Paper for Consideration by HSSC & S-100 WG

Extending S-100 to Non-navigational Marine Applications

Submitted by:	Canada, Australia
Executive Summary:	The intent of the development of the S-100 Universal Hydrographic Data Model has always been to support all marine application areas. Currently, the IHO S-100 standard primarily serves as the basis for the development of the Electronic Nautical Chart (ENC) and other complementary data product specifications to support "eNavigation". It is built upon an attribute structure focused on navigation which has been well defined by long experience in nautical charting. However, in order to properly describe and meet the requirements of other non-navigational marine applications such as Marine Limits and Boundaries, Marine Cadastre, Fisheries Management, etc., additional attribute structures are required. Building on experience acquired in other domains, such as Land Cadastre, this paper presents two basic concepts for supporting attribution in new marine application areas. It introduces the concept of the Intrinsic Type of a feature object so that the attribute structures represent the reality of feature objects, not their representation. The Intrinsic Type is defined in the Feature Concept Dictionary and does not appear in actual data sets or Application Schema: however it is extremely important so that the correct attribute types may be applied to a feature concept. This paper also introduces structures derived from the ISO standard for the Land Administrative Domain Model (ISO 19152), which can be adapted to the marine environment. This provides a mechanism for defining Rights, Restrictions and Responsibilities to establish an attribute structure capable of managing legal and sovereign attributes.
Related Documents:	
Related Projects:	S-121 Maritime Limits and Boundaries, S122 Marine Protected Areas

Introduction / Background

The sea is a vital resource shared by most nations[1]. Access to the sea is important for trade and for the many resources that are available in the marine environment. Mankind has been developing technology to navigate, extract resources and manage the marine environment for as long as civilization has existed.

Although nautical charts were introduced in antiquity, modern charting techniques date to the work of Gerardus Mercator and his contemporaries in the middle of the 16th century. Nautical charts have become highly structured documents composed of features, lines, symbols and other constructs. From shortly before 1990 the International Hydrographic Organization (IHO) and its member states have been trying to develop an electronic equivalent to the paper Nautical Chart, which is call the ENC (Electronic Nautical Chart). Far more functional than the paper chart, an

[1] There are 45 landlocked countries with no direct access to the sea, most of which are poor developing countries. UN-OHRLLS - UN Office of the High Representative for the Least developed countries, Landlocked developing countries and Small island developing states, < http://unohrlls.org/ >

ENC can be machine processed allowing for the development of “eNavigation”. This development is very important because it will increase trade between nations as well as increase safety.

IHO first developed the standards DX-90, then S-57 and more recently S-100 and S-101. The S-100 standard is called the Universal Hydrographic Model and allows for the support of many types of hydrographic information including but not restricted to navigation.

The feature types and attributes that were defined first in the IHO standard S-57 and now in S-101 derive directly from the navigational experience learned from paper charts. The initial extensions to the Electronic Nautical Chart (ENC) standard built upon S-100 have been complementary additional information that aids navigation such as S-102 Bathymetry. In the past few years the IHO members have been trying to extend the hydrographic data concept beyond nautical charting. Building on the ISO standards, S-100 is very flexible and integrates an Object Oriented approach. The first extensions for auxiliary navigational information simply added to the IHO Feature Object Catalogue, and added some simple additional “Groups” (Layers). Some of the extensions have been coverage information such as S-102 Bathymetry and S-111 Surface Currents.

To complement the S-101 standard dedicated to navigation new areas of application such as Marine Limits and Boundaries, Fisheries Management, Marine Cadastre and aspects of a Marine Spatial Data Infrastructure need to be considered. These new areas of application will likely require new data types to establish and describe different data contexts, and in that regard if theses news applications areas were to be directly built on ENC object for example, there would be a danger that information could be misinterpreted since the meaning of a feature is always context dependent.

One avenue could very well be to broaden the feature definitions defined for charting to address more communities of interest, but this would weaken their use in the ENC. For eNavigation, precise feature definitions are a requirement to ensure that eNavigation systems give consistent and predictable results. To organise the diverse data types and associated usages, there is a need for a different level of structure that distinguishes and describes available features within specific application context. This is where application schemas need to be developed independently for each application area; such as navigation, legal jurisdictions and maritime boundaries, scientific use, etc. These application areas overlap but their usage differs. It is all of these application schemas integrated together that will form, overtime, a complete marine spatial data infrastructure.

Generic standards for geospatial data have been developing through the International Organization for Standardization (ISO) committee TC211 for Geographic Information / Geomatics and the Open Geospatial Consortium. This effort began in 1994[2].

The level of standardization needed to manage marine data is much higher than for many other types of spatial data because of the legal and regulatory nature of its application. Marine data is a special type of data because of its critical role in maintaining safe navigation. Marine data is also used for other purposes such defining Marine Limits and Boundaries for establishing sovereign borders, fishing rights and resource and environmental monitoring.

The marine environment is different from many other geospatial environments with respect to legal issues. Nautical charts describe what areas are safe for navigation. Errors in charts may have liability on the producer. There are specific considerations for presentation of data on charts so that they can be understood by mariners. Data may also need to be presented in alternate manners so that it can be understood by regulators, in a court of law, or in an environmental assessment. Marine limits and boundary data may also be used in the description of sovereign limits and appear in or be cited by treaties. This means that the lineage of data must be traceable and that there be available a mechanism to authenticate data when needed.

The establishment of IHO standards is critical because standards need to comply with the UN International Maritime Organization regulations and the international treaties such as the International Convention for the Safety of Life at Sea (SOLAS)[3].

[2] W.Kresse, D.Danko, Springer Handbook of Geographic Information, Springer-Verlag, Berlin, 2012, ISBN 978-3-540-72678-4

[3] IMO SOLAS Convention Regulation 19 Chapter V <http://www.imo.org/OurWork/Safety/Navigation/Pages/Charts.aspx>

The IHO has identified a number of product specifications for use in the marine environment. Several of these standards are intended for navigation or to provide auxiliary aids to navigation. In that sense they all share a navigation context. However, several of the standards have broader usage or are primarily information about a separate marine context.

Table 1 – LIST OF S-100 BASED PRODUCT SPECIFICATIONS[4]

IHO: S-101 to S-199	**IALA: S-201 to S-299**
IHO S-101 ENC	IALA S-201 Aid to Navigation Information
IHO S-102 Bathymetric Surface	IALA S-20x Inter-VTS Exchange Format
IHO S-103 Sub-surface Navigation	IALA S-20x Application Specific Messages
IHO S-111 Surface currents	IALA S-20x (Maritime Safety Information)
IHO S-121 Maritime limits and boundaries	
IHO S-122 Marine Protected Areas;	**IOC: S-301 to S-399**
IHO S-123 Radio Services	
IHO S-124 Navigational warnings	**Various: S-401 to …**
IHO S-125 Navigational services	IEHG S-401 Inland ENC
IHO S-126 Physical Environment	JCOMM S-411 Sea ice
IHO S-127 Traffic Management	JCOMM S-412 Met-ocean forecasts
IHO S-1xx Marine Services	
IHO S-1xx Digital Mariner Routing Guide	
IHO S-1xx Harbour Infrastructure	
IHO S-1xx (Social/Political)	

These product specifications cannot just be created arbitrarily or independently. Information must be understood in context, and the context must be well defined. For example, a tower may be a building in one context and a landmark used as a reference for navigation in another. The context in which feature and attribute types are valid must be understood as part of the expression of the data. A coordinated suite of standards provides interoperability.

New complexity is introduced when one adds information intended for different purposes. A Marine Cadastre is fundamentally different from navigation, as are many scientific uses of ocean data. One needs to be able to maintain the separate contexts in which the data has its direct meaning. This is especially true when one addresses Maritime Limits and Boundaries (S-121), where there are fine legal aspects that need to be addressed in the boundary context, where the same objects can be used with a slightly different interpretation in a navigation context. Similar issues exist for Marine Protected Areas (S-122). The boundaries that appear on an electronic chart, such as in S-101 or S-57, may be derived from the limits and boundaries defined in S-121, but the objects in the S-121 context need to carry more and possibly different attribution. The Physical Environment (S-126) and Harbour Infrastructure (S-1xx) are also different contexts. The base objects need to be organised so they can be used in the different application schemas, limiting unnecessary duplication. There may be interdependency between the meanings of objects within different contexts that can be expressed as semantic relationships. The key advantage of such an approach is to focus the allocation of specific attributes to the appropriate application domain. Figure 1 shows various independent application domains making use of the same S-100 base standard and IHO S-100 Registry.

[4] Approved by the 5th HSSC Meeting, Shanghai, China, November 2013

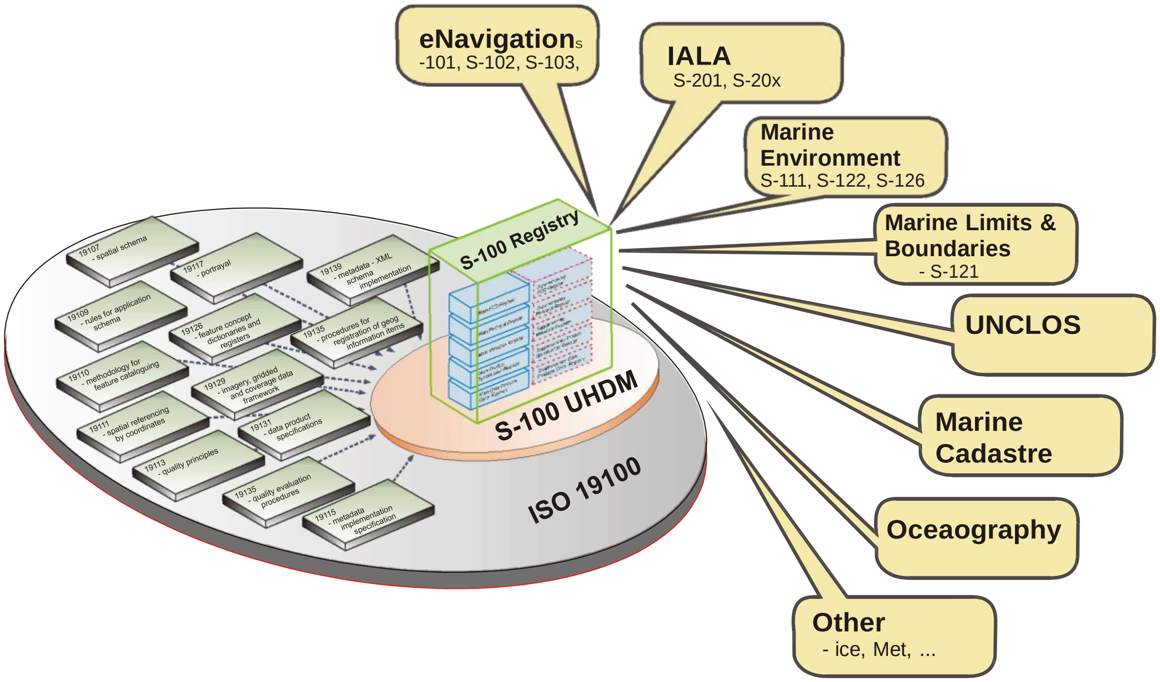

Figure 1 – Multiple Information Contexts Supported by S-100

A feature is an “abstraction of a real world phenomenon”, but it only has meaning within a particular information context. The meaning changes if the context changes. This is literally semantics in the linguistic sense. Up to now, IHO has only been addressing one information context: eNavigation, so there have been no issues. Marine Cadastre and Marine Limits and Boundaries are separate (though closely related) information contexts and are also distinct from eNavigation. The definitions of features cannot simply be put together. The same line object, for example a boundary, may have one meaning in a navigation environment, a second meaning in a context such as United Nations Convention on the Law of the Sea (UNCLOS) with specific sovereign legal implications tied to UN conventions, and a third in a Marine Cadastre with specific civil legal rights and responsibilities tied to a particular nation’s laws. The context needs to be described with the feature definition, and the relationship between similar features needs to be described.

Marine Limits and Boundaries are closely related to UNCLOS, but there are other boundaries that may be purely national, or may be for other purposes. The UNCLOS includes feature objects that are used in S-101 as Navigational object but it applies a different semantic meaning. The UNCLOS domain context addresses Navigation, Marine Ecosystem Management, and Maritime Limits & Boundaries.

This document provides an architecture for the extension of S-100 to address non-navigational application areas by building upon ISO standards, and establishing the intrinsic type of feature objects to provide consistent attribution. This architecture complies with ISO 19152 Land Domain Administrative Model which enables the management of legal aspects (Rights, Restrictions and Responsibilities).

The Feature Concept Dictionary and Feature Catalogue

Context is maintained for any application area within an Application Schema. Separate Application Schemas are required for each product specification. This means that the S-101 Electronic Nautical Chart, S-121 Marine Limits and Boundaries, etc. are separate and distinct context. Each Application Schema must define the objects and attributes that are used within that context. The details of how the features are used are described in a Feature Catalogue that selects the feature objects and binds the attributes that may be used with that feature object.

The definitions for the features, attributes and code lists are described in a Feature Concept Dictionary. As stated in S-100 “… a feature concept dictionary does not make associations or bind attributes to features”.

The intent is to keep the various application domains separate but ensure they are all using the same base S-100 Registry. Application domains may overlap but object integrity needs to be maintained. The current IHO S-32 dictionary already forms the base of the existing IHO S-100 Concept Dictionary. Information about context needs to be added.

Figure 2 shows the relationship of an Application Schema, Feature Catalogues and the Feature Concept Dictionary.

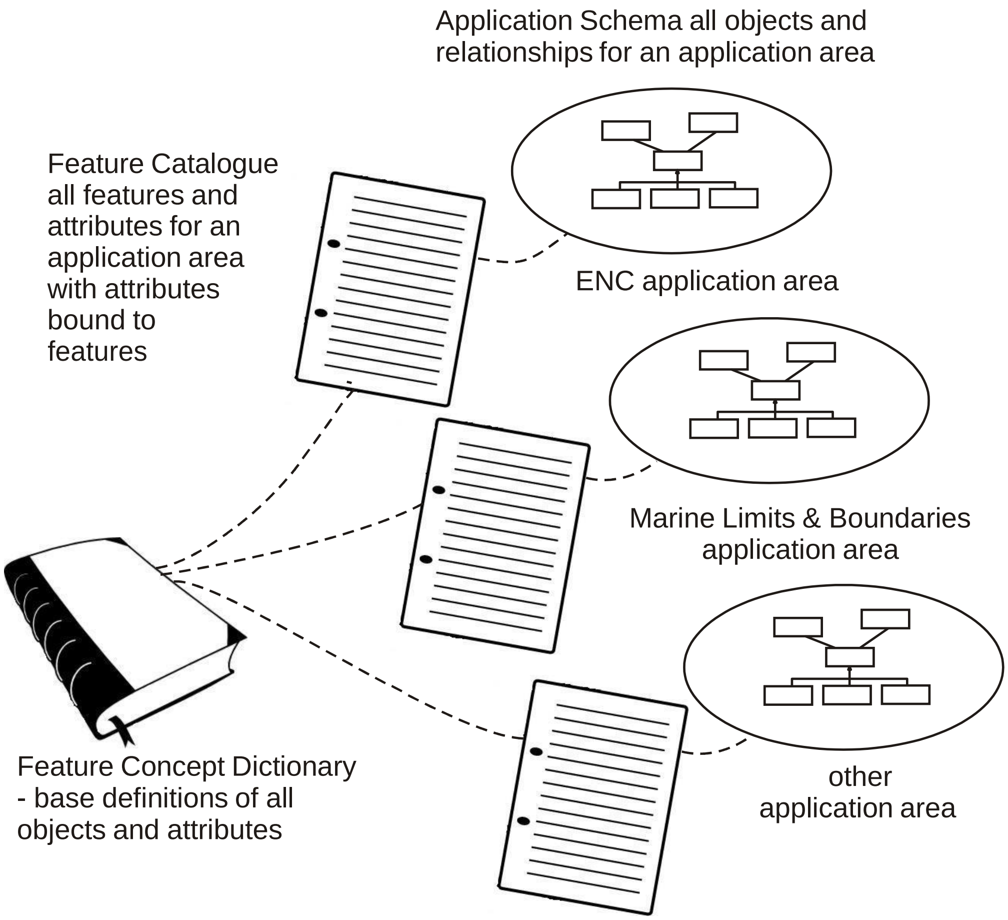

Figure 2 – Application Schema, Feature Catalogues and Concept Dictionary

The Feature Concept Dictionary needs to contain the generic definition of all feature objects, attributes and applicable code lists and enumerations; however, it also needs to carry a description of the context in which the definition(s) are applicable. This is what happens in current language dictionaries where the words with multiple meanings are defined in their various contexts. Also the Feature Concept Dictionary needs to describe other unchanging aspects of features such as their intrinsic geometry; that is, a scaleless description of the true geometry of an object.

Context Independent Object Type

The ISO standard 19101 defines a feature as an “abstraction of real world phenomena”. The expression of a feature object is established by its definition which is based on the true physical nature of the real world phenomena. One of the properties is the spatial geometry used to represent a feature instance. The feature is independent of the representational geometry and can be portrayed in different ways in different contexts. However, the real world phenomenon does not change and therefore the core definition of the object should not change. It may be augmented to add additional context specific information, refining but not changing the meaning.

The properties (attributes, spatial primitives, operations) that can apply to a feature type depend upon the intrinsic nature of the feature type. If the real world phenomenon feature object occupies an area on the earth, such as a building, it has an area nature and can be ascribed an optional area attribute. If a feature object is an abstract point such as the North Pole, it makes no sense to assign it an area attribute. A feature object can only have one intrinsic nature. It can only be a Location (abstract point), Limit (abstract curve), Zone (abstract area) or Space (abstract volume).

One property that has been assigned in the S-101 eNavigation context is "Geometry". This is the geometry used to describe the object in the data set. The geometry specified in S-100 is NOT the intrinsic nature of the feature object. For example an Anchorage Area (ACHARE) is defined as "An area in which vessels anchor or may anchor[5]." It is intrinsically an area (Zone), as stated right in the definition; however, it may be represented as P (Point) or A (Area). That is, in some situations an anchorage area feature instance may be represented as a geometric point primitive, because the area is too small to be represented as a Surface (Area) on the particular chart. The object retains its intrinsic nature of having an area, and could have an area attribute assigned even if that area is a small number.

In the S-57 and S-101 feature catalogues the geometry property (P, L, A) represents the type of geometric primitives that may be used to represent the feature type, not the intrinsic nature of the feature type. The intrinsic nature of the feature type defines the types of attributes that may be applied to a feature. The geometry property (P, L, A) defines how the object may be described geometrically and represented cartographically. Intrinsic nature and representational geometry are two separate properties.

Figure 3 shows a river object and an airport object. Both have the intrinsic nature of an area (zone). However they can be represented in different ways on a map or chart. At a large scale both the river and the airport objects are described as geometric surfaces. At a medium scale the river is described as a geometric curve and the airport is described as a simpler geometric surface; that is, its boundaries have been generalized (smoothed). At a small scale the airport is represented as a single point. The river is represented as a generalized curve.

Geometric representation is also separate from portrayal. The airport is portrayed as a point with a label, but it could have been portrayed with a symbol. Lines can also be portrayed with texture, such a dashed line.

[5] IHO Dictionary, S-32, 5th Edition, 130

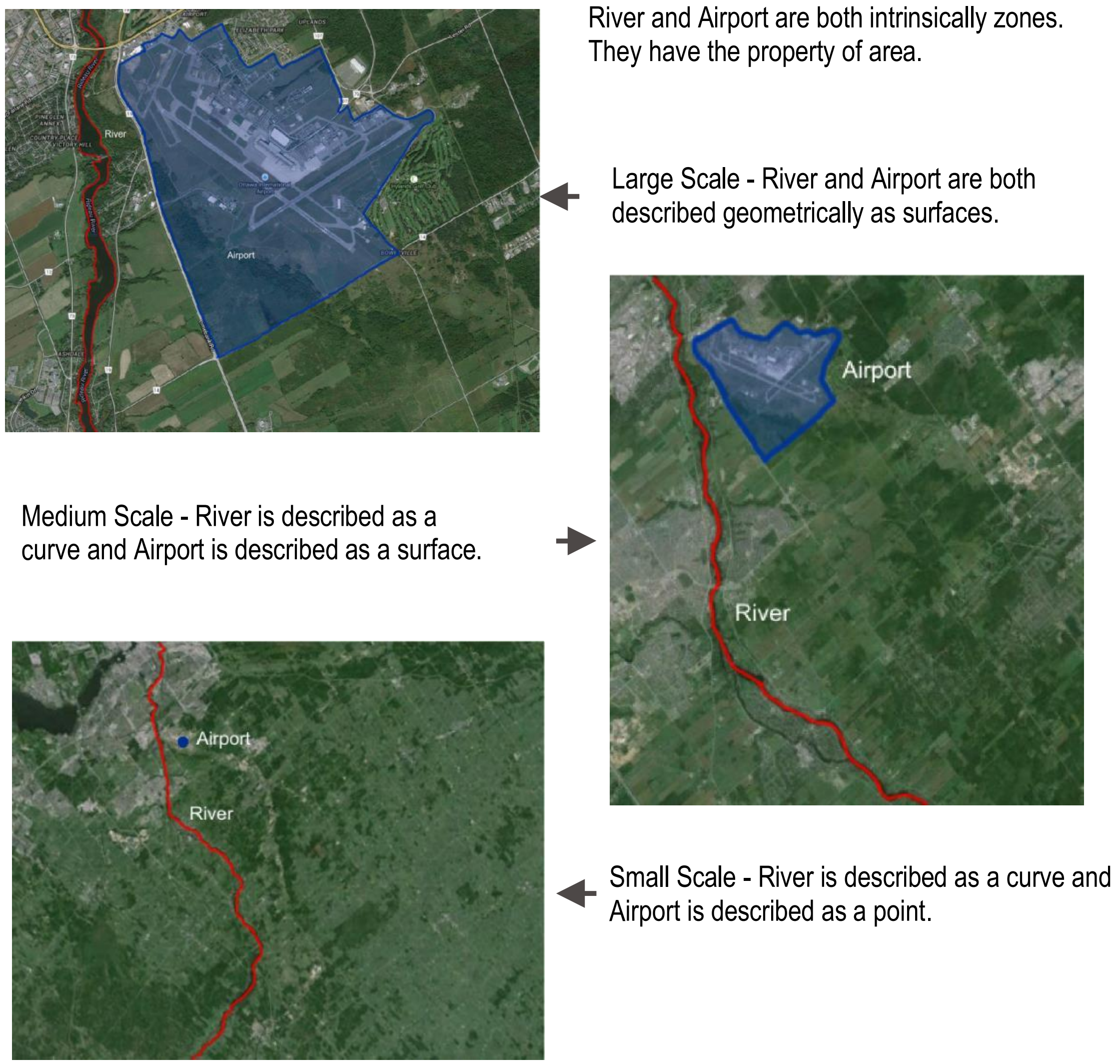

Figure 3 – Intrinsic Nature

The essential structure required to address context independent geometry is a separation of all objects into the categories **Location**, **Limit**, and **Zone**. This can be extended to **Space** (volume) in three dimensional which will have applicability for a Marine Cadastre. For example, a Marine Archaeological Park may cover an area of the sea floor but only extend to occupy a volume several tens of meters above the sea floor allowing navigation over the area. This separation into **Location**, **Limit**, **Zone** and **Space** is based on the intrinsic nature of the feature objects. The objects may be represented geometrically by degenerative spatial representations in charts and maps where a volume may be projected onto a surface as an area, and an area may degenerate to a curve (line) or point if it is too small to represent as an area, or a curve may degenerate to a point representation. The categories Location, Limit, Zone and Space, are separate properties of a feature from the geometry (P, L, A) geometric primitives.

There are very few features that are intrinsically a conceptual point. The North Pole is an example of something that is by definition an intrinsic point. Most features are intrinsically zones or spaces (zones in 3 dimensions with 2 dimensional spatial extent and a height attribute). They can take on attributes that describe this nature. These areas or volumes can be represented geometrically in a particular type of data product (at specific scales) using the geometric primitives (GM_Point, GM_Curve, GM_Surface, GM_Solid as derived from the ISO defined Spatial Schema and IHO S-100). The geometric representation is not necessarily the same as the intrinsic nature. A boundary is a separation between zones. It is usually represented as a geometry line (L), but it could be represented as a geometry point (P) in some degenerate situations. The important thing is that the boundary does not take on the attributes of the zones it separates. Those attributes belong to the zones.

Table 2 describes the relationship between Topological Primitives, Spatial Primitives and Intrinsic Nature (or Intrinsic Type). All of these concepts are geometrically related, so the terminology is similar, but it is important to distinguish between Intrinsic Nature, Spatial Geometry and Topology. Different terms have been chosen deliberately to minimize confusion. The terminology related with Intrinsic Nature describes the "truth on the ground" and therefore the type of attributes that may be applied to an object.

Topo Primitives	Spatial Primitives	Intrinsic Nature
Node	Point	Location
Edge	Curve/Line	Limit
Face	Surface/Area	Zone
Volume	Solid	Space

Table 2 – Geometric Primitives and Intrinsic Nature

For Spatial Primitives the correct term for a linear primitive is a "Curve", although the term "Line" is often used. The term "Curve" better describes the fact that the linear object may not be a straight line. The term "Surface" better describes a two dimensional object since "Area" is used to describe the geometric property of area.

The terms used for intrinsic nature are distinct to avoid confusion. Two terms are defined for a linear intrinsic nature; "Limit" and "Boundary"[6]. A "Boundary" is a special type of limit that is a demarcation between two zones. A boundary is intrinsically a line linear object. A "Limit" is a linear object that describes the extent of one zone. A "Zone" is an object that has the real geometric property of area. A "Location" is of 0-dimensions. An object such as the North Pole is an intrinsic location object.

The special case of a "Boundary" object delimiting two zones is important. The border between Canada and the US does not have a right hand attribute[7] of the US and a left hand attribute of Canada. Rather the zone Canada and the zone USA are demarked by the boundary. A boundary can carry legal attributes describing the role of the boundary, but the practical jurisdiction attributes apply beyond the boundary itself and must be carried by the neighbouring zones. Figure 4 shows that the sign, representing the attribute "Canada" is on the Canadian side, in the Canadian zone, and similarly the sign representing the United States is in the US zone.

[6] ISO TC211 defines boundary to be a "set that represents the limit of an entity". In a note it says that the term is used to "describe the transition between an entity and the rest of its domain of discourse". This definition is consistent with the definition of boundary in this document, but not as precise.

[7] Determining left and right along a line would require a topological analysis.

Figure 4 – A Boundary type object[8] with a Zone for Canada and a Zone for the USA

A feature may only have one intrinsic nature based on the "truth on the ground".

- An object of 0 dimensions is a location and may be represented as a point or topological node.
- An object of 1 dimension has only length and no width. It may be represented as a geometric curve (line), or at certain scales as a point. It is called a boundary if it separates two zones and a limit if it is associated with only one object.
- An object of 2 dimensions has a physical area and can describe a real world physical object in a 2 dimensional space. This is called a zone. It can be represented as a 0, 1 or 2 dimensional object dependent upon the scale of representation and portrayal. An object may actually have more than one spatial geometry associated with it to represent it at different scales.
- An object of 3 dimensions has a physical volume and can describe a real world physical object in a 3 dimensional space. This is called a space. It can be represented as a 0, 1, 2 or 3 dimensional object dependent upon the scale of representation and portrayal. Sometimes the third dimension exists but it is only described as an attribute and is not portrayed.

Figure 5 shows the four high level abstract Feature Type objects. From these objects derive all of the other object types in a Feature Catalogue. The attributes pertain to the types of conceptual objects, such as whether a point, line etc. is a real measured point, or whether it is a construction point or line.

[8] Photo from Library and Archives Canada, 1941

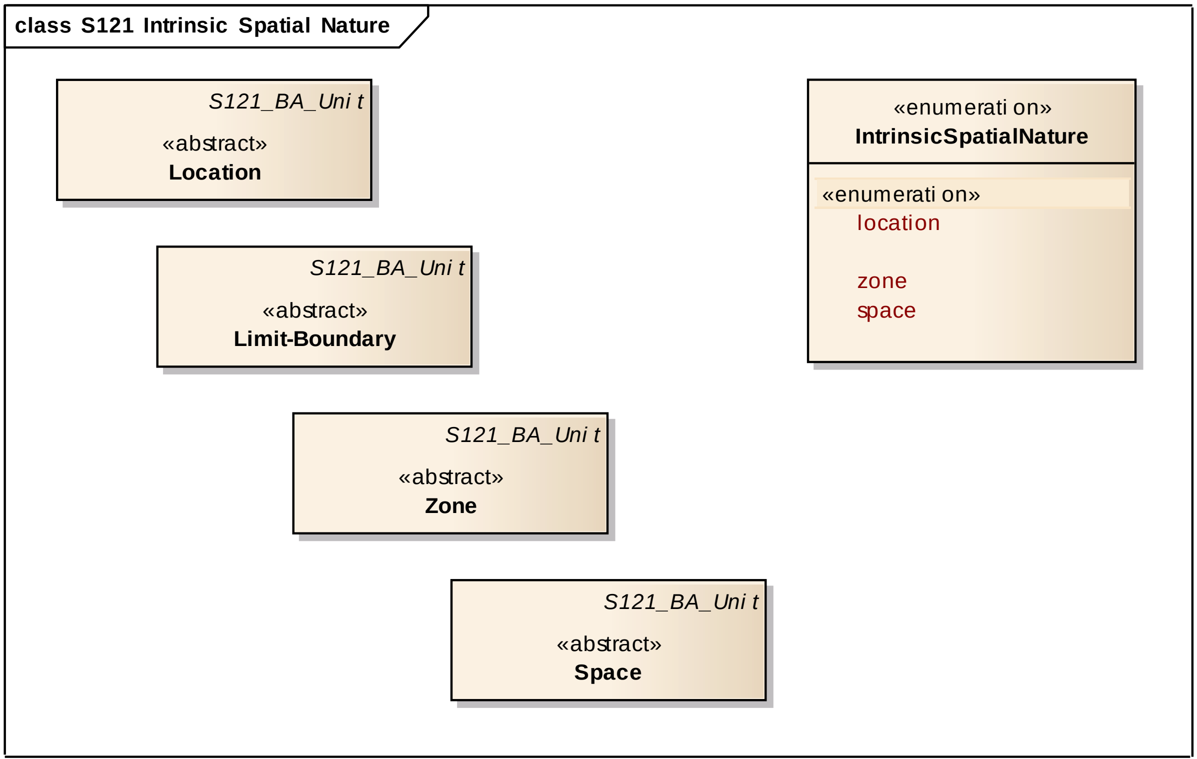

Figure 5 – Intrinsic Spatial Nature

There are great advantages to separating objects into these intrinsic conceptual abstract types. It is important to know whether a feature is a limit or a zone in order to establish attributes. Only zones have certain attributes, and boundaries separate zones. A viewer software system, such as an Electronic Chart Display & Information System (ECDIS)[9] viewer may not see any difference in the intrinsic nature of a feature object. For example a boundary may simply be represented as a GM_Curve with an associated TP_Edge topological primitive in a ENC data product complying with the S-101 ENC Product Specification. In a Product Specification relating to UNCLOS or a separate one relating to Marine Cadastre the distinction may be very important, since the UNCLOS legal attributes and the rights, responsibilities and restrictions of Marine Cadastre depend upon the distinction. Such UNCLOS or Cadastre data may not only be viewed but it may be read explicitly to determine the value of attributes such as ownership or sovereignty.

The attributes that may be ascribed to an object on one side of a demarcation may be different than those ascribed on the other side. Separate attributes may be ascribed to the boundary itself describing, for example, the role of the boundary object.

Figure 6 shows the several of the zones and boundaries defined in article 76.5 of UNCLOS. Sovereign rights apply to the zones on one side of legal continental shelf boundary but not on the other.

[9] A certified electronic chart display and information system (ECDIS) meets the “Carriage requirements for shipborne navigational systems” in accordance with IMO Regulation 19 Chapter V.

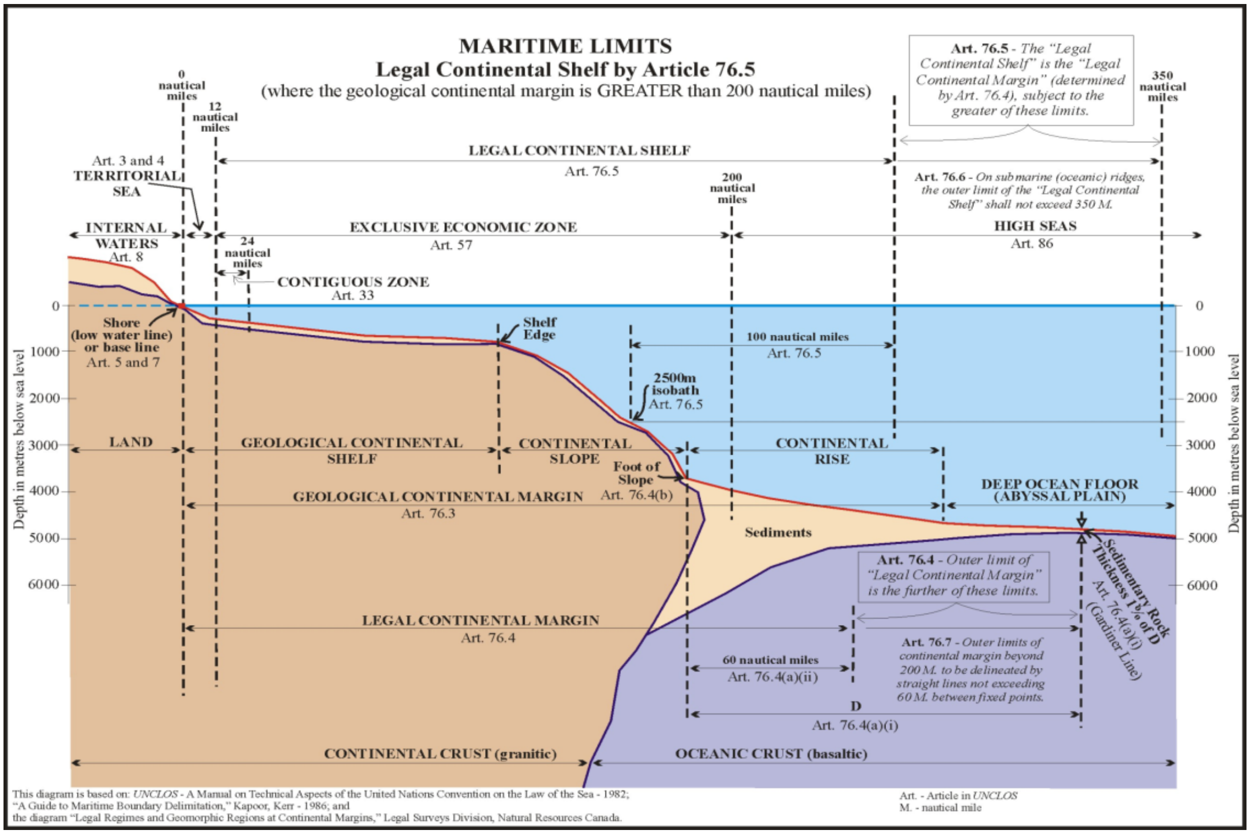

Figure 6 – UNCLOS Related Maritime Limits and Boundaries

The Architectural Structure

The definition of context adds structure to the general feature model. The IHO S-100 Universal Hydrographic Data Model builds upon this ISO General Feature Model and adds several new concepts such as the concept of a **S100_GF_NameType** class an Information Type Object (**S100_GF_InformationType).** S-100 also deliberately constrains the represent representational geometry to a few geometry types. This was introduced into the S-100 model to support eNavigation applications. To support other contexts such as legal attributes additional constructs need to be defined.

Figure 2 shows three separate application areas each with their own Feature Catalogues, and Application Schema. All reference the same Feature Concept Dictionary which provides the definition for each feature and establish its intrinsic type (location, limit, zone or space).

The current S-57 (and S-101) Feature Catalogue is one application area specific feature catalogue. Other feature catalogues for other application areas may select the same feature types from the Feature Concept Dictionary, but bind different attributes to the feature types. For example rights, restrictions and responsibility and versioning attributes may be applied in the Marine Cadastre or Marine Limits and Boundaries context but not in the ENC context. A Product Specification may also refine the definition of the feature for the specific application domain context. The issue of context specific meanings needs to be addressed in the Feature Catalogue. Since context affects the meaning of most features, one cannot simply add new feature definitions to the concept dictionary where a context specific interpretation is needed. The dictionary definition needs to be general enough to allow the various context specific interpretations, and the feature catalogue(s) need to narrow the meaning to a specific context. The Feature Concept Dictionary needs to allow for the interpretation of concepts in different contexts.

Figure 6 shows a Feature Concept Dictionary with three types of entries, a Feature Type, an Attribute Type and a Code List / Enumeration. A Code List / Enumeration is a set of listed values that may be used in an attribute.

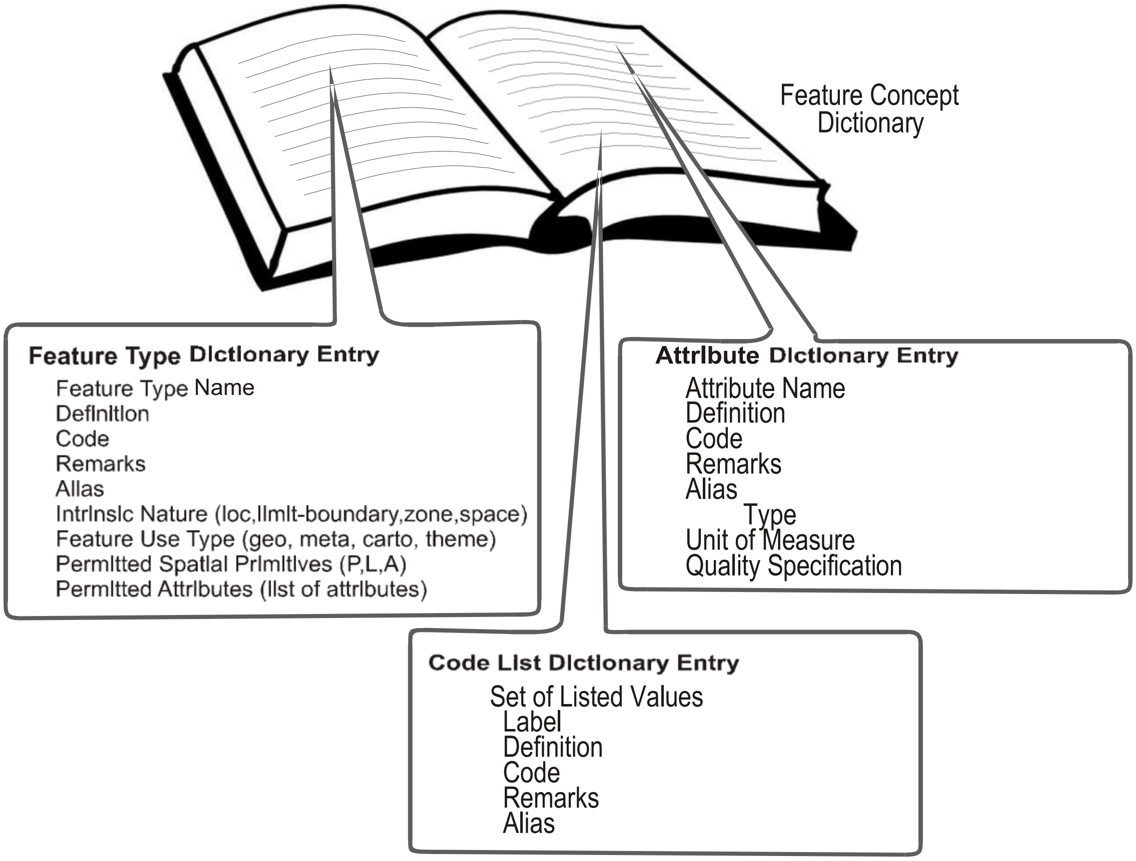

Figure 7 – Feature Concept Dictionary Contents

UNCLOS is an important but very specific domain context. It needs to build upon S-121 Maritime Limits and Boundaries, but it may also build in part upon some aspects of a Marine Cadastre, Marine Protected Areas and fishery information. Maritime Limits and Boundaries, Marine Protected Areas, fisheries, UNCLOS and Marine Cadastre are all separate but overlapping contexts.

The Feature Concept Dictionary elements to be defined for S-121 are shown in Figure 8. The Feature Catalogue contains the *IntrinsicNature* attribute for S-121 defined objects. It may, in the future, be desirable to apply the concept of Intrinsic Nature to all S-100 defined objects.

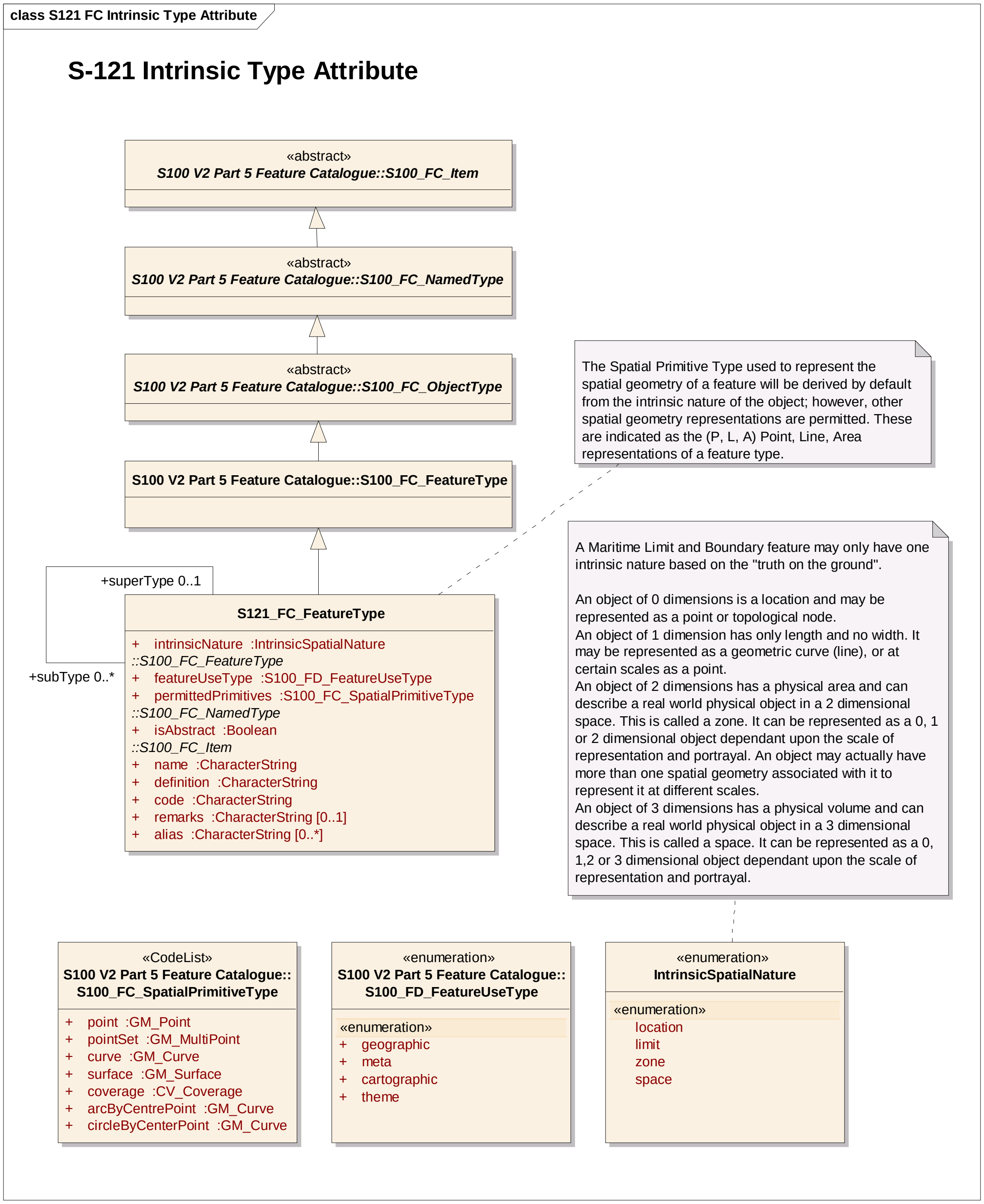

Figure 8 – S-121 Feature Concept Dictionary Entries with Intrinsic Type

Attribution

The attribution for ENC charts is well known by IHO, based on the long history of nautical charting. However, as new products develop such as those identified in Table 1, new features and attributes will need to be defined. Some of the identified products are coverage data such as bathymetry. In coverage data, the grid (or other coverage function) is a value matrix and is the attribute of the data. However for vector type coverages such as S-121 Maritime Limits and Boundaries, S-122 Marine Protected Areas, Marine Cadastre and other Product Specifications, great care is needed to define the appropriate features and attributes. Introducing legal attributes is important for these products, but legal attributes need to be rigorously defined. A good approach is to make use of the attributional model in the Land Domain Administrative Model established in the standard ISO 19152. This also supports a Marine Cadastre.

A Marine Cadastre should be built upon the ISO 19152 Land Domain Administration Model. Although the title of the ISO standard says “Land” the scope statement of the ISO standard includes water. If IHO does not develop a Marine Cadastre, a Marine Cadastre will become an extension of the adjacent land cadastre systems throughout the world. There are many incompatible ones. IHO should decide that its Cadastre is purely based on geometry, since S-100 is geometry based. Many land cadastre systems need to accommodate many legacy survey methods that are not geometry based. The marine world does not have this legacy[10]. A solid spatial geometry based on the ISO 19107 Spatial Schema is one of the strengths of S-100 that will carry forward into a Marine Cadastre.

Rights, Responsibilities and Restrictions

A Marine Cadastre is a separate context from Maritime Limits and Boundaries and distinct from UNCLOS, but it would build upon and use the boundaries defined in S-121. An UNCLOS Product Specification would also build upon some aspects of a Marine Cadastre. Such association is in fact the basis of Object Oriented System Design which enables efficient usage and refinement of a parent object into more specific and usable object sets.

A Marine Cadastre built upon ISO 19152 is a good fit. There are only some minor issues that can easily be overcome. The ISO standard adds the concept of “Parties” and “Rights, Restrictions and Responsibilities”. This is exactly what UNCLOS needs, built upon the boundaries that would be defined in S-121 Maritime Limits and Boundary standard. The Marine Cadastre is one of the clearly separate application areas, that may reuse available objects from the base structure, such as the “Parties” and “Rights, Restrictions and Responsibilities” taken from ISO 19152.

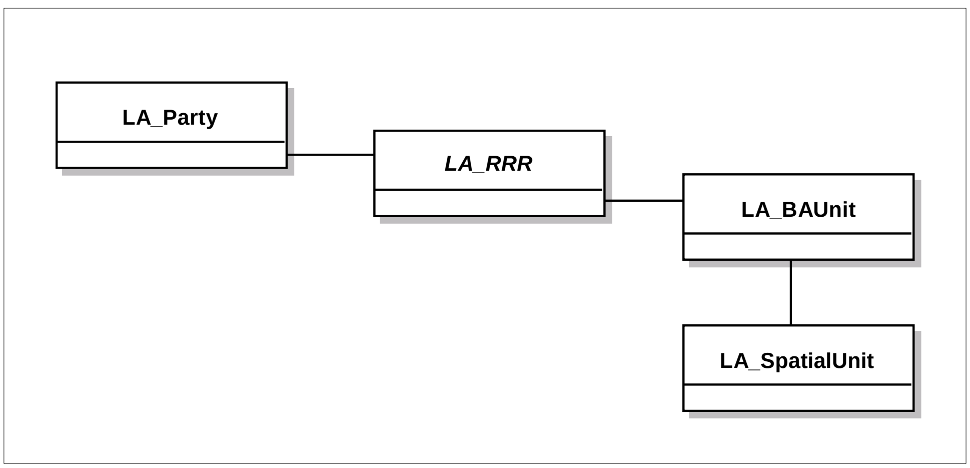

Figure 9- Domain Administrative Area classes

Figure 9 shows the basic classes defined in the ISO 19152 standard. The LADM model is a very simple model. The basic administrative units (LA_BAUnit) have spatial geometry (LA_SpatialUnit), which may be defined in several ways. Rights, restrictions and/or responsibilities (LA_RRR) relate parties (LA_Party) to the basic administrative units (LA_BAUnit). The ISO Domain Administrative Model standard uses the same feature types (LA_BAUnit) and spatial geometry (LA_SpatialUnit) as all of the other ISO standards, but it adds the rights, restrictions and responsibilities related to parties or groups of parties.

S-121 Marine Limits and Boundaries is a set of structures used to build a boundary oriented products. It is a structural standard, not a Product Specification.

[10] Pirate maps aside – e.g. “Go fourteen paces from the large oak tree toward the big rock and turn left ten paces.”

Future work on a Marine Cadastre is a set of structures used to build a cadastre oriented products. It is distinct from S-121 Marine Limits and Boundaries but will build upon S-121. It is also not an end use Product Specification.

UNCLOS would be a Product Specification, build upon S-100, S-121, and possibly elements from a Marine Cadastre specification as well as fisheries and other data.

Figure 10 shows the basic classes of the ISO 19152 structure adapted for use in the IHO S-100 series of standards. These objects are built as S-100 Information Objects. That is they contain attributes but have no spatial location. The spatial geometry derives from the S100_GF_SpatialAttributeType and makes use of the same spatial primitives as defined in S-100.

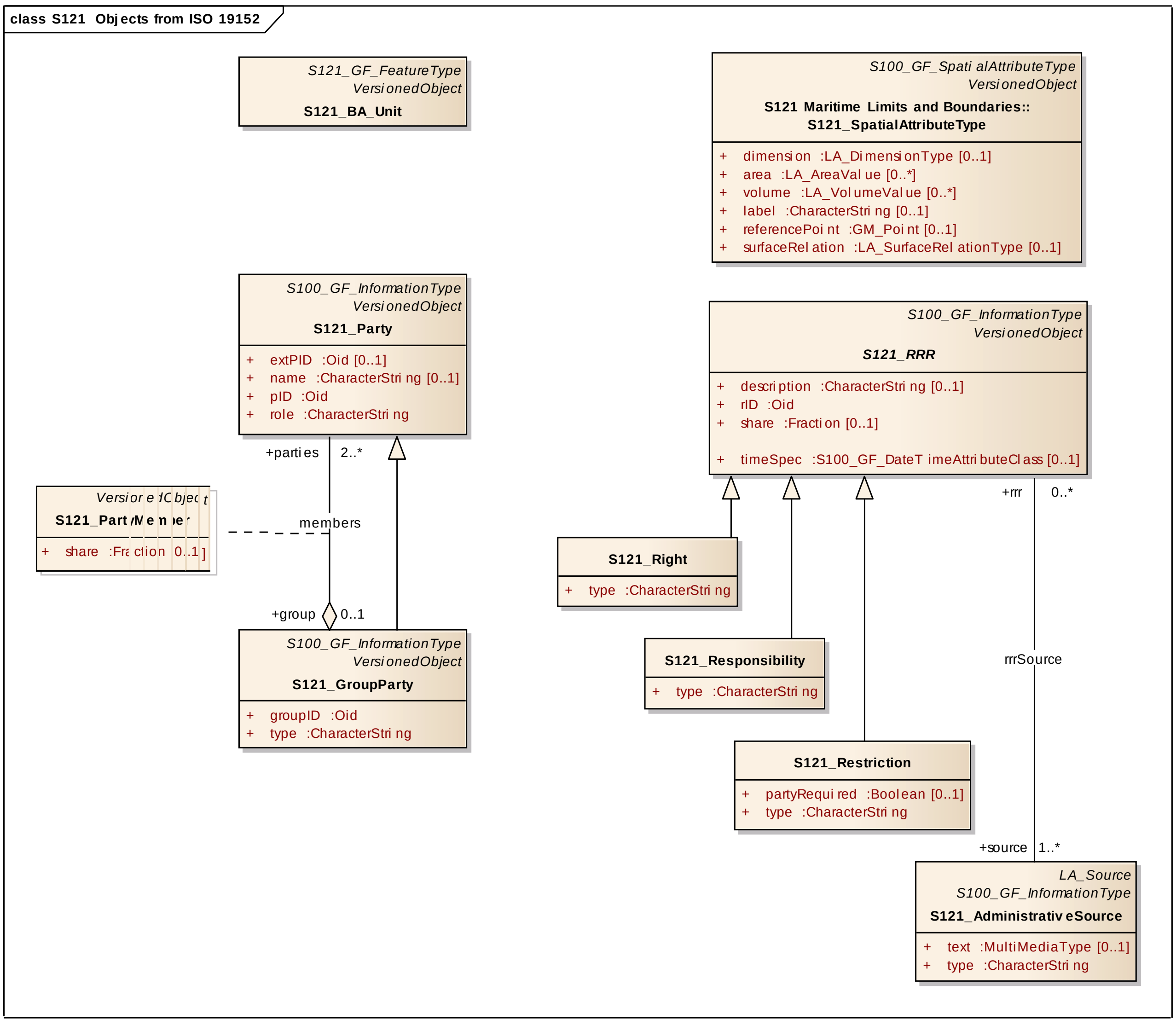

Figure 10- Objects Adapted from the ISO 19152 LADM

The detailed lists of rights, responsibilities and restrictions defined for the land domain do not apply directly to the marine environment. For example, the concept of ownership is different on land, and responsibilities such as mortgages do not exist. A new set of rights, responsibilities and restrictions will need to be defined in S121 and registered for the marine environment.

The architecture is built upon S-100 (and ISO). This establishes the type of spatial attributes that are available. This is a limited set, which has advantages in implementation; however, it is not the same set of primitives that were chosen for the Land Administrative Domain Model from ISO 19152. The IHO permitted spatial attributes are simpler than the ISO 19152 spatial attributes. Essentially, the capability for "multi" geometries are not supported. This means that feature objects with composite geometries need to be constructed out of several simple objects. This presents no fundamental problem.

Versioned Object

The versioned object capability in ISO 19152 LADM allows objects to include a set of versioning attributes. These attributes consist of begin and end dates and optional quality and source attributes. The quality and source attributes apply to the quality and source of the versioning and are not general metadata. This object can be inherited directly form ISO and used in the MSDI model.

IHO S-100 allows for many feature types to be non-versioned. For example, features in an ENC would follow the S-101 Product Specification and would be non-versioned. The whole ENC data product would be versioned. Versioned and non-versioned objects may be mixed. A particular Product Specification would incorporate versioning by using the classes identified in Figure 11, which shows the objects that inherit the versioning attributes. An example of a versioned object would be a marine oil lease, where the rights, responsibility and restriction attributes may change by referencing a new party.

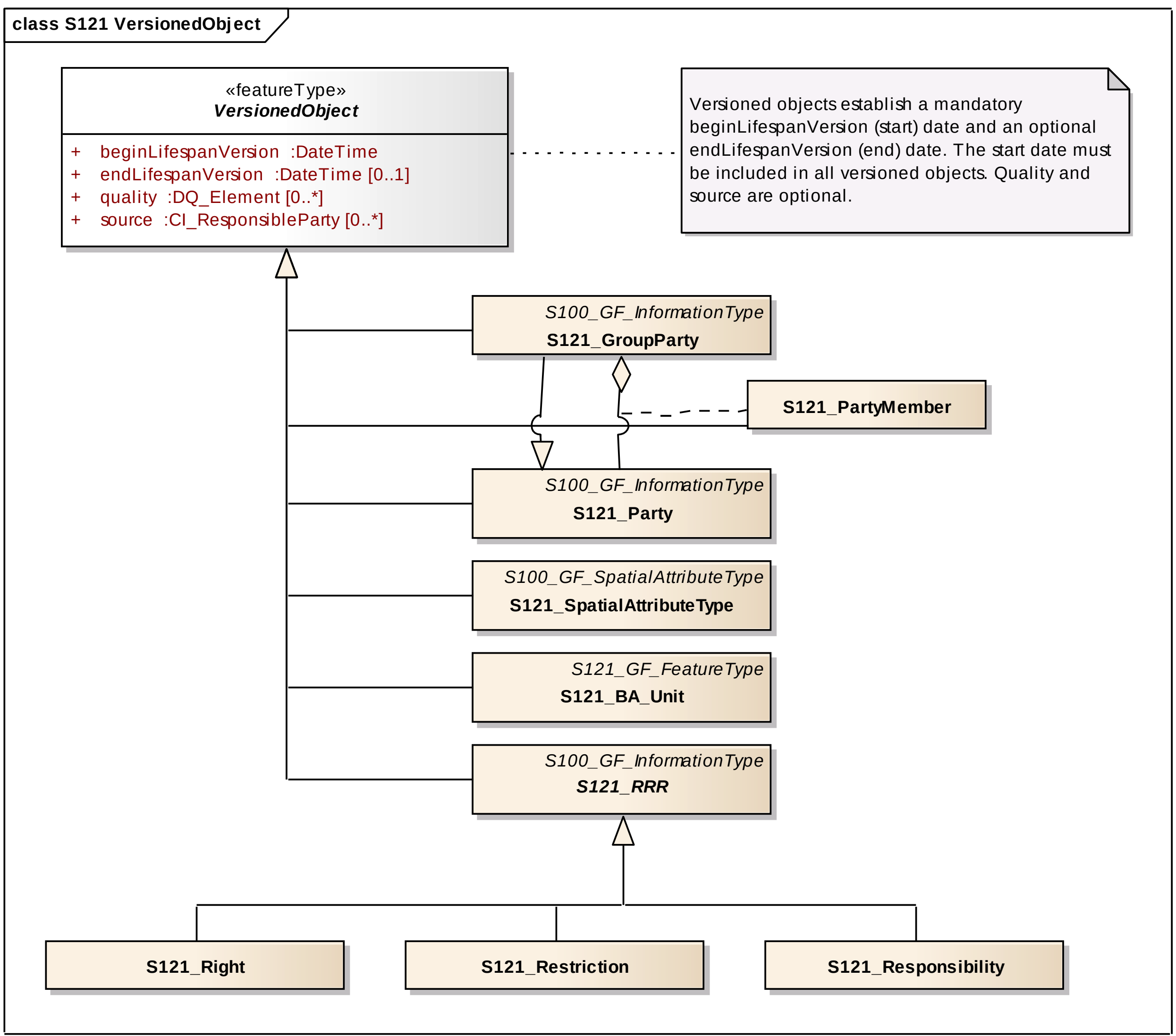

Figure 11- Versioned Objects

Summary

This document presents a structure for implementing extensions to the S-100 model to support navigational and marine applications. This supports other information contexts such as Marine Limits and Boundaries, Marine Cadastre, Marine Protected Areas, the Marine Physical Environment and Harbour Infrastructure. The main element of the structure that has been introduced is the use of intrinsic types to establish the type of objects. The intrinsic types of location, limit, zone and space define the type of attributes that can be associated with an object.

The architecture introduces the Rights, Responsibilities and Restriction (RRR) and Party attributional structure from ISO 19152. Since these attributes are not universal across all of the existing IHO Product Specifications they need to be optional. This means that some objects may be versioned and carry the RRR attributes and others in the same data set might not. The use of when the RRR attributes are appropriate must be defined in each Product Specification for an information type.

A more detailed description on how to support the ISO 19152 Land Domain Administrative Model in a Marine Environment will be given in a separate paper. This paper and the associated paper on support for the LADM will form the basis for the S-121 standard, and allow of the extension to other types of non-navigational product specifications.

Recommendation

It is recommended that IHO adopt the proposed structure for implementing extensions to the S-100 model to support navigational marine applications such as Marine Limits and Boundaries, Marine Cadastre, and other non-navigational application areas. This structure includes the concept of intrinsic types to establish the type of objects in the Feature Concept Dictionary and support for the Land Administrative Domain Model from ISO 19152 to establish an attributional structure of Rights, Responsibilities and Restriction (RRR) and Parties.

Action Required of HSSC and S-100 WG

The HSSC and S-100 WG are invited to endorse the use of the Intrinsic Nature concept as an element to be described within the IHO Feature Concept Dictionary for all feature types, especially those for S-121 and S-122.