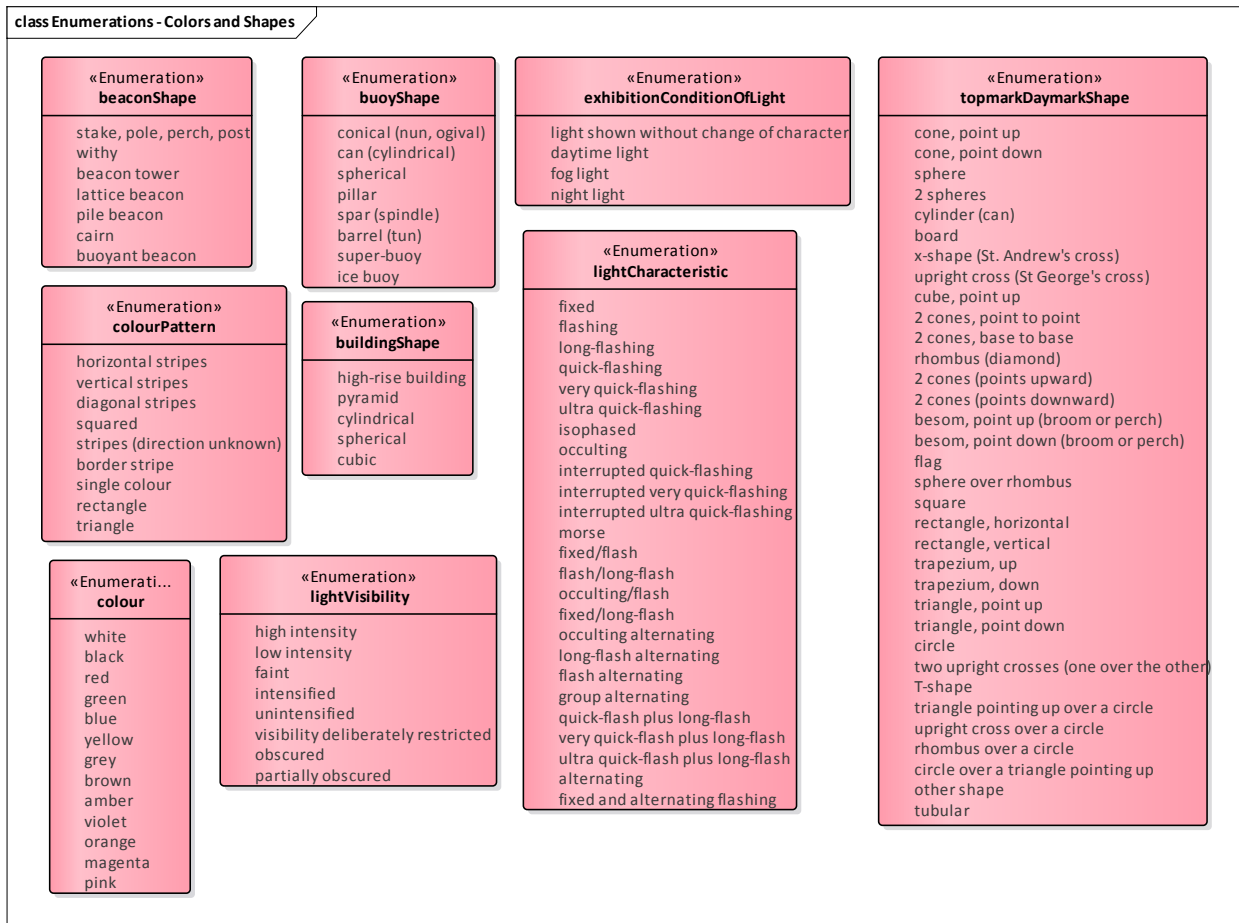


Figure 6. Enumerations – Colour, characteristics, and shape enumerated attributes

# class Enumerations - Other

<b>«Enumeration» function</b> <ul style="list-style-type: none"> <li>harbour-master's office</li> <li>custom office</li> <li>health office</li> <li>hospital</li> <li>post office</li> <li>hotel</li> <li>railway station</li> <li>police station</li> <li>water-police station</li> <li>pilot office</li> <li>pilot lookout</li> <li>bank office</li> <li>headquarters for district control</li> <li>transit shed/warehouse</li> <li>factory</li> <li>power station</li> <li>administrative</li> <li>educational facility</li> <li>church</li> <li>chapel</li> <li>temple</li> <li>pagoda</li> <li>shintō shrine</li> <li>buddhist temple</li> <li>mosque</li> <li>marabout</li> <li>lookout</li> <li>communication</li> <li>television</li> <li>radio</li> <li>radar</li> <li>light support</li> <li>microwave</li> <li>cooling</li> <li>observation</li> <li>timeball</li> <li>clock</li> <li>control</li> <li>airship mooring</li> <li>stadium</li> <li>bus station</li> </ul>	<b>«Enumeration» product</b> <ul style="list-style-type: none"> <li>oil</li> <li>gas</li> <li>water</li> <li>stone</li> <li>coal</li> <li>ore</li> <li>chemicals</li> <li>drinking water</li> <li>milk</li> <li>bauxite</li> <li>coke</li> <li>iron ingots</li> <li>salt</li> <li>sand</li> <li>timber</li> <li>sawdust/wood chips</li> <li>scrap metal</li> <li>liquefied natural gas (LNG)</li> <li>liquefied petroleum gas (LPG)</li> <li>wine</li> <li>cement</li> <li>grain</li> </ul>	<b>«Enumeration» aidAvailabilityCategory</b> <ul style="list-style-type: none"> <li>Category 1</li> <li>Category 2</li> <li>Category 3</li> </ul>	<b>«Enumeration» verticalDatum</b> <ul style="list-style-type: none"> <li>Mean low water springs</li> <li>Mean lower low water springs</li> <li>Mean sea level</li> <li>Lowest low water</li> <li>Mean low water</li> <li>Lowest low water springs</li> <li>Approximate mean low water springs</li> <li>Indian spring low water</li> <li>Low water springs</li> <li>Approximate lowest astronomical tide</li> <li>Nearly lowest low water</li> <li>Mean lower low water</li> <li>Low water</li> <li>Approximate mean low water</li> <li>Approximate mean lower low water</li> <li>Mean high water</li> <li>Mean high water springs</li> <li>High water</li> <li>Approximate mean sea level</li> <li>High water springs</li> <li>Mean higher high water</li> <li>Equinoctial spring low water</li> <li>Lowest astronomical tide</li> <li>Local datum</li> <li>International Great Lakes Datum 1985</li> <li>Mean water level</li> <li>Lower low water large tide</li> <li>Higher high water large tide</li> <li>Nearly highest high water</li> <li>Highest astronomical tide (HAT)</li> </ul>
	<b>«Enumeration» techniqueOfSoundingMeasurement</b> <ul style="list-style-type: none"> <li>found by echo-sounder</li> <li>found by side scan sonar</li> <li>found by multi-beam</li> <li>found by diver</li> <li>found by lead-line</li> <li>swept by wire-drag</li> <li>found by laser</li> <li>swept by vertical acoustic system</li> <li>found by electromagnetic sensor</li> <li>photogrammetry</li> <li>satellite imagery</li> <li>found by levelling</li> <li>swept by side-scan sonar</li> <li>computer generated</li> </ul>	<b>«Enumeration» natureOfConstruction</b> <ul style="list-style-type: none"> <li>masonry</li> <li>concreted</li> <li>loose boulders</li> <li>hard surfaced</li> <li>unsurfaced</li> <li>wooden</li> <li>metal</li> <li>glass reinforced plastic (GRP)</li> <li>painted</li> <li>fiberglass</li> <li>plastic</li> </ul>	<b>«Enumeration» qualityOfPosition</b> <ul style="list-style-type: none"> <li>surveyed</li> <li>unsurveyed</li> <li>inadequately surveyed</li> <li>approximate</li> <li>position doubtful</li> <li>unreliable</li> <li>reported (not surveyed)</li> <li>reported (not confirmed)</li> <li>estimated</li> <li>precisely known</li> <li>calculated</li> </ul>
		<b>«Enumeration» signalGeneration</b> <ul style="list-style-type: none"> <li>automatically</li> <li>by wave action</li> <li>by hand</li> <li>by wind</li> </ul>	<b>«Enumeration» radarConspicuous</b> <ul style="list-style-type: none"> <li>radar conspicuous</li> <li>not radar conspicuous</li> <li>radar conspicuous (has radar reflector)</li> </ul>
<b>«Enumeration» qualityOfSoundingMeasurement</b> <ul style="list-style-type: none"> <li>depth known</li> <li>depth unknown</li> <li>doubtful sounding</li> <li>unreliable sounding</li> <li>no bottom found at value shown</li> <li>least depth known</li> <li>least depth unknown, safe clearance at value shown</li> <li>value reported (not surveyed)</li> <li>value reported (not confirmed)</li> <li>maintained depth</li> <li>not regularly maintained</li> </ul>	<b>«Enumeration» status</b> <ul style="list-style-type: none"> <li>permanent</li> <li>occasional</li> <li>recommended</li> <li>not in use</li> <li>periodic/intermittent</li> <li>reserved</li> <li>temporary</li> <li>private</li> <li>mandatory</li> <li>extinguished</li> <li>illuminated</li> <li>historic</li> <li>public</li> <li>synchronized</li> <li>watched</li> <li>un-watched</li> <li>existence doubtful</li> <li>confirmed</li> <li>candidate</li> <li>under modification</li> <li>candidate for modification</li> <li>under removal/deletion</li> <li>removed/deleted</li> </ul>	<b>«Enumeration» visuallyConspicuous</b> <ul style="list-style-type: none"> <li>visually conspicuous</li> <li>not visually conspicuous</li> </ul>	<b>«Enumeration» topmarkDaymarkShape</b> <ul style="list-style-type: none"> <li>cone, point up</li> <li>cone, point down</li> <li>sphere</li> <li>2 spheres</li> <li>cylinder (can)</li> <li>board</li> <li>x-shape (St. Andrew's cross)</li> <li>upright cross (St George's cross)</li> <li>cube, point up</li> <li>2 cones, point to point</li> <li>2 cones, base to base</li> <li>rhombus (diamond)</li> <li>2 cones (points upward)</li> <li>2 cones (points downward)</li> <li>besom, point up (broom or perch)</li> <li>besom, point down (broom or perch)</li> <li>flag</li> <li>sphere over rhombus</li> <li>square</li> <li>rectangle, horizontal</li> <li>rectangle, vertical</li> <li>trapezium, up</li> <li>trapezium, down</li> <li>triangle, point up</li> <li>triangle, point down</li> <li>circle</li> <li>two upright crosses (one over the other)</li> <li>T-shape</li> <li>triangle pointing up over a circle</li> <li>upright cross over a circle</li> <li>rhombus over a circle</li> <li>circle over a triangle pointing up</li> <li>other shape</li> <li>tubular</li> </ul>
<b>«Enumeration» marksNavigationalSystemOf</b> <ul style="list-style-type: none"> <li>IALA A</li> <li>IALA B</li> <li>no system</li> <li>other system</li> </ul>	<b>«Enumeration» trafficFlow</b> <ul style="list-style-type: none"> <li>inbound</li> <li>outbound</li> <li>one-way</li> <li>two-way</li> </ul>	<b>«Enumeration» lightCharacteristic</b> <ul style="list-style-type: none"> <li>fixed</li> <li>flashing</li> <li>long-flashing</li> <li>quick-flashing</li> <li>very quick-flashing</li> <li>ultra quick-flashing</li> <li>isophased</li> <li>occulting</li> <li>interrupted quick-flashing</li> <li>interrupted very quick-flashing</li> <li>interrupted ultra quick-flashing</li> <li>morse</li> <li>fixed/flash</li> <li>flash/long-flash</li> <li>occulting/flash</li> <li>fixed/long-flash</li> <li>occulting alternating</li> <li>long-flash alternating</li> <li>flash alternating</li> <li>group alternating</li> <li>quick-flash plus long-flash</li> <li>very quick-flash plus long-flash</li> <li>ultra quick-flash plus long-flash</li> <li>alternating</li> <li>fixed and alternating flashing</li> </ul>	
<b>«Enumeration» condition</b> <ul style="list-style-type: none"> <li>under construction</li> <li>ruined</li> <li>under reclamation</li> <li>wingless</li> <li>planned construction</li> </ul>			

Figure 7. Enumerations - Other enumerated attributes

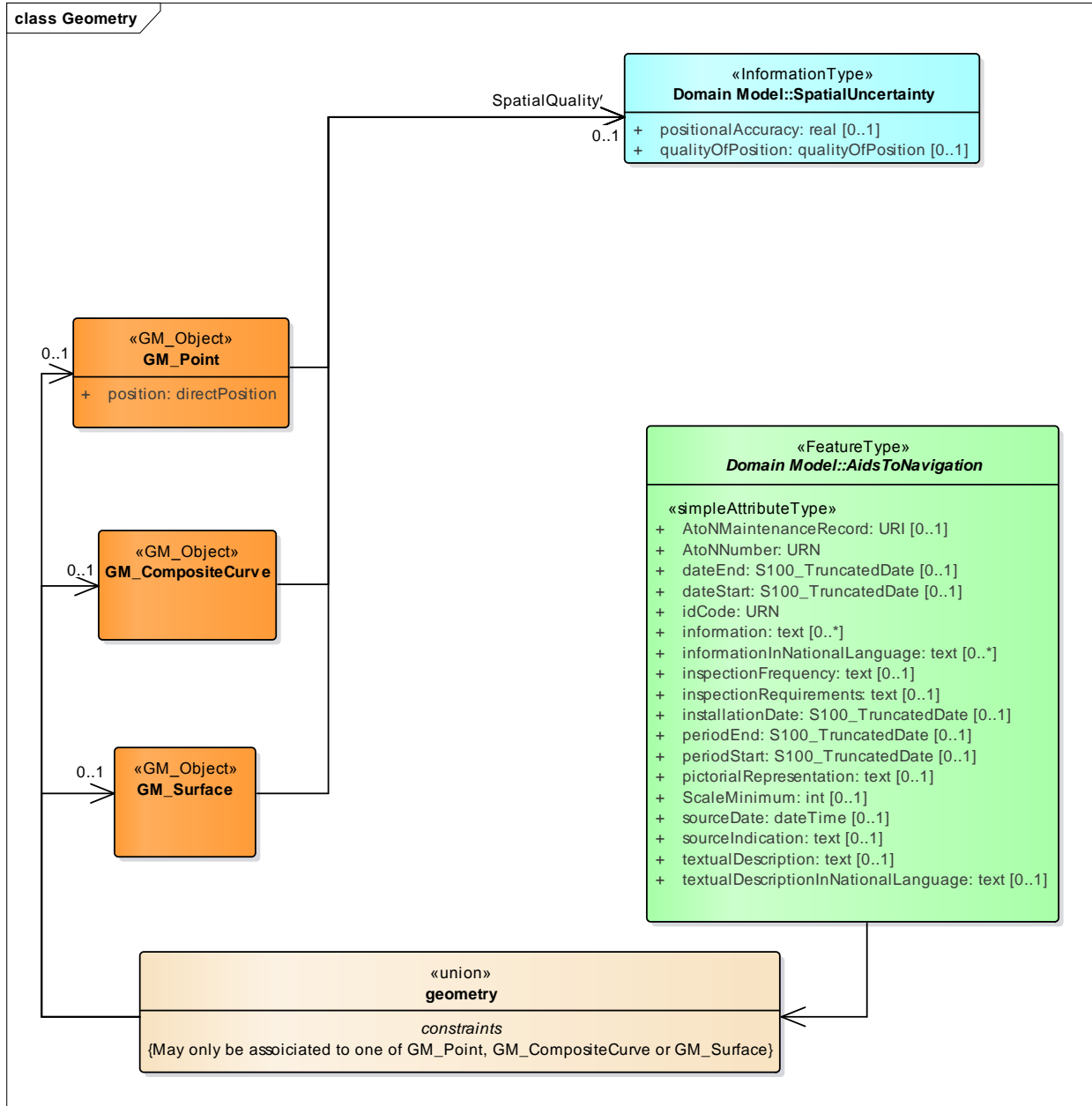


Figure 8. Spatial Attributes

#### 4.3 Meta features application schema

Meta features include data coverage, data quality, datums and areas with established characteristics for navigational systems of marks (buoyage direction and system of marks). The application schema for meta-features is depicted in figure 9.

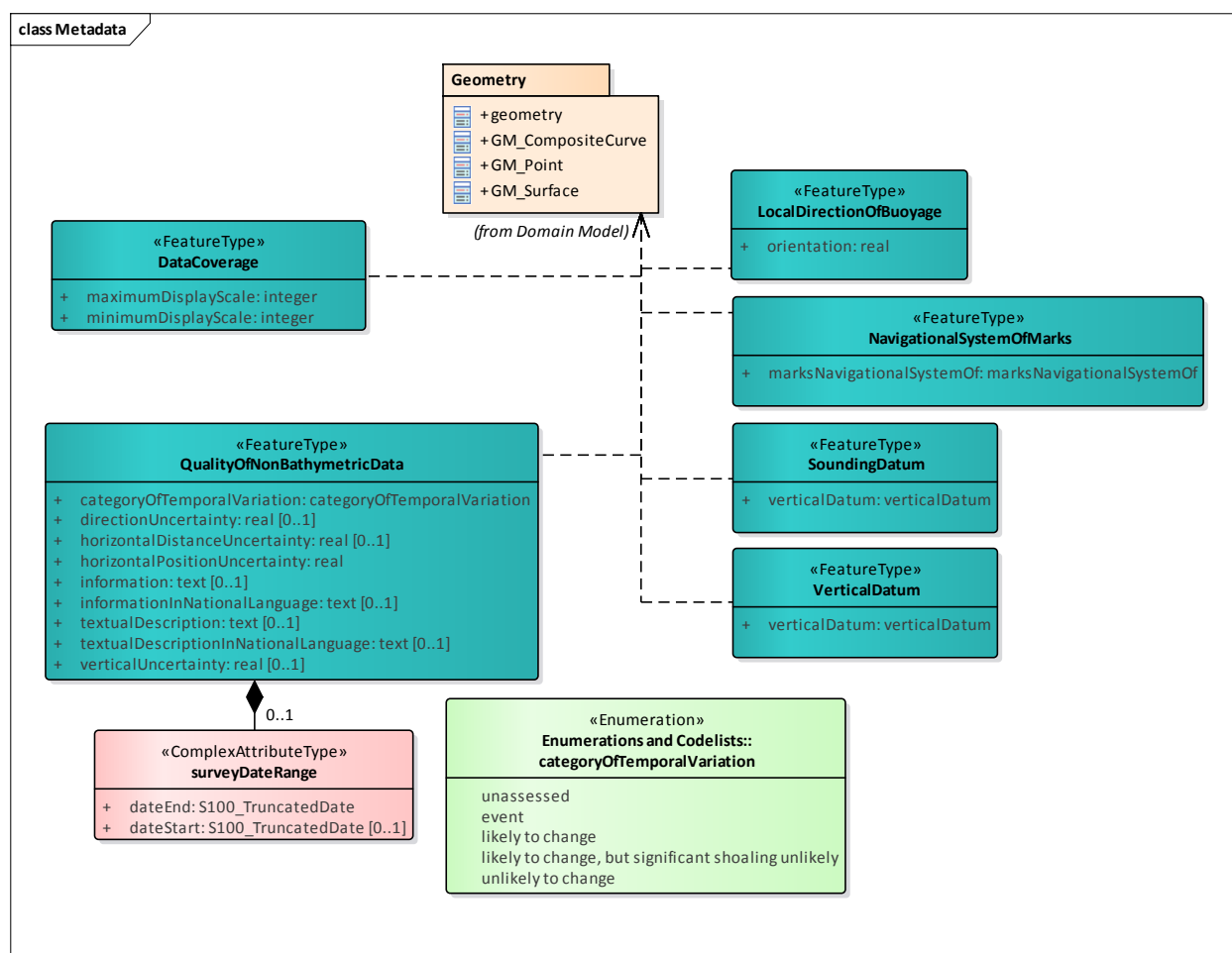


Figure 9. Meta features application schema

#### 4.4 Feature Catalogue

The Feature Catalogue describes the feature types, information types, attributes, attribute values, associations and roles which may be used in the product. It also assigns the geometric primitives. The S-201 Feature Catalogue is available in an XML document which conforms to the S-100 XML Feature Catalogue Schema and can be downloaded from the IALA website (iala-aism.org). A printed version of the feature catalogue is provided in Annex D.

**Name:** Aids to Navigation Feature Catalogue

**Scope:** Ocean, Coastal, Ports, Harbours and Inland waters

**Version Number:** 1.0.0

**Version Date:** 2019-10-10

**Producer:** IALA-AISM

10, rue des Gaudines

78100 Saint Germain en Laye, France

Telephone: +33 1 34 51 70 01, Fax: +33 1 34 51 82 05

URL : <https://www.iala-aism.org>

**Language:** English

## 4.5 Feature Types

Feature types contain descriptive attributes and do not contain any geometry (i.e. information about the shape and position of a real world entity). Features have two aspects – feature type and feature instance. A feature type is a 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 dataset. A feature instance is located by a relationship to one or more spatial instances. A feature instance may exist without referencing a spatial instance.

S-201 makes use of the following feature types:

- Geographic (Geo) feature type – carries the descriptive characteristics of a real-world entity.
- Relationship feature type – A feature relationship links instances of one feature type with instances of the same or a different feature type.

Meta features – Meta features contain information about other features within a dataset. Information defined by meta features overrides the default metadata values defined by the dataset descriptive records. Meta attribution on individual features overrides attribution on meta features.

## 4.6 Data Product Types

A Dataset is a grouping of features, attributes, geometry and metadata which comprises a specific coverage. AtoN data is scale independent, but may use the scaleMinimum and scaleMaximum attributes of S100\_GF\_SpatialAttributeType to declutter the data in certain viewing scales. The use of scaleMinimum and scaleMaximum is at the discretion of the data producer.

## 4.7 Dataset rules

In order to facilitate the efficient processing and cataloguing of AtoN data the geographic coverage may be split into multiple datasets. There must be no overlapping datasets, except at the agreed adjoining national data limits, where, if it is difficult to achieve a perfect join, a 5-metre overlapping buffer zone may be used; and for this situation, there must be no gaps in data. The discovery metadata of a dataset must list all the Data Coverage features contained within that dataset.

Datasets are replaced by new editions that must be considered a whole replacement of the previous version. Delta change datasets are not permitted.

Datasets must not exceed 20MB.

## 4.8 Geometry

The specifications for S-201 geometry are the same as for S-101 geometry except that 3-D geometry is not permitted even for sounding features since these features are not part of the S-201 application schema. The relevant (modified) extract from the S-101 product specification is reproduced below.

The underlying geometry of an S-201 dataset is constrained to level 3a which supports 0, 1 and 2 dimensional features (points, curves and surfaces) as defined by S-100 Part 7 – Spatial Schema.

Level 3a is described by the following constraints:

- Each curve must reference a start and end point (they may be the same).
- Curves must not self-intersect.
- Areas are represented by a closed loop of curves beginning and ending at a common point.
- In the case of areas with holes, all internal boundaries must be completely contained within the external boundary and the internal boundaries must not intersect each other or the external boundary. Internal boundaries may touch other internal boundaries or the external boundary tangentially (i.e. at one point).
- The outer boundary of a surface must be in a clockwise direction (surface to the right of the curve) and the curve orientation positive. The inner boundary of a surface must be in a counter-clockwise direction (surface to the right of the curve) and the curve orientation negative.

S-201 further constrains Level 3a with the following:

- Coincident linear geometry must be avoided when there is a dependency between features.
- The interpolation of GM\_CurveSegment must be loxodromic.
- Linear geometry is defined by curves which are made of curve segments. Each curve segments contains the geographic coordinates as control points and defines an interpolation method between them. The distance between two consecutive control points must not exceed 0.3 mm at a display scale of 1:10000.

The following exception applies to S-201:

- The use of coordinates is restricted to two dimensions.
- Soundings features which use GM\_Point or GM\_Multipoint with three dimensional coordinates are not currently included in S-201.



## **5 Co-ordinate Reference Systems (CRS)**

### **5.1 Introduction**

The single coordinate reference system is separated into the horizontal and vertical components.

### **5.2 Horizontal Geodetic Datum**

WGS84 (World Geodetic System of 1984) must be used for the horizontal reference system for spatial data. WGS84 must be used as the reference ellipsoid.

### **5.3 Vertical Datum**

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. Positive value is above vertical datum and negative is below vertical datum.

### **5.4 Units of Measure**

Units of measure for S-201 datasets must be as follows,

For height, depth and vertical length it must be metres.

For range, it must be nautical miles

For orientation, it must be degrees

For signal duration, it must be seconds

For audible signal output, it must be decibel

For signal frequency, it must be Hertz

## **6 Data Quality**

### **6.1 Introduction**

Data Quality is considered to be meta information and for S-201 it is divided into two parts:

- Compliance and integrity
- Uncertainty and lineage

### **6.2 Data Compliance and Integrity**

S-201 datasets must be validated using the conformance checks that are listed in S-58. The data quality elements listed in S-100 Part 4C that are applicable to S-201 are indicated in the table of conformance checks listed in S-58.

Datasets must not be published unless they pass all the compliance checks designated as “Critical”.

The detailed results of applying compliance checks listed in S-58 are not required to be reported as part of the exchange set. They may be conveyed as support files or by separate arrangement.

### **6.3 Positional accuracy**

S-201 positional accuracy data quality indicators do not use the model of data quality data quality elements defined in S-100 Part 4c.

However, positional accuracy must be evaluated and must be indicated in dataset metadata or spatial attribute metadata as provided in the application schema (Figure 8). This specification does not prescribe a specific required level of positional accuracy.

### **6.4 Lineage**

Lineage and process step information elements are not required to be present in S-201 datasets distributed to end user. They may be included as extra metadata in exchange sets distributed to vendors and distributors.

Required source information about S-201 datasets is limited to the source and distribution information contained in discovery metadata described in S-100 Part 4a and Section 12 of this product specification.

## **7 Data Capture and Classification**

The Data Capture and Classification Guide (DCEG) is found in Annex A

## **8 Data Maintenance**

### **8.1 Introduction**

Datasets are replaced by new editions that must be considered a whole replacement of the previous version. Delta change datasets are not permitted. Each edition of a dataset shall have an edition number that is greater than the previous version by one. First edition of a dataset shall have edition number set to 1.

### **8.2 Maintenance and Update Frequency**

Datasets are maintained as needed in accordance with data producer policy.

## 9 Portrayal

The Portrayal catalogue is found in Annex D.

## 10 Data Product format (encoding)

### 10.1 Introduction

The GML encoding of S-201 datasets is based on the S-100 profile of GML 3.2.1. This is described in S-100 Edition 4.0.0 Part 10b.

Detailed documentation of the S-201 encoding schema is provided in Annex B of this document.

Format Name: GML, Specification: S-100 profile of GML Part 10b.

**File Structure: S-201 (IALA AtoN Product Specification), Annex B.**

### 10.2 Encoding of Latitude and Longitude

Values of latitude and longitude must be expressed with a precision of 9 decimal places. Coordinates must be encoded as decimals in the format described below. The encoding is indicated by multiplication factor fields defined in the dataset identification record by the S-100 GML schemas.

### 10.3 Encoding of coordinates as decimals

Values should be coded as decimal numbers with 9 or fewer digits after the decimal. The normative encoding is in degrees, with an accuracy of  $10^{-9}$  degrees, i.e., 9 digits after the decimal point.

The decimal point must be indicated by the “.” character.

Trailing zeroes after the decimal point (and the decimal point itself if appropriate) may be omitted at producer discretion, but the accuracy must still be as indicated (e.g.,  $10^{-9}$  degrees for coordinates of default accuracy).

Latitude and longitude multiplication factors held in the Dataset Structure Information field under [coordMultFactorX] and [coordMultFactorY] must be set to a value corresponding to the encoding, e.g., {1} for coordinates encoded in decimal degrees.

EXAMPLE 1 A longitude = 42.0000 is converted into  $X = \text{longitude} * \text{coordMultFactorX} = 42.0000 * 1 = 42.000000000$ .

### 10.4 Numeric Attribute Encoding

Floating point and integer attribute values must not contain leading zeros. Floating point attribute values must not contain non-significant trailing zeros.

## 10.5 Text Attribute Values

Character strings must be encoded using the character set defined in ISO 10646-1, in Unicode Transformation Format-8 (UTF-8).

## 10.6 Mandatory Attribute Values

There are four reasons why attribute values may be considered mandatory:

- They determine whether a feature is in the display base,
- Certain features make no logical sense without specific attributes,
- Some attributes are necessary to determine which symbol is to be displayed,
- Some attributes are required for safety of navigation.

All mandatory attributes are identified in the Feature Catalogue and summarised in Annex A – Data Classification and Encoding Guide.

## 10.7 Unknown Attribute Values

When a mandatory attribute code or tag is present but the attribute value is missing, it means that the producer wishes to indicate that this attribute value is unknown. Missing mandatory attributes must be “nilled” with a GML *nilReason* attribute giving the reason for omission.

Optional attributes must be omitted altogether if the value is unknown or missing. They must not be “nilled.”

**EXAMPLE** An isolated danger beacon feature has unknown colour (mandatory attribute) and condition (optional attribute). The feature could be coded as:

```
<BeaconIsolatedDanger>  
  <beaconShape>beacon tower</beaconShape>  
  <colour nilReason="unknown"/>  
  ... other attributes...  
  ... <condition> is NOT coded ...  
</BeaconIsolatedDanger>
```

## 10.8 Structure of dataset files

The order of data objects in each dataset file is described below:

Dataset Identification Information

Dataset structure information

Spatial records for by-reference geometries

Point

Multi point

Curve

Composite Curve

- Surface
- Information objects
- Feature objects (Geometry may be encoded inline or by reference.)
  - Meta features
  - Geo features
- S-201 Collection objects

## 10.9 Object identifiers

Features, information types, collection objects, meta features, and geometries (inline or external) are all required by the schema to have a **gml:id** attribute with a value that is unique within the dataset. The **gml:id** values must be used as the reference for the object from another object in the same dataset or another dataset.

All geographic feature classes in S-201 have the **idCode** attribute. This attribute shall be used to hold the Maritime Resource Name (MRN) identifier for the object instance.

## 10.10 Dataset validation

Fields may be repeated or omitted as permitted by the XML schemas and the validation tests. Since XML schema cannot encode rules for conditional presence or attributes, these rules are checked by Schematron rules or other validation code.

## 10.11 Detailed documentation of schema

The detailed documentation of the S-100 Profile of GML Part 10b schema is in Annex B (currently a separate document enclosed with this file).

## 10.12 Data coverage

All areas of a dataset must be covered by a **DataCoverage** meta feature.

## 10.13 Data overlap

S-201 datasets must not overlap other S-201 datasets.

## 10.14 Data quality

One or more **QualityOfNonBathymetricData** features must cover the dataset.

## 10.15 Data extent

Datasets must not cross the 180° meridian of longitude

## 11 Data Product Delivery

This clause specifies the encoding and delivery mechanisms for an S-201 dataset. Data that conforms to this product specification must be delivered by means of an exchange set.

Name	ISO 19131 Elements	Value
Format name	DPS_DeliveryInformation.deliveryFormat > DPS_DeliveryFormat.formatName	GML*
Version	DPS_DeliveryInformation.deliveryFormat > DPS_DeliveryFormat.version	3.2.1
Specification description	DPS_DeliveryInformation.deliveryFormat > DPS_DeliveryFormat.specification	GML*
Language	DPS_DeliveryInformation.deliveryFormat > DPS_DeliveryFormat.language	English
Character set	DPS_DeliveryInformation.deliveryFormat > DPS_DeliveryFormat.characterSet > MD_CharacterSetCode	004 – utf8

*Table 11.1 Data product delivery*

\* GML is an XML encoding for the transport and storage of geographic information, including both the geometry and the properties of geographic features, between distributed systems. The XML Schema for the GML application schema is provided in a schema document S201.xsd which imports other schema(s) defining common types. (All files are available on the S-100 distribution site <https://github.com/IHO-S100WG>). Feature instances must validate against S201.xsd and conform to all other requirements specified in this data product specification including all constraints not captured in the XML Schema document.

### 11.1 Exchange set

S-201 datasets are grouped into exchange sets. Each exchange set consists of one or more AtoN datasets with an associated XML metadata file and a single Exchange Catalogue XML file containing metadata. It may also include one or more support files.

**Units of Delivery:** Exchange Set

**Transfer Size:** Unlimited

**Medium Name:** Digital data delivery

**Other Delivery Information:**

Each dataset must be contained in a physically separate, uniquely identified file on the transfer medium.

Each exchange set has a single exchange catalogue which contains the discovery metadata for each dataset and references to any support files.

Support files are supplementary information which are linked to the features and information types by attributes. The attributes containing these links are described in the application schema and feature catalogue.

An exchange set may be encapsulated into a form suitable for transmission by a mapping called a transmission encoding. An encoding translates each of the elements of the exchange set into a logical form suitable for writing to media and for transmission online. An encoding may also define other elements in addition to the exchange set contents (i.e., media identification, data extents etc...) and also may define commercial constructs such as encryption and compression methods.

If the data is transformed (e.g., for encryption or compression purposes) its content must not be changed. Digital signature and data security should be covered by a Memorandum of Understanding between involved parties.

This product specification does not define the transmission encoding which must be used as a default for transmission of data between parties.

The exchange set elements are as follows:

#### Mandatory Elements

- AtoN datasets – GML encoding of features/attributes and their associated geometry and metadata.
- Exchange Catalogue – the XML encoded representation of exchange set catalogue features [discovery metadata].

#### Optional Elements

- Supplementary files – These are contained within the exchange set as files and the map from the name included within the dataset and the physical location on the media is defined within the Exchange Catalogue.
- Feature Catalogue – If it is necessary to deliver the latest feature catalogue to the end user it may be done using the S-201 exchange set mechanism for datasets – i.e., include the updated feature catalogue in an exchange set.
- Portrayal Catalogue - If it is necessary to deliver the latest portrayal catalogue to the end user it may be done using the S-201 exchange set mechanism for datasets datasets – i.e., include the updated feature catalogue in an exchange set.

## 11.2 Datasets

Datasets are distributed as files which are part of exchange sets structured as described in this specification. The distribution media are left to the discretion of the producer and distributor.

The following types of dataset files may be produced and contained within an exchange set:

- New dataset and new edition of a dataset (base dataset): Each new edition of a dataset must have the same name as the dataset that it replaces. A new edition can also be AtoN data that has previously been produced for this area. The encoding structure is located in Annex B.
- Cancellation: The dataset is cancelled and is deleted from the SYSTEM. The structure for a cancellation is described in clause 12.2.5.

## 11.3 Dataset size

Datasets must not exceed 20 MB.

## 11.4 Dataset file naming

Dataset files shall be named

CCCCXXXXXXXXX\_EEE.GML

The file name forms a unique identifier where:

- the first four characters identify the issuing agency (mandatory) in accordance with IHO S-62.
- the fifth to twelfth characters are optional and may be used in any way by the producer to provide the unique file name. It is not required to use all characters. The following characters are allowed in the dataset name, A to Z, 0 to 9 and the special character \_ (underscore).
- EEE – new editions and re-issues use 000, and increment until a limit of 999 (mandatory).
- the maximum number of characters preceding \_EEE is ten.
- GML – the character sequence “GML” or “gml”.

## 11.5 Cancellations

In order to cancel a dataset, a cancellation dataset is created for which the edition number must be set to 0. Dataset edition number is a field in exchange set metadata, class S100\_DatasetDiscoveryMetadata (clause Metadata classes). The cancellation dataset file may contain no data objects (features, information types, etc.) and any data objects present it in are ignored. The cancellation dataset may be part of an exchange set which contains other datasets, e.g., a new edition of a different dataset. This method is only used to cancel a dataset. Where a dataset is cancelled and its name is reused later, the issue date must be



greater than the issue date of the cancelled dataset. When the dataset is cancelled, it must be removed from the system.

### **11.6 Support Files**

Dataset support files offer supplementary information that can be included in an ENC exchange set.

Text files must contain only general text as defined by this standard. (Extensible mark-up language (XML) supports UTF-8 character encoding). Text files may be (TXT), (XML) or (HTM) files. Text files should not reference picture files.

Support files may be in any of the support file formats defined in the S-100 enumeration S100\_SupportFileFormat (defined in Part 4a-D-2.12) except that “Other” may not be used.

### **11.7 Support File Naming**

All support files must have unique universal file identifiers. The file identifier of support information should not be used to describe the physical content of the file. The support file metadata that accompanies the file will inform the user of the name and purpose of the file (i.e. new, replacement and deletion).

In this encoding the support files are named according to the specifications given below:

CCCCXXXXXXXXX.EEE

The main part forms an identifier where:

- the first four characters identify the issuing agency (mandatory)
- the fifth to twelfth characters can be used in any way by the producer to provide the unique file name. It is not required to use all characters. The following characters are allowed in the support file name, A to Z, 0 to 9 and the special character \_ (underscore)
- .EEE – support file extension. (Must conform to the file format.)
- the maximum number of characters is ten

### **11.8 Support file management**

When a support file is created or a subsequent version is issued it must carry its own issue date and be supported with a digital signature which authenticates it against the producer’s public key included in the exchange set metadata.

The type of support file is indicated in the “purpose” field of the discovery metadata. Support files carrying the “deletion” flag must be removed from the system. When a feature pointing to a text, picture or application file is deleted or updated so that it no longer references the file, the system software must check to see whether any other feature referenced the same file, before that file is deleted.

Each support file must be used only once in the exchange set.

Support files should be stored in a separate folder within the exchange set.

### **11.9 Exchange Catalogue**

The exchange catalogue acts as the table of contents for the exchange set. The catalogue file of the exchange set must be named S201CATALOG.XML. No other file in the exchange set may be named S201CATALOG.XML. The contents of the exchange catalogue are described in Clause 13.

XML schemas for the exchange catalogue are located at <http://registry.iho.int/>

## **12 Metadata**

### **12.1 Introduction**

The metadata description is based on the S-100 metadata document section, which is a profile of the ISO 19115 standard. These documents provide a structure for describing digital geographic data and define metadata elements, a common set of metadata terminology, definitions and extension procedures.

The realization of exchange set classes, the exchange set catalogue, and the structure of exchange sets are the same as in S-100. The relevant UML diagrams from S-100 are therefore reproduced here for reference.

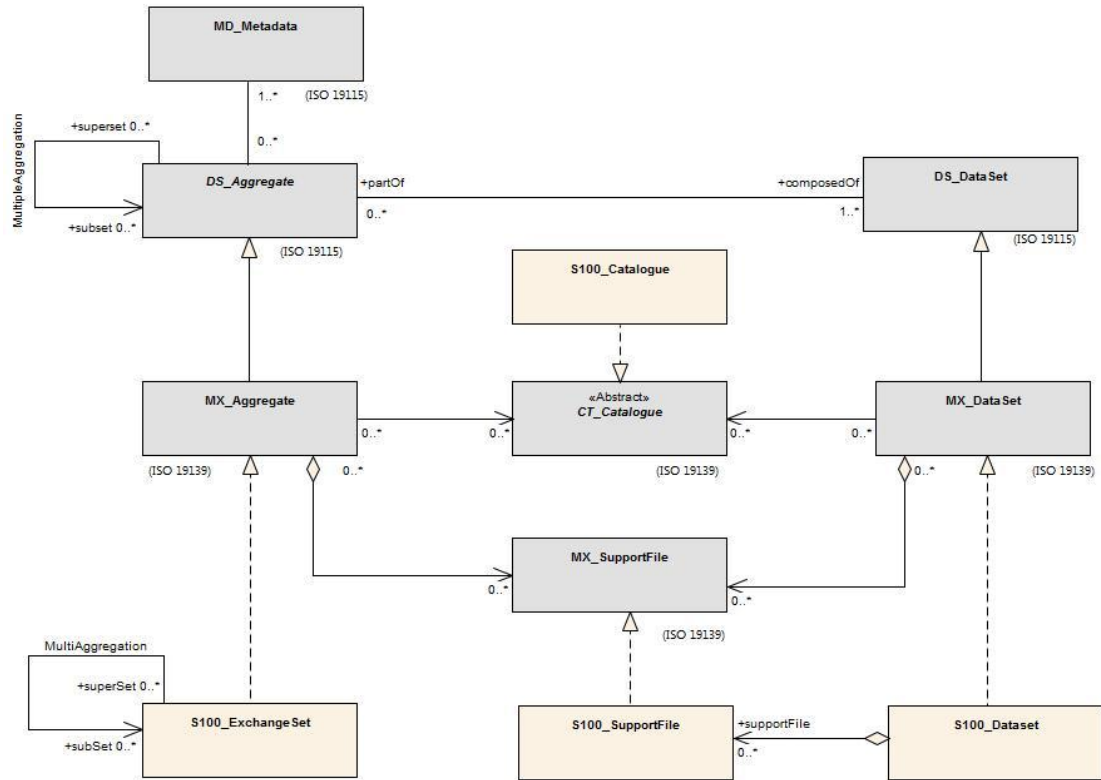


Figure 10. Realization of the Exchange Set Classes (from S-100)

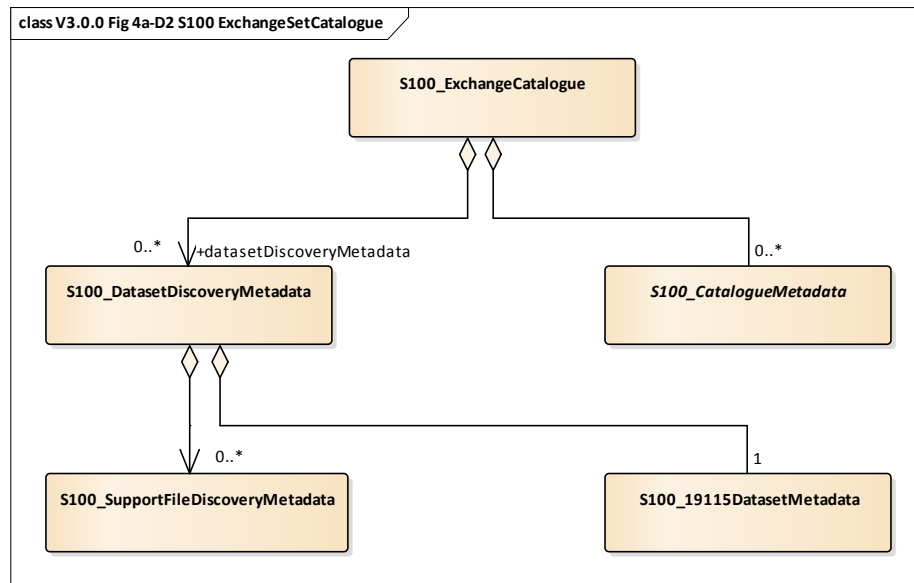


Figure 11. Exchange set catalogue and metadata (from S-100)

Since the class S100\_DatasetDiscoveryMetadata aggregates ISO 19115 metadata (class S100\_19115DatasetMetadata), metadata conforming to ISO 19115 is required to be included. Metadata for each support file is required if the exchange set contains support files.

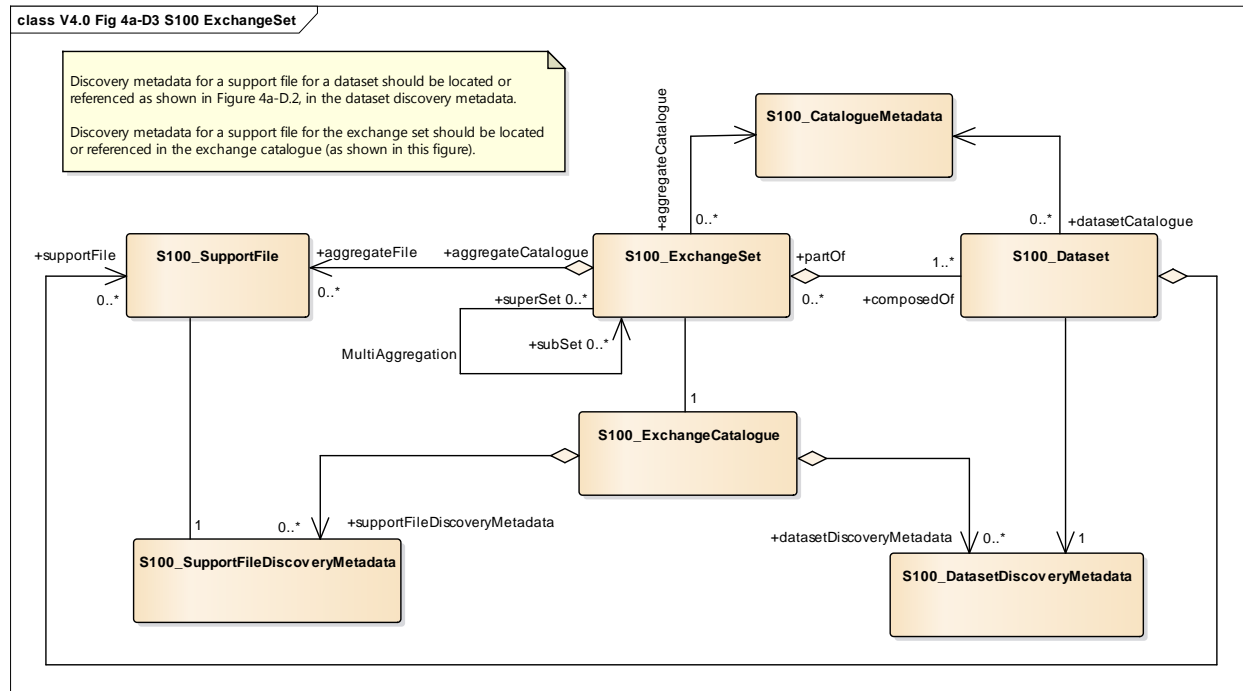


Figure 12. Exchange set including metadata (From S-100)

ISO 19115 metadata conforms to ISO 19115 with the additional constraints in S-100 Part 4A Appendix 4A-B.1 (Table B.1) which make the **fileIdentifier** element mandatory.

## 12.2 Metadata classes

Details for the S-100 metadata classes are depicted in the figure below.

### Figure 13. S-100 metadata class details

NOTE 1: Types with Cl\_, EX\_, and MD\_ prefixes are from packages defined in ISO 19115-1 and 19115-3 and adapted by S-100. Types with S100\_ prefix are from packages defined in S-100.

NOTE 2: When a dataset is terminated, the purpose metadata field is set to 3 (terminated), and the editionNumber metadata field is set to 0. All inapplicable but mandatory metadata fields must be nilled.

Refer to S-100 Edition 3.0.0 Part 4A-D.2 for detailed documentation of S-100 metadata. Any attributes that are mandatory and not relevant for S-201 shall be given dummy values.

### 12.3 S100\_ExchangeSet

Refer to S100\_ExchangeSet table in S-100 Part 4 Annex 4a-D.

### 12.4 S100\_ExchangeCatalogue

All S-201 Exchange Catalogue files must contain at least the mandatory metadata elements.

Name	Multiplicity	Value	Type	Remarks
S100_ExchangeCatalogue			Class	
identifier	1		S100_CatalogueIdentifier	See Notes below this table.
contact	1		S100_CataloguePointOfContact	No special constraints on the S-100 class.
productSpecification	0..1		S100_ProductSpecification	Conditional on all the datasets using the same product specification. See note below this table for constraints on values.
metadataLanguage	1	English	CharacterString	All datasets conforming to this PS must use English language. A catalogue in English must be provided. Discovery metadata elements within catalogues have their own locale attributes and may be repeated in languages other than English.
exchangeCatalogueName	1	S201CATALOG.XML	CharacterString	Catalogue filename
exchangeCatalogueDescription	1		CharacterString	
exchangeCatalogueComment	0..1		CharacterString	Any additional Information
compressionFlag	0..1		Boolean	TRUE: compressed FALSE: not compressed If compressed, the method must be that specified in S-100 Part 15.
sourceMedia	0..1		CharacterString	
replacedData	0..1		Boolean	
dataReplacement	0..1		CharacterString	
datasetDiscoveryMetadata	0..*		Aggregation S100_DatasetDiscoveryMetadata	
--	0..*		Aggregation S100_CatalogueMetadata	Metadata for the feature, portrayal, and interoperability catalogues, if any

supportFileDiscoveryMetadata	0..*		Aggregation S100_SupportFileDiscoveryMetadata	
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#### NOTES:

- 1) Attribute productSpecification: Class **S100\_ProductSpecification** is depicted in Figure 13 and defined in S-100 Appendix 4a-D. The values of sub-attributes name and version must correspond to this version of the S-201 product specification. (Clause **Error! Reference source not found.**). The value of sub-attribute number must be the number assigned to this version of the S-201 product specification in the GI registry.
- 2) Attribute catalogueIdentifier: Class **S100\_CatalogueIdentifier** is depicted in Figure 13 and defined in S-100 Appendix 4a-D. The value of sub-attribute S100\_CatalogueIdentifier>identifier must be chosen so that a 1/1 mapping from exchange set name to catalogue identifier is recommended. This assumes a system for assigning unique names to exchange sets – as opposed to datasets – is developed, either by the producer or in this specification. Note that an exchange set may contain multiple datasets.

#### 12.5 S100\_Dataset

Refer to S100\_Dataset table in S-100 Part 4 Annex 4a-D.

## 12.6 S100\_DatasetDiscoveryMetadata

Dataset metadata is intended to describe information about a dataset. It facilitates the management and exploitation of data and is an important requirement for understanding the characteristics of a dataset. Whereas dataset metadata is usually fairly comprehensive, there is also a requirement for a constrained subset of metadata elements that are usually required for discovery purposes. Discovery metadata are often used for building web catalogues, and can help users determine whether a product or service is fit for purpose and where they can be obtained.

Name	Multiplicity	Value	Type	Remarks
S100_DataSetDiscoveryMetadata			Class	The following S-100 attributes are not used: optimumDisplayScale, maximumDisplayScale, minimumDisplayScale.
fileName	1		CharacterString	Dataset file name (see 11.6)
filePath	1		CharacterString	Full path from the exchange set root directory
description	1		CharacterString	Short description of the area covered by dataset, e.g., area, harbour, or port name, between two named locations etc.
dataProtection	0..1		Boolean	TRUE: Encrypted FALSE: Unencrypted
protectionScheme	0..1		S100_ProtectionScheme	See <b>Error! Reference source not found.</b> and S-100 Appendix 4a-D.
digitalSignatureReference	1		S100_DigitalSignature	Specifies the algorithm used to compute digitalSignatureValue. See <b>Error! Reference source not found.</b> and S-100 Appendix 4a-D.
digitalSignatureValue	1		S100_DigitalSignatureValue	The value resulting from application of digitalSignatureReference. Implemented as the digital signature format specified in S-100 Part 15.
copyright	0..1		MD_LegalConstraints>MD_RestrictionCode <copyright> (ISO 19115-1)	"copyright" for copyrighted datasets, omitted otherwise
classification	0..1	(one of the literals from the ISO codelist)	Class MD_SecurityConstraints>MD_ClassificationCode (codelist) ISO 19115-1	1. unclassified 2. restricted 3. confidential 4. secret 5. top secret 6. sensitive but unclassified 7. for official use only 8. protected 9. limited distribution



purpose	1	{1}, {2}	MD_Identification>purpose (character string)	1. New dataset 2. New edition 3. Cancel
specificUsage	1		MD_USAGE>specificUsage (character string) MD_USAGE>userContactInfo (CI_Responsibility)	brief description of the resource and/or resource series usage
editionNumber	1		CharacterString	When a dataset is initially created, the edition number “1” is assigned to it. The edition number is increased by one with each new edition.
issueDate	1		Date	Date on which the dataset was generated.
issueTime	0..1		Time	Encoded only if time of issue is significant.
productSpecification	1		S100_ProductSpecification	See Notes below this table for constraints on values.
producingAgency	1		CI_Responsibility>CI_Organis ation or CI_Responsibility>CI_Individu al	Party responsible for generating the dataset. See Part 4a Tables 4a-2 and 4a-3.
horizontalDatumReferenc e	1	EPSG	CharacterString	
horizontalDatumValue	1	4326	Integer	WGS84
epoch	0..1		CharacterString	For example, G1762 for the 2013- 10-16 realization of the geodetic datum for WGS84
verticalDatum	0..1		Vertical Datum of the entire dataset	
soundingDatum	0..1		Sounding Datum of the entire dataset	
dataType	1	GML	S100_DataFormat	The only value allowed is “GML”.
dataTypeVersion	1	3.2.1	CharacterString	
dataCoverage	1..*		S100_DataCoverage	See Figure 13 and S-100 Appendix 4a-D. A S-201 dataset must have at least one coverage.
comment	0..1		CharacterString	Any additional Information
layerID	0..*	S-101	CharacterString	Any additional layers the S-201 dataset must be used with.
defaultLocale	1		PT_Locale	See <b>Error! Reference source not found.</b> and S-100 Appendix 4a-D.
otherLocale	0..*		PT_Locale	See <b>Error! Reference source not found.</b> and S-100 Appendix 4a-D.
metadataFileIdentifier	1		CharacterString	For example, identifier for ISO 19115-3 metadata file

metadataPointOfContact	1		CI_Responsibility>CI_Individual or CI_Responsibility>CI_Organization	See S-100 Part 4a Tables 4a-2 and 4a-3.
metadataDateStamp	1		Date	Metadata creation date, which may or may not be the dataset creation date
metadataLanguage	1..*		CharacterString	Language of the metadata. English is default.
--	0..*		Aggregation S100_SupportFileDiscoveryMetadata	One for each support file linked to this dataset and present in the exchange set.

## 12.7 S100\_SupportFileDiscoveryMetadata

Support file metadata is intended to describe information about a data resource. It facilitates the management and exploitation of data and is an important requirement for understanding the characteristics of a data resource.

Name	Multiplicity	Value	Type	Remarks
S100_SupportFileDiscoveryMetadata			Class	
fileName	1		CharacterString	
fileLocation	1		CharacterString	Path relative to the root directory of the exchange set. The location of the file after the exchange set is unpacked into directory <EXCH_ROOT> will be <EXCH_ROOT>/<filePath>/<filename>
purpose	1		S100_SupportFilePurpose	new, replacement, or deletion. Values "replacement" and "deletion" are allowed only in update datasets.
editionNumber	1		CharacterString	When a dataset is initially created, the edition number 1 is assigned to it. The edition number is increased by 1 at each new edition. Edition number remains the same for a re-issue
issueDate	1		Date	
supportFileSpecification	1		S100_SupportFileSpecification	See <b>Error! Reference source not found.</b> and S-100 Appendix 4a-D.
dataType	1		S100_SupportFileFormat	The only values allowed for support files referenced in datasets are: ASCII (for text files), TIFF, and HTML.

				Values XML, XSLT, and LUA are reserved for portrayal catalogue files.
otherDataTypeDescription	0..1		CharacterString	
comment	0..1		CharacterString	
digitalSignatureReference	0..1		S100_DigitalSignature	Specifies the algorithm used to compute digitalSignatureValue. See <b>Error! Reference source not found.</b> and S-100 Appendix 4a-D.
digitalSignatureValue	0..1		S100_DigitalSignatureValue	The value resulting from application of digitalSignatureReference. Implemented as the digital signature format specified in S-100 Part 15.
defaultLocale	1		PT_Locale	See <b>Error! Reference source not found.</b> and S-100 Appendix 4a-D.
otherLocale	0..*		PT_Locale	See <b>Error! Reference source not found.</b> and S-100 Appendix 4a-D.