S100WG01-10.3A Rev 1

Paper for Consideration by HSSC & S-100 WG

Supporting the ISO 19152 Land Domain Administrative Model in a Marine Environment

Submitted by:	Canadian Hydrographic Service & Geoscience Australia
Executive Summary:	There has been a long history of marine charting that has established the structure of a navigational chart. Mapping other areas of the marine environment introduces other attribute structures that do not derive from the same history. Establishing legal attributes, such as rights and jurisdictions in the marine environment requires the establishment of limits and boundaries that has more in common with land mapping. Also, some of the experiences developed in land mapping can be inherited into mapping non-navigational marine applications. The Land Domain Administrative Model (LADM) establishes a structure for managing rights, responsibilities, and restrictions relating features to parties. The LADM has been standardized through the International Organization for Standardization as ISO standard 19152. Although the title of the standard mentions land, the scope of the standard clearly indicates that it can be applied to water. This document outlines the method of incorporating the standard ISO 19152 Land Domain Administrative Model together with the IHO S-100 Universal Hydrographic Model to address the requirement for non-navigational information in a marine environment. The S-100 Universal Hydrographic Data Model is the basis for the entire IHO suite of standards. Extending S-100 to support the LADM is straight forward and a good fit. Application areas such as Maritime Limits and Boundaries and Marine Cadastre require different attribute structures such as support for sovereign rights which are easily addressed by the LADM within S-100. This paper describes structures derived from the ISO standard for the Land Administrative Domain Model (ISO 19152), which have been adapted to the marine environment.
Related Documents:	
Related Projects:	S-121 Maritime Limits and Boundaries, S122 Marine Protected Areas, Marine Cadastre

Introduction / Background

Nautical charts include information about safety as well as depictions of the physical environment. They are based on a number of conventions developed over the long history of navigation at sea. The International Hydrographic Organization (IHO) has long standardized the format of paper based nautical charts. Since the mid-1980s IHO has extended the standardization of nautical charts to the Electronic Navigational Chart (ENC). This was first standardized in the IHO standard S-57. The S-57 standard was revised to become the S-100 Universal Hydrographic Model and the S-101 Electronic Navigational Chart product specification. This approach allowed the development of additional product specifications to address other aspects of the marine environment. The first additional product specifications addressed auxiliary information also in the realm of navigation, such as S-102 Bathymetry and S-111 Surface Currents.

The suite of standards developed to support electronic marine navigation (eNavigation) is a consistent information context. However, the S-100 Universal Hydrographic Model also allows for the representation of other aspects of the marine environment. These other types of data may be compatible with the eNavigation information, but there are

some fundamental differences. Marine resources maps, fisheries maps, a marine cadastre, political and jurisdictional maps and marine limits and boundaries include concepts of rights, ownership, and legal aspects. The theme behind some of these additional types of marine data is legal rights.

A map is an abstraction that endeavours to describe the physical world. The theme behind eNavigation is safety at sea and a Nautical Charts may deliberately distort the physical representation to enhance navigation showing the maximum area of dangers. Nautical Charts also contain certain prescriptive information such as maritime traffic separation schemes and other regulations that guide the mariner in safe navigation.

The theme behind many of the additional types of marine charts data is legal rights. Certain lines such as political boundaries and maritime limits derived from both physical geographic information as well as from external information such as treaties and other agreements that set the rules that define the boundary line. These lines must be calculated accurately following the rules established in the agreements or other defining sources and placed accurately on the map in conformance with the reference system and projection used on the map. Fishing zones, oil exploration rights, political maps and many other types of maritime data need to incorporate and accurately depict the concepts of rights, restrictions and responsibilities. Experience in this area does not derive from marine navigation but it largely is based on the methods by which these legal rights issues are addressed in terrestrial mapping. However, there is still an important marine component that can be quite different than land mapping.

The Land Administrative Domain Model (LADM) standardized in ISO standard 19152 establishes a rigorous mechanism for handling legal Rights, Responsibilities and Restrictions (RRR) for individuals, groups or other parties. This mechanism can be used in the IHO standard S-121 Marine Limits and Boundaries and in other marine application areas such as a Marine Cadastre. The title of the ISO standard says “Land Administrative Domain Model" however, the scope of the standard explicitly addresses the water[1]. This report outlines how Maritime Limits and Boundaries and other marine application areas can be handled in alignment with the RRR and Party structures inherited from ISO. The goal of the Universal Hydrographic Model defined in S-100 is to cover all aspects of hydrographic and marine information. In the land domain there are also new structures being standardized, in ISO 19152 and other forums, to address areas such as land cadastre, road networks, land cover, etc. Integrating other information domains for the marine environment that include legal, economic and management aspects related to the ocean can build upon this work in ISO. The work is being done in parallel, so that new capabilities introduced in one area can be reused in another increasing the level of interoperability.

It is very important for associated legal attributes to be used together with Maritime Limit and Boundary (MLB) information so that one can determine under whose authority, or international treaty a particular limit or boundary is defined. Similar processes of defining MLBs exist in many countries; however, they are not exactly the same so that there may be differences in how information is defined in various jurisdictions. The IHO standard S-121 on Maritime Limits and Boundaries must be general enough to satisfy the requirements of all nations since boundary information involves more than one state actor. Accurate calculation and representation of the resultant boundaries and original legal sources are of great importance. There can be significant legal and political implications resulting from errors.

Maritime Limits and Boundaries information may be used in many different ways. Additional information may also be required in legal or political disputes to justify the representation of a particular maritime boundary line.

One aspect of wide reaching importance is the definition of the coast which is often used as part of the boundary of a maritime area. The oceans are constantly in motion due to tides, weather and seasonal variations. The level of rivers can change even more due to seasonal variations such as spring flooding. For this reason sea level is based on an average, and there are many different ways to calculate this average.

Because there may be several different state actors involved with different technological approaches and levels of sophistication in their system implementations, the management of legal rights standard needs to be very flexible. The S-121 standard will be the structure on which other Product Specifications such as Marine Limits and

[1] International Standard ISO 19152:2012 Geographic information -- Land Administration Domain Model (LADM), Clause 1 Scope – “including those over water and land, and elements above and below the surface of the earth”; <https://www.iso.org/obp/ui/#iso:std:51206:en>

Boundaries, Marine Cadastre, Marine Spatial Data Infrastructure (MSDI), etc. will be based, since all information found within the extensions depends upon the legal and administrative entities described by S-121.

Maritime Limits and Boundaries

Coastal states have the rights to and the responsibility to manage adjacent waters. These rights and responsibilities are more complex than boundaries on land. It is not only more difficult to describe maritime boundaries, but the sea is constantly changing and conventions are required to ensure that various nations establish consistent and non-conflicting boundaries. A coastline is very difficult to define. From the point of view of a terrestrial land map a coast line is the zero contour of the geodetic datum used on a topographic map. From the point of view of a sea chart a coastline is mean sea level based on a Hydrographic datum such as Lowest Low Water Low Tide (LLWLT), Mean Lowest Low Water line (MLLW) or Lowest Astronomical Tide (LAT). Even so the detailed shape of a coastline varies with resolution, coastlines or shorelines may be used to define a political boundary as prescribed in some treaty, act and regulations. In fact, in order to officially delineate the outer extent of a country and to support the computation of other Maritime Limits and Boundaries, baselines are used.

A baseline is defined in the UN Convention on the Law of the Sea[2]. The baseline is composed of either normal or straight baselines and is the main reference from which all MLBs are computed. The baseline is used to define the outer limits of the Territorial Sea (TS), the Contiguous Zone (CZ), the Exclusive Economic Zone (EEZ) and even the Extended Continental Shelf (ECS). Aside from the computation of those limits which involves a single country or state, a boundary would exist between two nations when any of the defined zones are adjacent.

Maritime Limits and Boundaries (MLB) are an important new information context that is quite different from the eNavigation context that is the current focus of the IHO standards. Similar application areas are also developing; in particular there is a need to develop a Marine Cadastre. Both MLB and Marine Cadastre have the requirement for a strong attributional structure that is capable of managing legal attributes. All marine applications need to be built upon the IHO Universal Hydrographic Model S-100; however, the need to support the relationships between parties and rights goes beyond what is currently defined in S-100. The standard ISO 19152 for a Land Domain Administrative Model provides a mechanism for managing the relationships between parties, rights, responsibilities and restrictions. This standard was designed based on extensive experience in Land Cadastre. It needs minor adaptation to be applied to the Marine Environment.

Features and Attributes in S-100

The ISO suite of geographic information standards and the derivative IHO S-100 Universal Hydrographic Data Model are built upon an object structure. A real world feature is an object that has properties. These properties are represented as attributes and associations. The attributes are of two types, Spatial Attributes describing its geometric representation, and Thematic Attributes describing its nature. There may also be constraints placed upon an attribute or association. The IHO S-100 has added to the ISO General Feature Model the concept of Named Types, to allow for Feature Types and also Information Types.

A feature has existence in the real world. A particular feature instance could be a buoy or a segment of coast line. Limits and Boundaries are also features with existence in the real world.

An information object is an object with no real geographic spatial position. In a navigational chart it may be something like a note that can appear on a chart. Information objects can have thematic attributes and so they can be used to implement the Administrative Objects defined to describe Rights, Restrictions and Responsibilities and Parties derived from the ISO 19152.

Figure 1 Shows a Feature Object and its Associated Attributes taken from the IHO S-100 standard.

[2] UNCLOS Part II Territorial Sea and Contiguous Zone, Section 2. Limits of the Territorial Sea Article 5, 6 and 7

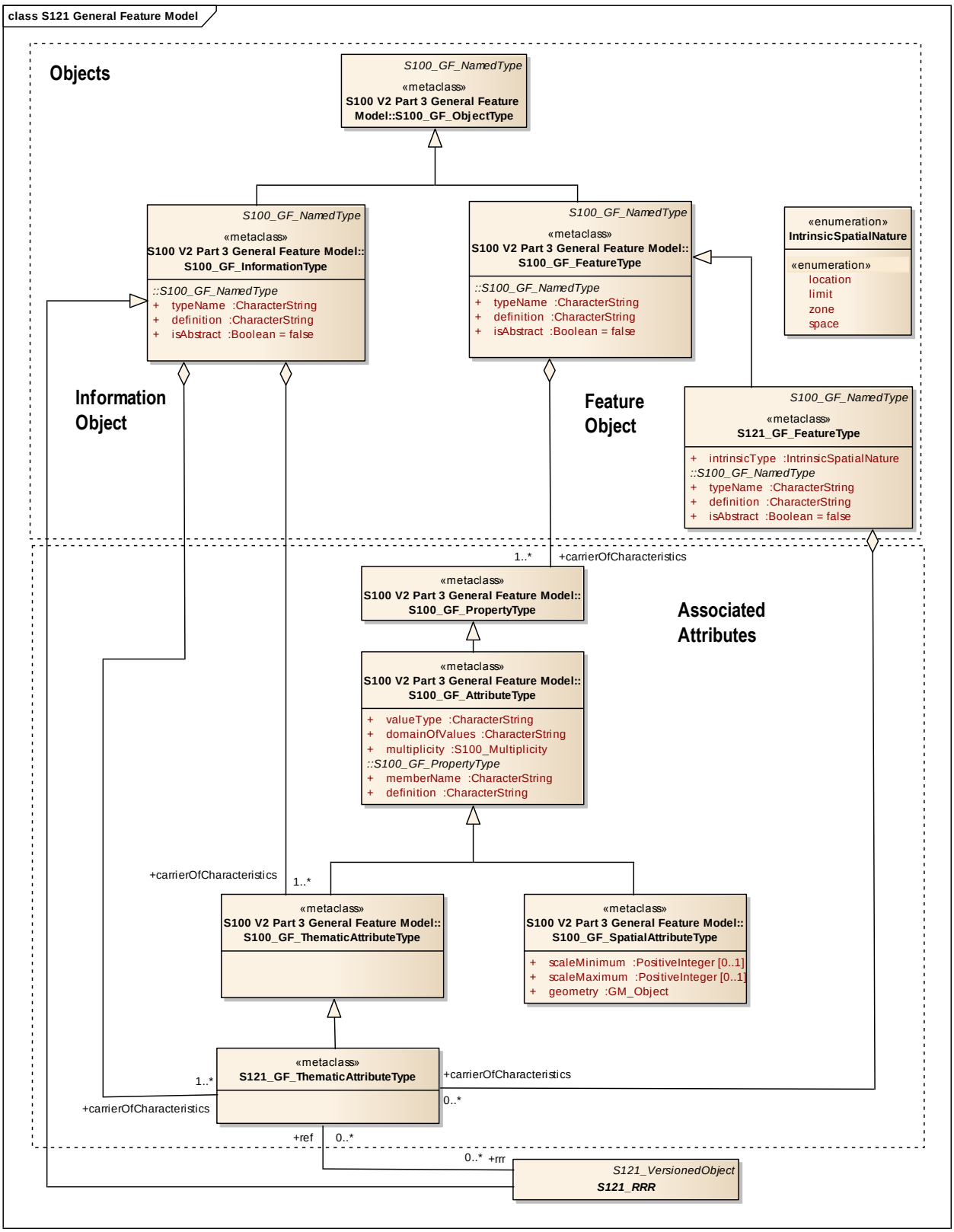


Figure 1 – General Feature Model with S121 Specialized Classes

The General Feature Model is a metamodel; that is, it is a template upon which actual Application Schema are defined. Every data set has an Application Schema that defines the allowable objects and attributes and the allowed relationships for that particular type of data set. There is a hierarchy of models ranging from the abstract metamodel template to the specific application schema and to the specific set of instance data corresponding to a particular instance of a data set. S-121 defines two new classes at General Feature Model (template metamodel) level. It specializes S100_GF_FeatureType by adding the attribute IntrinsicType and specializes S100_GF_ThematicAttributeType in order to add a relationship to the Rights, Restrictions and Responsibilities structure which is inherited from the ISO 19152 standard. The attribute IntrinsicType establishes context independence by separating 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. The feature 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 representational (P, L, A) geometric primitives.

The feature type object takes its definition from the S-100 object S100_FC_FeatureType with the addition of the attribute intrinsicType. All of the inherited attributes are shown in the S121_FC_FeatureType object together with the associated code lists.

An important restriction is that S-100 limits the types of spatial primitives that may be used to represent the object to GM_Point, GM_MultiPoint, GM_Curve, GM_Surface, CV_Coverage, GM_Curve (arcByCentrePoint and circleByCentrePoint). This is a simplification from the more extensive set of primitives available in ISO 19107 Spatial Schema upon which both the ISO 19152 LADM and the IHO S-100 is based. This subset makes the implementation of systems such as an ECDIS system easier by limiting the types that need to be implemented. This restriction is important in S-100 because navigation systems must be testable to ensure safety. For compatibility this same restriction carries through to other marine application areas such as a Maritime Limits and Boundaries and a Marine Cadastre.

Rights, Responsibilities and Restrictions from ISO

Attributes provide detail that establish context for a feature. S-100 defines two types of attributes that may be associated with a feature. These are spatial attributes and thematic attributes. The spatial attribute references GM_Object from ISO 19107 for the geometry, but the types of geometry are limited by the Spatial Primitive Types defined in S-100.

Thematic attributes have their definitions recorded in the Feature Concept Dictionary and feature Catalogue. The elements recorded in the Feature Catalogue are shown in Figure 2.

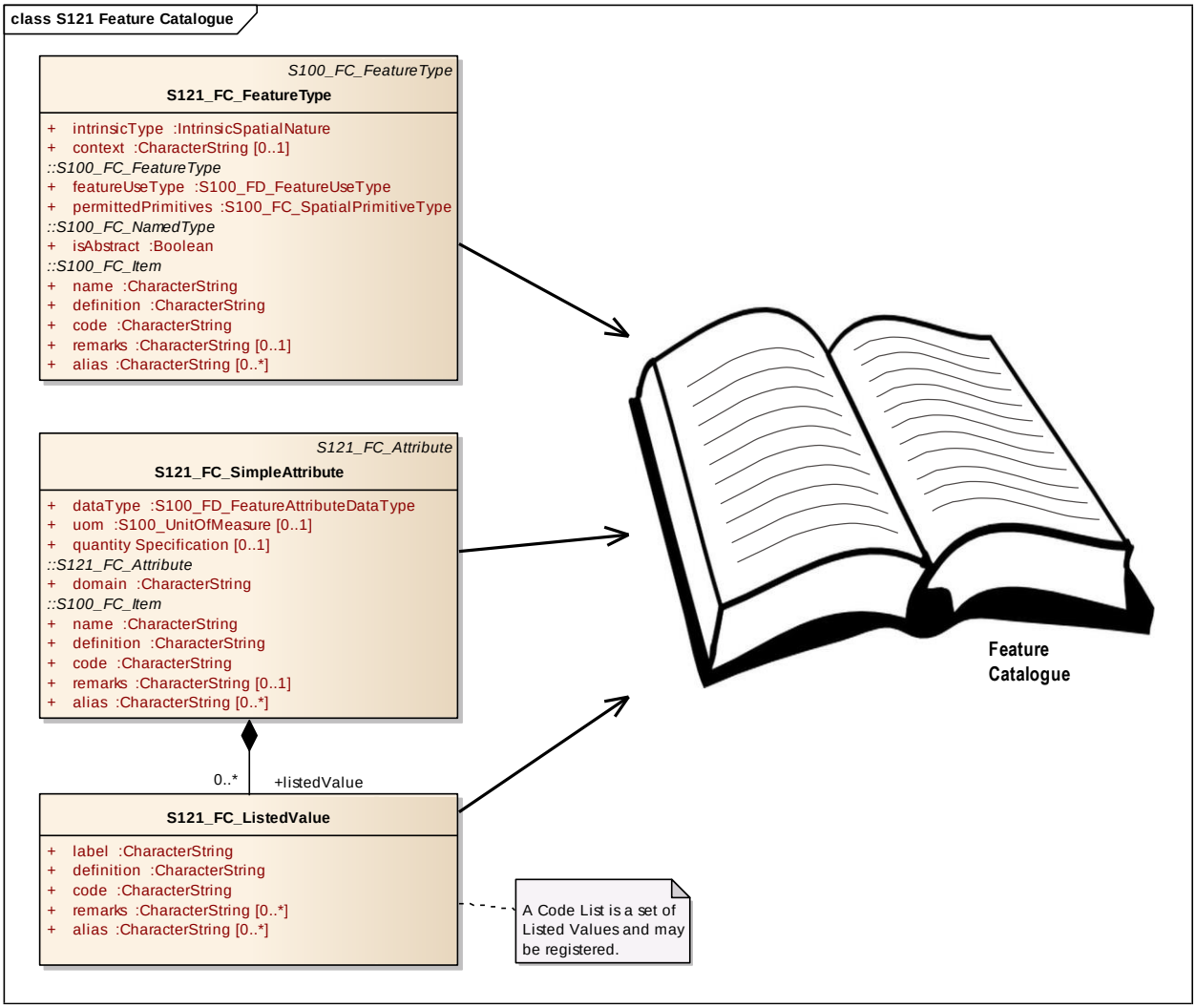


Figure 2 – Objects Recorded in the Feature Catalogue

There are two types of attributes, simple attributes and complex attributes. Both have a name, definition and code. In addition a simple attribute has a data type and optionally a unit of measure and quality. A simple attribute may have a set of listed values, which are also defined in the Feature Catalogue. A complex attribute has a set of bindings that link attributes and listed values. This structure derives directly from S-100 and is illustrated in Figure 3. This structure allows the recording of attributes and code lists / enumerations (sets of listed values) in the Feature Concept Dictionary and in the Feature Catalogue.

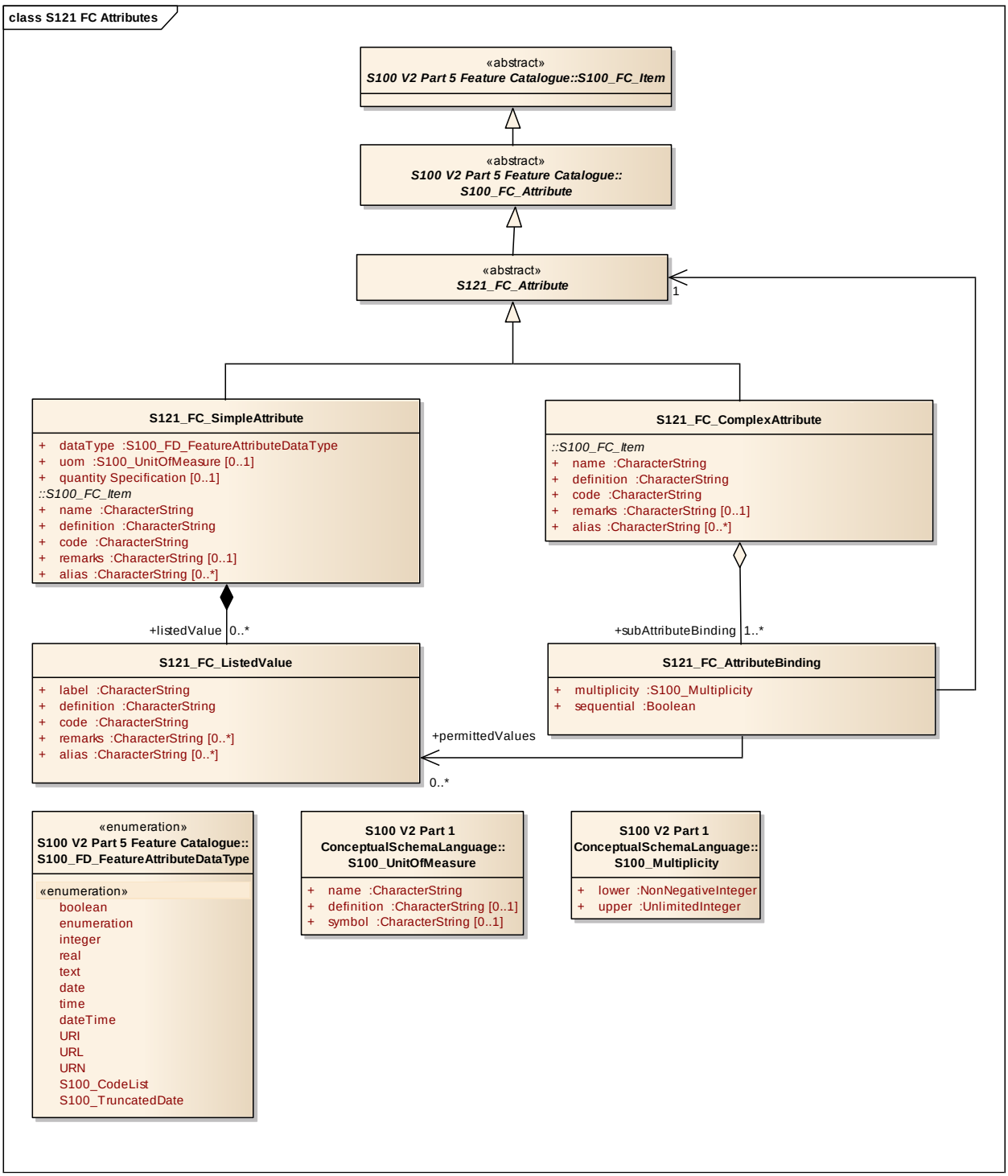


Figure 3 – S121 Feature Catalogue Attributes

For the establishment of the Electronic Nautical Chart (ENC) data product and for specific other data products, the definition of attributes has been guided by a wealth of experience in creating paper navigational charts, and scientific experience in bathymetry, currents, tides etc. However, when one broadens the scope to more general objects which IHO intends to cover, such as Marine Limits and Boundaries, Cadastre, resource management and general spatial data infrastructure, the definition of attributes becomes more involved. There are many ways to describe the same

conditions and some consistency is required. This is especially true of attributes that involve legal rights where consistency is very important.

Experience in this area comes from land administration, and this experience has been documented in the Land Domain Administrative Model (LADM) standardized in ISO. The standard ISO 19152:2012 Geographic information -- Land Administration Domain Model (LADM) "defines a reference Land Administration Domain Model (LADM) covering basic information-related components of land administration (including those over water and land, and elements above and below the surface of the earth)"[3]. The LADM "provides an abstract, conceptual model with four packages related to parties (people and organizations); basic administrative units, rights, responsibilities, and restrictions (ownership rights); spatial units (parcels, and the legal space of buildings and utility networks); spatial sources (surveying), and spatial representations (geometry and topology)"[4].

Whereas Hydrographic information, and MLB information in particular has its own spatial units, spatial sources and spatial representations derived from IHO S-100, there is a need for consistency that the LADM parties (people and organizations) and basic administrative units, rights, responsibilities, and restrictions provide. Since the LADM and IHO S-100 are both built on the ISO TC211 suite of Geographic Information standards, these elements are compatible and can be inherited into IHO.

Figure 4 illustrates the Domain Administrative Area Classes defined in the LADM. The basic administrative units (LA_BAUnit) have spatial geometry (LA_SpatialUnit), which may be defined in several ways. The explicit geometry used is S-100 is compatible. 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.

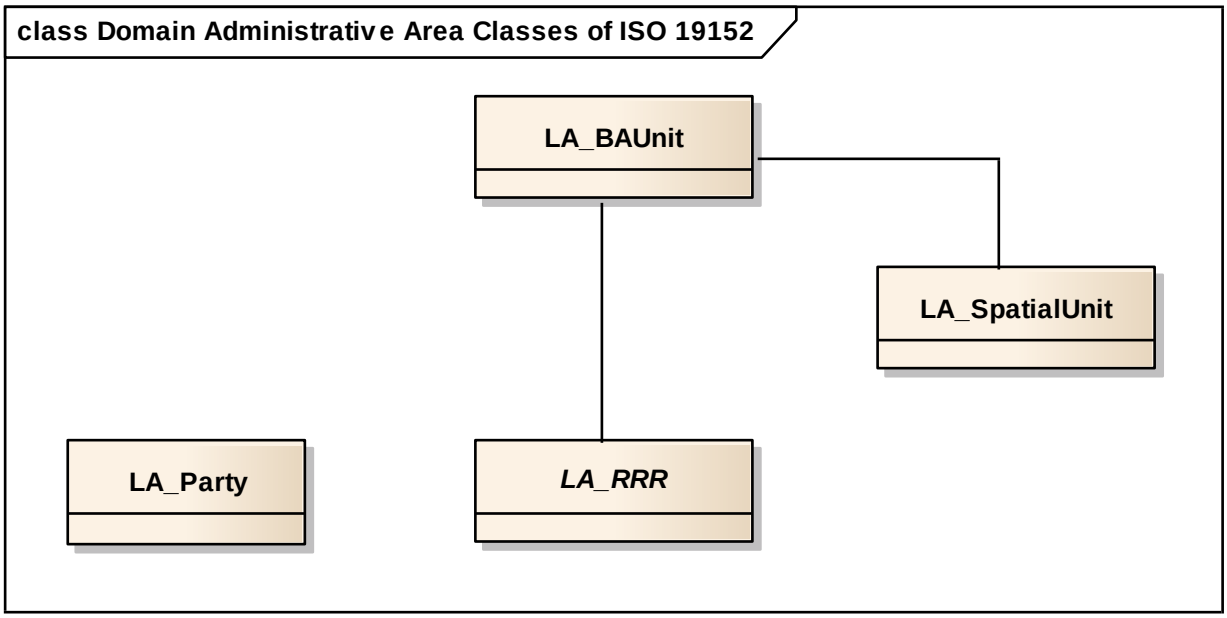


Figure 4 – Domain Administrative Area classes

ISO 19152 also provides the capability to version objects. This Versioned Object structure is extremely valuable in the MLB application area (and in other application areas such as Marine Cadastre). In the area of nautical charts, both paper charts and ENCs, the whole chart or data set is versioned. This is appropriate approach for this type of data product; however, for Marine Limits and Boundaries and for Marine Cadastre it is necessary to be able to

[3] ISO 19152 scope statement

[4] ibid

manage the version of features and attributes at the individual object level. For example, the rights to a fishing zone may change without altering anything else. Individual versioning of objects allows changes to be managed at a fine level.

Basic Administrative Unit Package

The Basic Administrative Unit as defined for S-121 is derived from the class LA_BAUnit defined in ISO 19152. The BA Unit is a feature type to "which (one or more) unique and homogeneous rights, responsibilities or restrictions are associated". This is a realization of the class S121_FeatureType and as such the definition of the feature type can be included in the Feature Concept Dictionary. For example the feature type "Territorial Sea", which would be used in a Maritime Limits and Boundaries Product Specification (S-121), would have a registered definition in the Feature Concept Dictionary. This feature type would also be able to take on the rights, responsibilities and restrictions attributes so it would also inherit from LA_BAUnit.

The S121_BA_Unit object also inherits from ISO 19152 VersionedObject. This allows the definition begin and end lifespans for an object and also provides optional quality and source references. This is illustrated in Figure 5.

Realization relationships are used to prevent double inheritance. The relationship between LA_BAUnit and S121_LA_BA_Unit is a "realize" relationship because only some of the attributes are inherited. One attribute *type* is overwritten with a different code list that is appropriate for a marine environment since the list from ISO 19152 is land oriented. Attribute values such as basicPropertyUnit and leasedUnit are only needed in a land cadastre. The attribute *typeName* (derived from S-100) is equivalent to *name* derived from ISO 19152 and so overwrites the *type* attribute.

The relationship between S121_GF_FeatureType and S121_ BAUnit is also a "realize" relationship. Since S121_BAUnit is a metaclass only some of the attributes are required. The *definition*, *intrinsicType* and *isAbstract* flag attributes are recorded in the Feature Concept Dictionary and are not required as part of S121_BAUnit. The *typeName* attribute is inherited. The relationships of S121_GF_FeatureType are also inherited.

The primary source for the model is IHO S-100. This provides direct compatibility with other IHO product specifications. The inheritance from ISO 19152 allows for compatibility with Land Cadastre and land based limits and boundaries. Those structures and attributes from the Land Administrative Domain Model that do not apply to a marine environment are not inherited.

The attribute uID is used in relationships between instances of the S121_BAUnitand S121_BA_Unit Rights, Restrictions and/or Responsibilities (LA_RRR) and parties (LA_Party) information objects.

The attribute *type* makes use of the code list S121_BAUnitType. This code list includes types that have a common characteristic related to the marine environment .

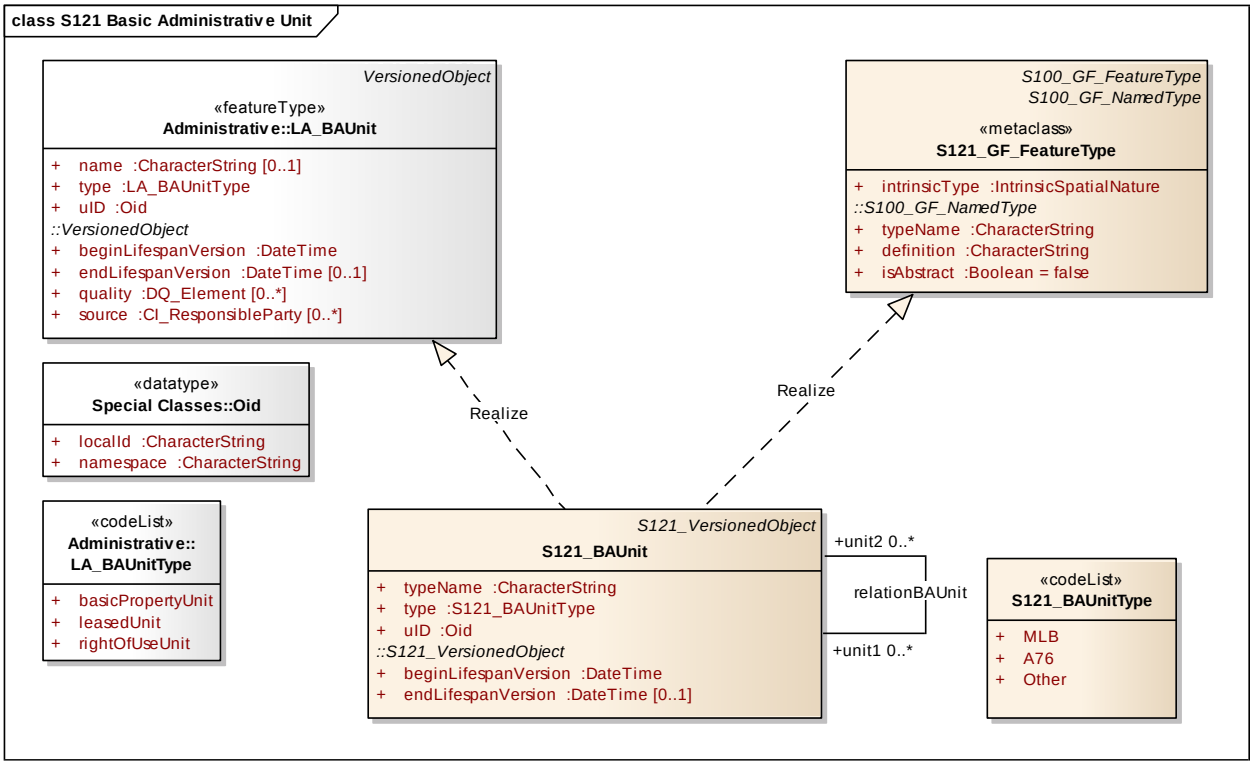


Figure 5 – S121 Basic Administrative Unit Inheritance

Spatial Unit Package

The Spatial Unit as defined for S121 is derived from the class LA_SpatialUnit defined in ISO 19152. It also inherits from S121_GF_SpatialAttributeType. This means that the geometry types inherited from S-100 apply. Only the geometry types GM_Point, GM_MultiPoint, GM_Curve, GM_Surface, CV_Coverage, GM_Curve (arcByCentrePoint and circleByCentrePoint) may be used.

The relationship to LA_SpatialUnit is a realization relationship. This means that selected characteristics are inherited. Some of the attributes of LA_SpatialUnit do not apply in the marine environment context; for example, in a marine environment there is no need for a postal address (*extAddressID*) in the same sense that it would be used on land. Other optional attributes such as *area, volume* and *dimension* are not required. Dimension is known from the Intrinsic Type of the object as recorded in the Feature Concept Dictionary.

The attribute *suID* is the spatial unit identifier that is referenced by the other elements of the RRR structure.

The attribute *label* is an optional short textual description of the spatial unit.

The Spatial Unit may be associated with zero or more S121_BAUnits; that is, the geometry may be shared. This is the same shared geometry construct as established for all feature types defined using IHO S-100.

ISO 19152 allows spatial units to be organized into groups or layers. Since this capability of grouping already exists in S-100 it is not necessary to inherit a duplicate structure from ISO 19152.

Figure 6 shows the inheritance relationship for S121_SpatialAttributeType. Note that S121_SpatialAttributeType is also a versioned object.

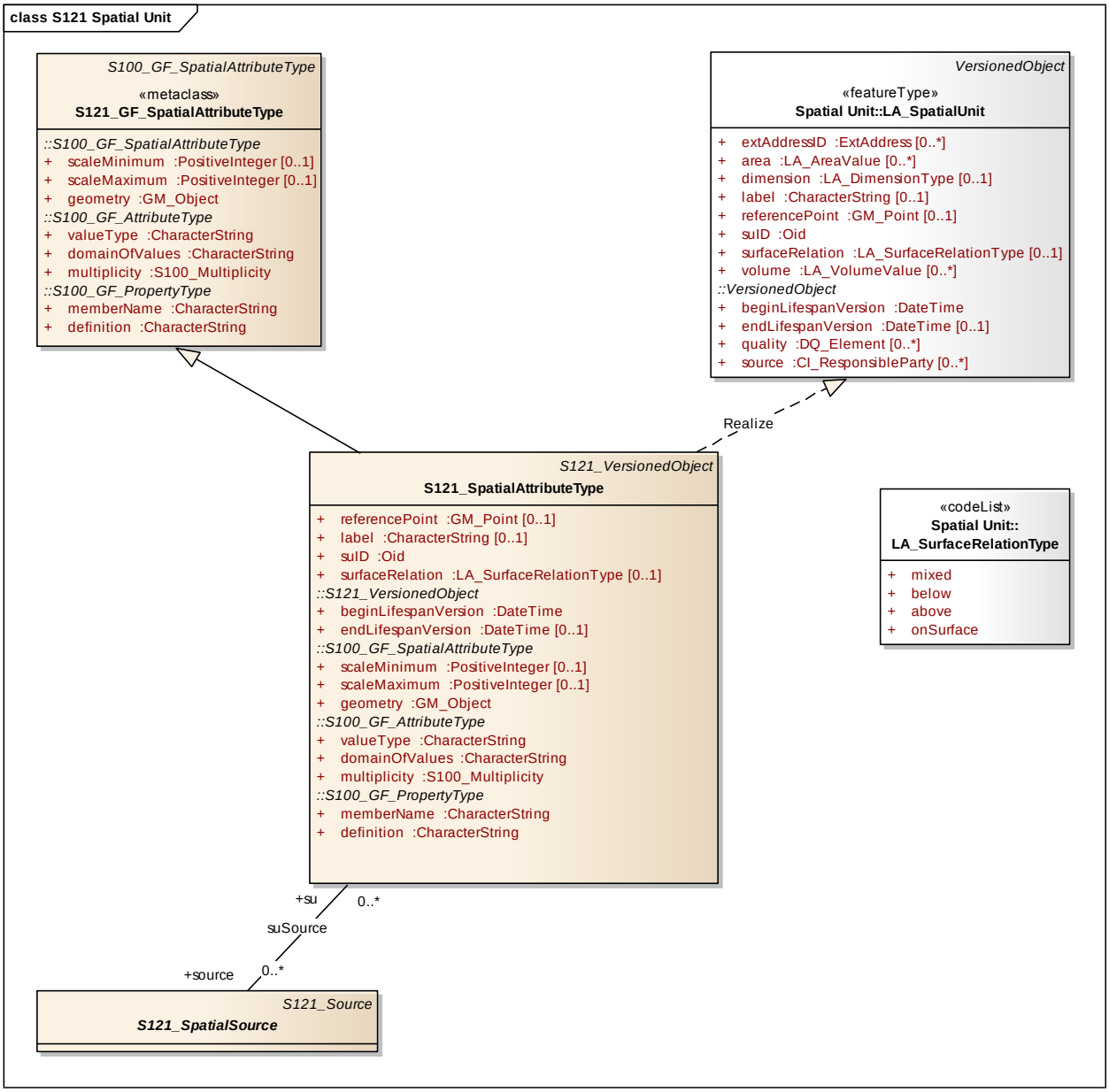
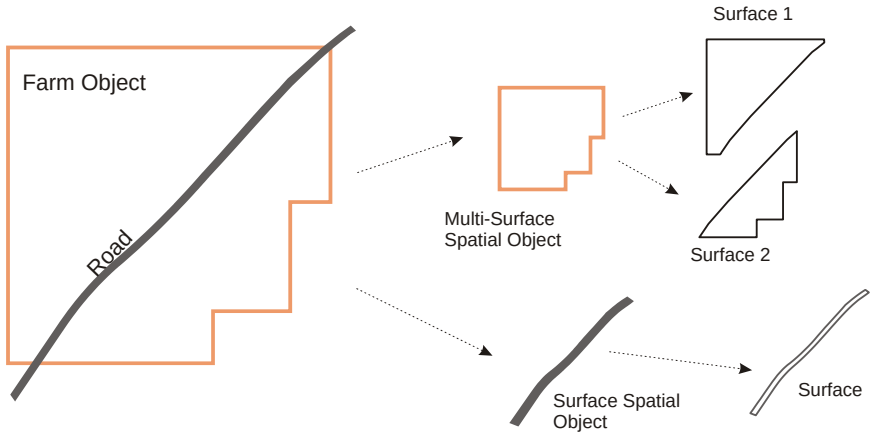


Figure 6 – S121 Spatial Unit Inheritance

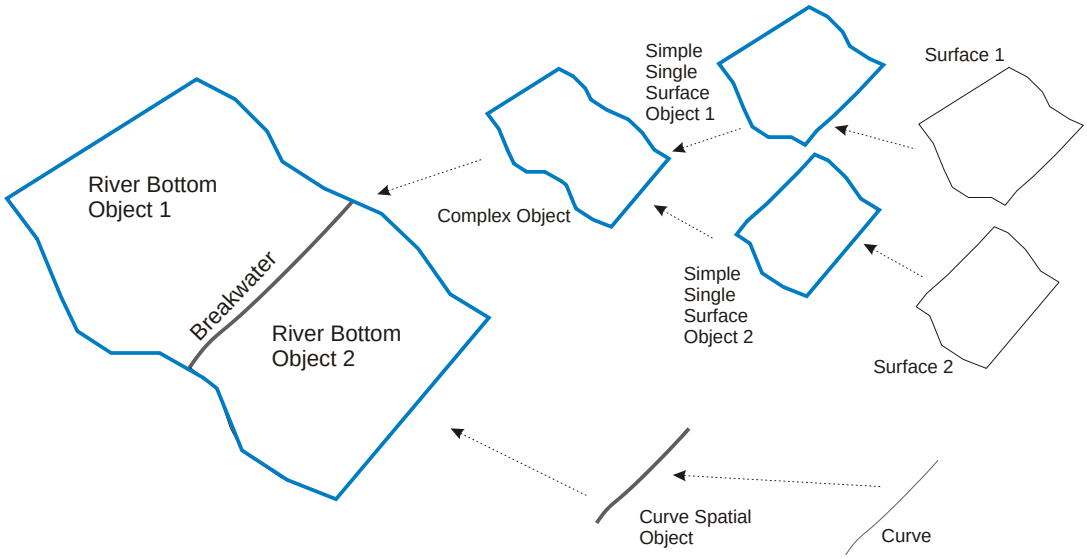
The ISO 19152 class LA_SpatialUnit makes use of the ISO spatial primitives GM_MuliCurve and GM_MultiSurface. IHO does not use the GM_Multi primitives except for GM_MultiPoint (for soundings). S-100 does support GM_Curve and GM_Surface, therefore these primitives are supported by the S121_SpatialAttributeType class. The composition is handled at the feature level.

Figure 7 shows an example of the use of the Multi-primitive GM_MultiSurface in a land cadastre environment. A farm land parcel object is crossed by a power line. In the land cadastre environment the farm would be one feature object that is defined by two surfaces using a GM_MultiSurface construct. In the marine environment there is a requirement from S-100 that each spatial primitive (except soundings) be a simple primitive. In this case one would generate two feature objects each with a single GM_Surface geometry. These two simple features would be combined into a complex feature with two parts. Both constructs are equivalent. In the marine environment the geometry is simpler whereas in the land cadastre environment the feature structure is simpler.

Land Administrative Domain Model Spatial Structure



NGDA Spatial Structure (in alignment with S-100)



Only one geometry per object is allowed in S-100 therefore multi-spatial objects must be constructed using a complex object.

Figure 7 – Spatial Structure

Two additional spatial primitives are defined in ISO 19152 to address three dimensional objects. These are LA_BoundaryFace and LA_BoundaryString. These are not used in S-121. Since three dimensional objects are not addressed in S-100 these two objects are implicitly an extension to the spatial schema. Since S-100 does not include any 3D spatial primitives the LA_BoundaryFace and LA_BoundaryString primitives must be constructed in the S-121 and in a Marine Cadastre. This is done by defining 3D objects as 2D objects with a height description. This can be done through attribution by either defining the vertical position and height of the object or describing the shape of the object. Defining the shape of a 3D object would apply if one were describing, for example, a hemispherical dome shaped safety area around an undersea well head. Also the domain of rights for some of the UNCLOS[5] feature objects have different vertical extents.

As illustrated in Figure 6 a source may optionally be defined for a spatial attribute. Figure 8 shows details of the S121_SpatialSource. Although there exists a class LA_SpatialSource defined in ISO 19152 it is not directly applicable in S121 since the method of managing the spatial unit is different and the methods of gathering information over water is also different than on land. Instead the class S121_SpatialSource realizes the ISO class LA_Source.

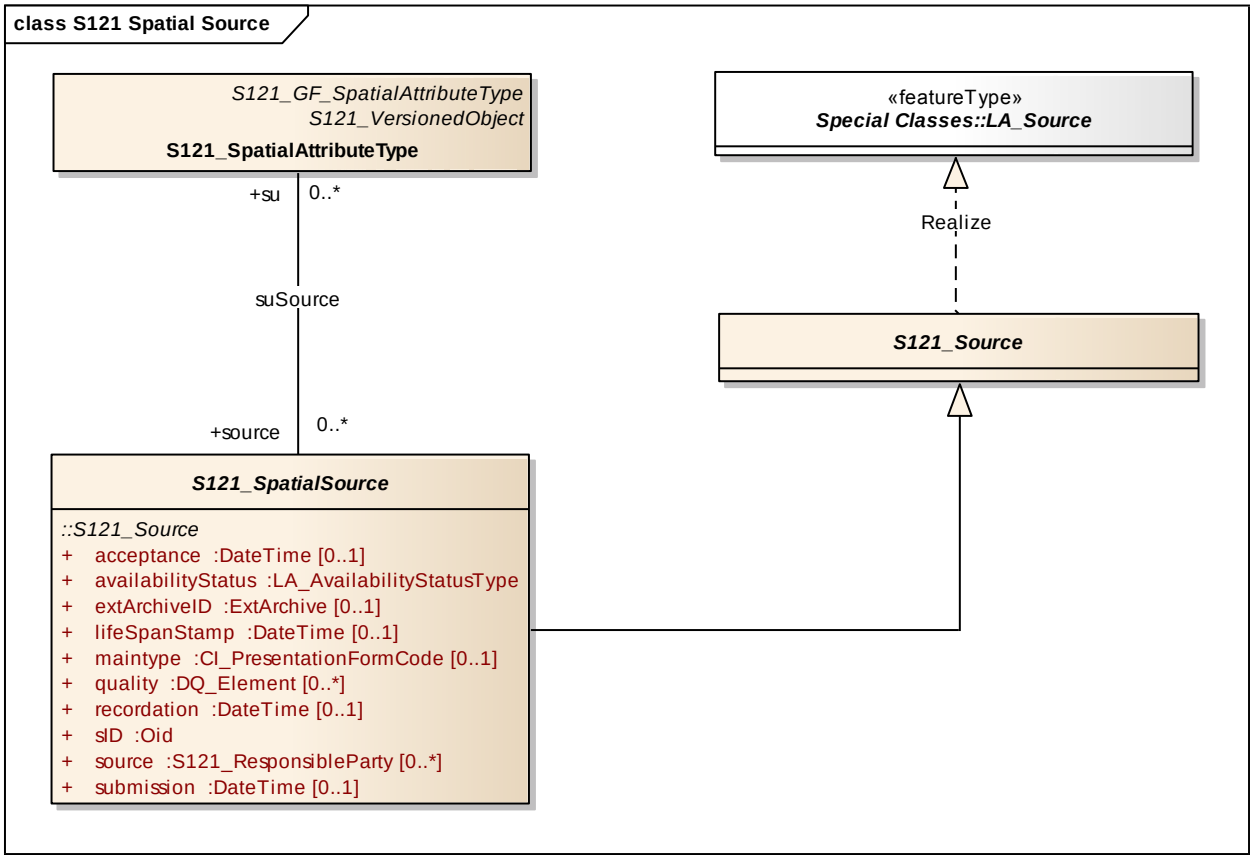


Figure 8 – Spatial Source

The ISO class LA_Source invokes a number of other ISO classes. These are:

- **DateTime** – a data type for recording clock time;
- **LA_AvabilityStatusType** – a code list identifying the status of a source archive;
- **EX_Archive** – metadata about an external archive;

[5] UNCLOS UN Convention on the Law Of the Sea

- **CI_PresentationFormCode** – a code list identifying the mode in which the source data is represented;
- **DQ_Element** – a metadata class describing data quality of the source data;
- **DQ_EvaluationMethodTypeCode** – a code list of the method used to evaluate data quality;
- **DQ_Result** – results of the data quality evaluation;
- **CI_RoleCode** – a code list of information about the function performed by the responsible party for the source data;
- **CI_OnlineFunctionCode** – a code list of the online function performed by an online resource as part of a contact for a responsible party for a source

In addition the ISO metadata class CI_ResponsibleParty has been realized in S-121 to be S121_ResponsibleParty. This includes the classes S121_Contact, S121_OnlineResource and S-121_Address that are realizations of the ISO classes CI_Contact, CI_Address and CI_OnlineReaource. The attributes and inheritance of S121_Source are shown in Figure 9.

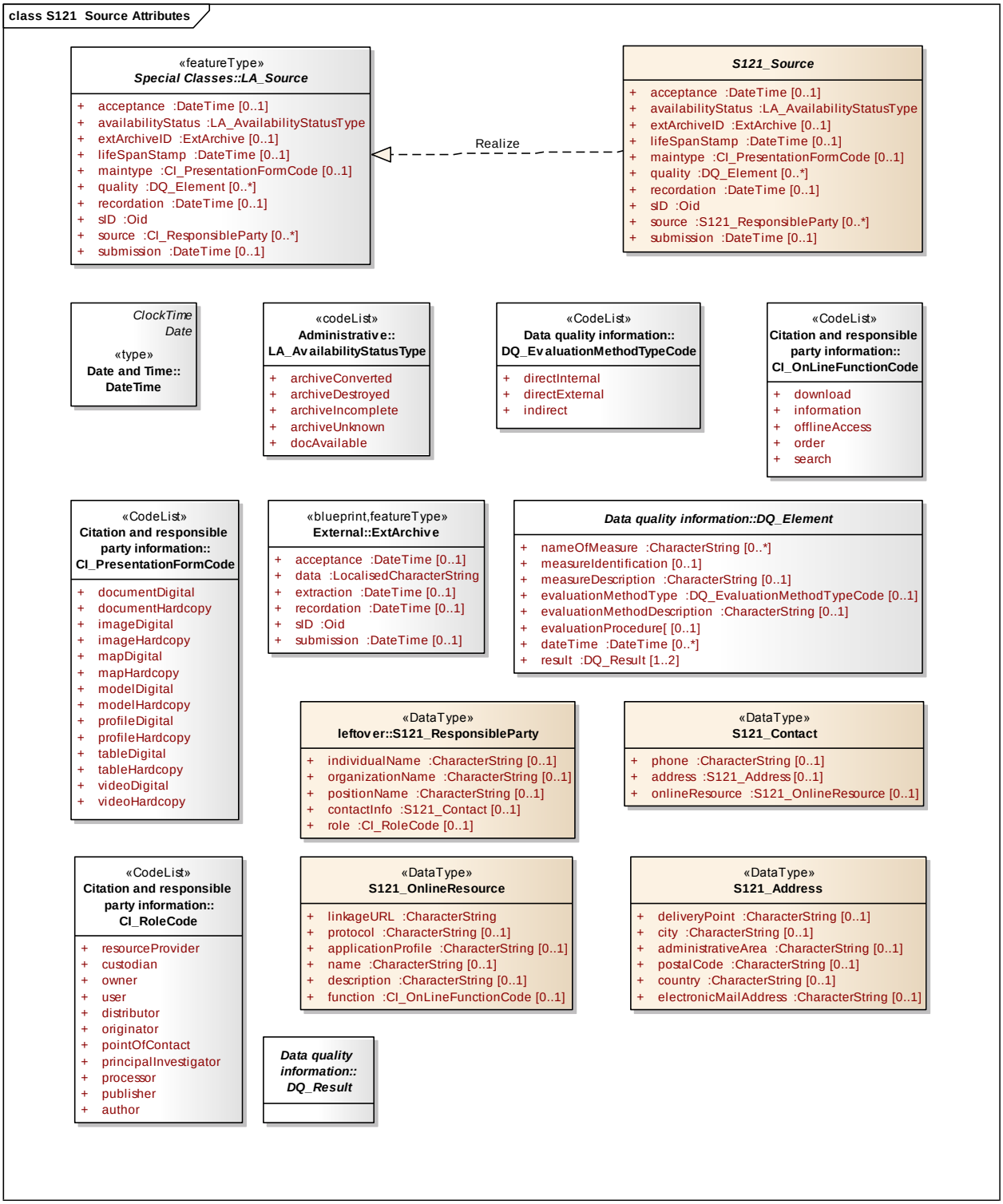


Figure E9 – S121_Source Attributes

Party Unit Package

A party is **"**a person or organization that plays a role in rights[6]**".** A Party is considered as an object. ISO 19152 has a Party model that allows for the establishment of groups as well as individual parties as individual objects. This is shown in Figure 10 which is based on the model in ISO 19152.

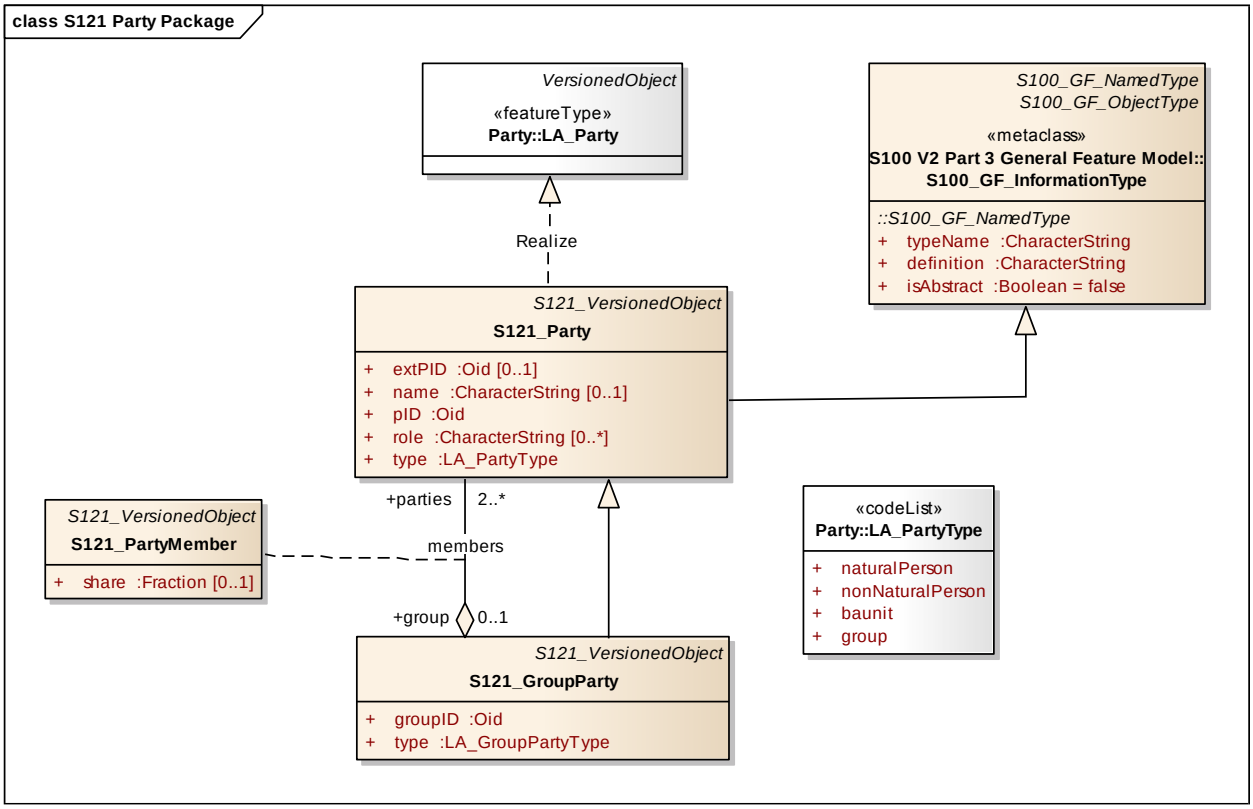


Figure 10- S121 Party Package

ISO 19152 states that **"**The basic class [is] LA_Party (with party as an instance). LA_Party has a specialization: LA_GroupParty (with group party as an instance). Between LA_Party and LA_GroupParty there is an optional association class: LA_PartyMember (with party member as an instance). … A group party, being a specialization of party, is also a party." This means that the aggregation relationship between S121_LA_Party and S121_LA_GroupParty in Figure 10 creates group parties with (registered) parties as constituents. An individual may be a member of a group, and a group as a whole can be treated as a party. Every party, being a constituent of a group party, may then be registered as a party member of class LA_PartyMember.[7]" This structure allows instances of individuals and groups to be uniquely identified. The S121_PartyMember class is effectively an optional attribute on the relationship of membership (members).

The relationship between Parties, Group Parties, Rights, Restrictions and Responsibilities and feature objects (S121_ BAUnit) is by reference through the *Oid* (Object ID).

RRR Administrative Package

ISO 19152 defines an administrative package that associates parties with BA_Units. Most of this package also applies to S-121 (and also to Marine Cadastre and a Marine Spatial Data Infrastructure).

An aggregate class LA_RRR is defined in ISO 19152 that has three specializations.

[6] ISO 19152 LADM clause 4.1.13

[7] ISO 19152 LADM clause 5.3

1. LA_Right, with rights as instances. Rights are primarily in the legal domain. A cadastre may define ownership rights. ISO 19152 provides code lists to support ownership within a national legal structure.
2. LA_Responsibility, with responsibilities as instances.
3. LA_Restriction, with restrictions as instances. Restrictions usually apply to objects independent of the rights; that is, the related party can change and the restriction remains.

Rights, responsibilities and restrictions appear as attributes for an S121_BA_Unit. These are subtypes of the collection class S121_RRR. In the S121 model these classes are realizations of the ISO 19152 RRR classes.

In the ISO 19152 Land Administration Domain Model there are code lists which assign type to the rights, responsibilities and restrictions classes. These are land oriented types. For the marine environment these code lists have been generalized to be replaced with code lists specialized to the marine environment.

Note: These code lists are currently generic and the contents need to be defined as part of the S-121 project development. Code lists are used, rather than character strings in order to ensure consistency. This is a requirement from ISO 19152.

Also classes particularly aimed at Land Cadastre applications (such as mortgage) have not been expressed in the model. Since this is a realization, any of the ISO classes could be introduced into the S-121 (or Marine Cadastre) model if they are needed.

These objects are subtypes of the S100_GF_InformationType. This is a preferable structure to introducing rights, responsibilities and restrictions as attributes of feature objects. Feature objects may point to the appropriate information objects using the *Oid* (Object ID) attribute. For example if a particular restriction applies to a fishing zone, then all features that invoke the restriction would point to the information object that establishes that restriction. If the restriction is changed it only needs to be changed once, not through the attributes in possibly hundreds of feature objects.

Figure 11 shows the S121 Administrative Rights, Responsibilities and Restrictions:

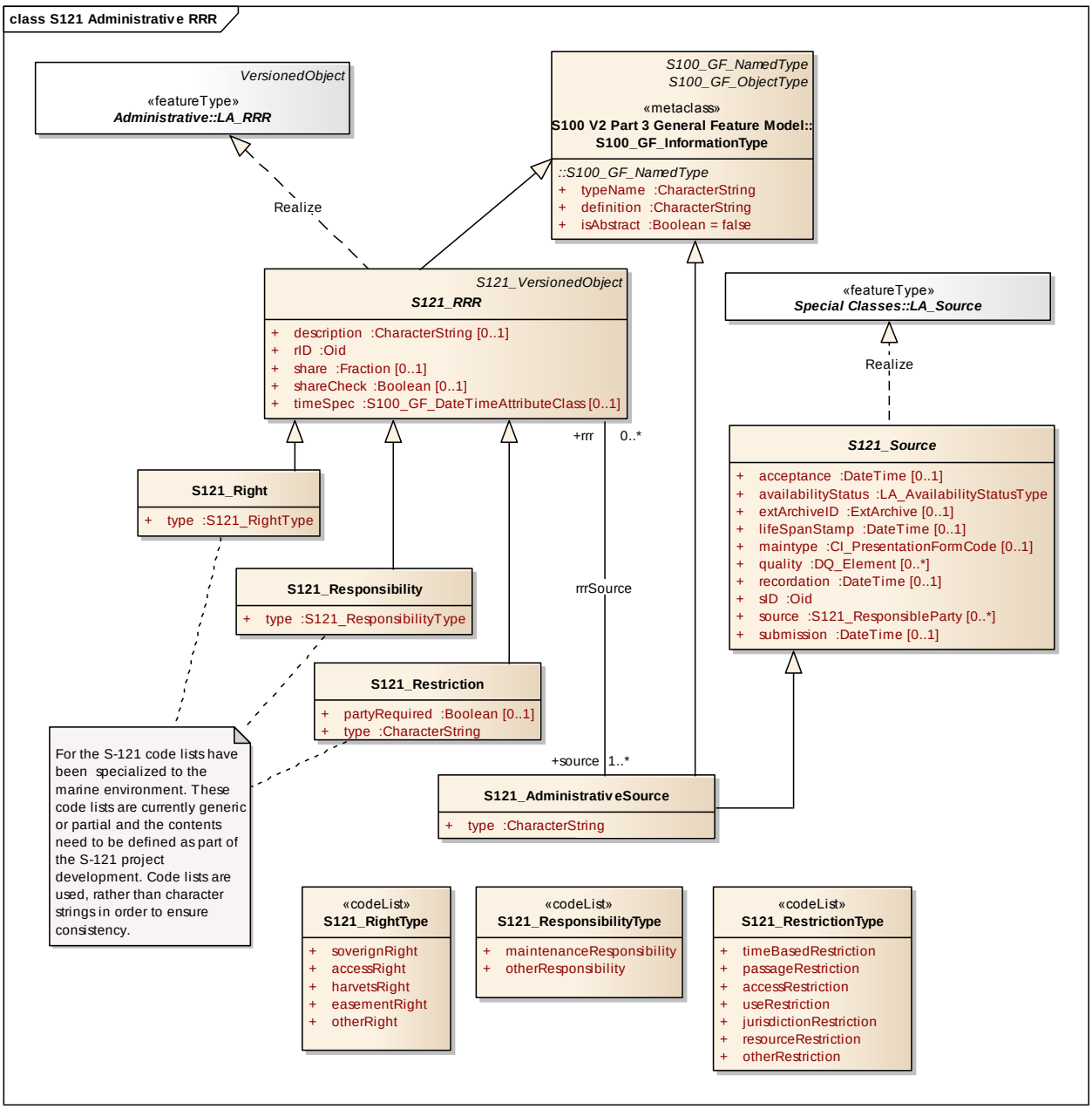


Figure 11 - RRR Administrative Package

RRR Structure

Figure 12 shows the combined structure of the attribute classes realized from the ISO 19152 LADM model. The Rights, Responsibilities and Restrictions provide guidance on how to define attributes that are included in the Feature Catalogue attributes as described in Figure 2. Each Right, Responsibility, and Restriction will be included in the Feature Catalogue as a separate simple or complex attribute.

The S121_Party and S121_GroupParty are non-spatial objects which are extensions beyond S-100. The S121 Party classes are not features and do not need to be included in the Feature Catalogue. Individual parties are identified by the attribute values of the party classes.

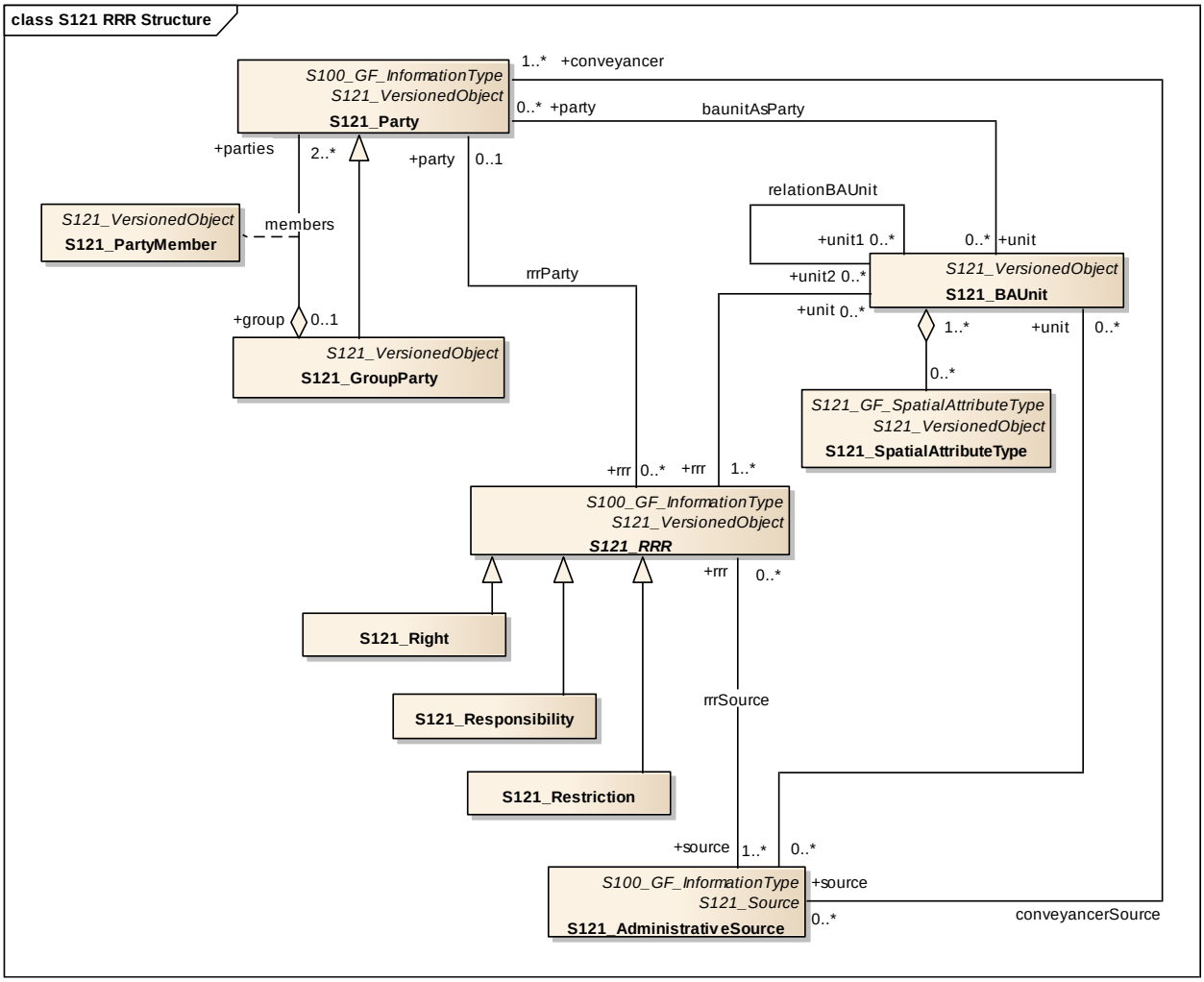


Figure 12- S121 Party and RRR Structure

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. This object has been realized from ISO. The optional quality and source attributes are not inherited.

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; however, whole ENC data product would be versioned. Versioned and non-versioned objects may be combined. A particular Product Specification would incorporate versioning by using the classes identified in Figure 13, which shows the S121 objects that inherit the versioning attributes.

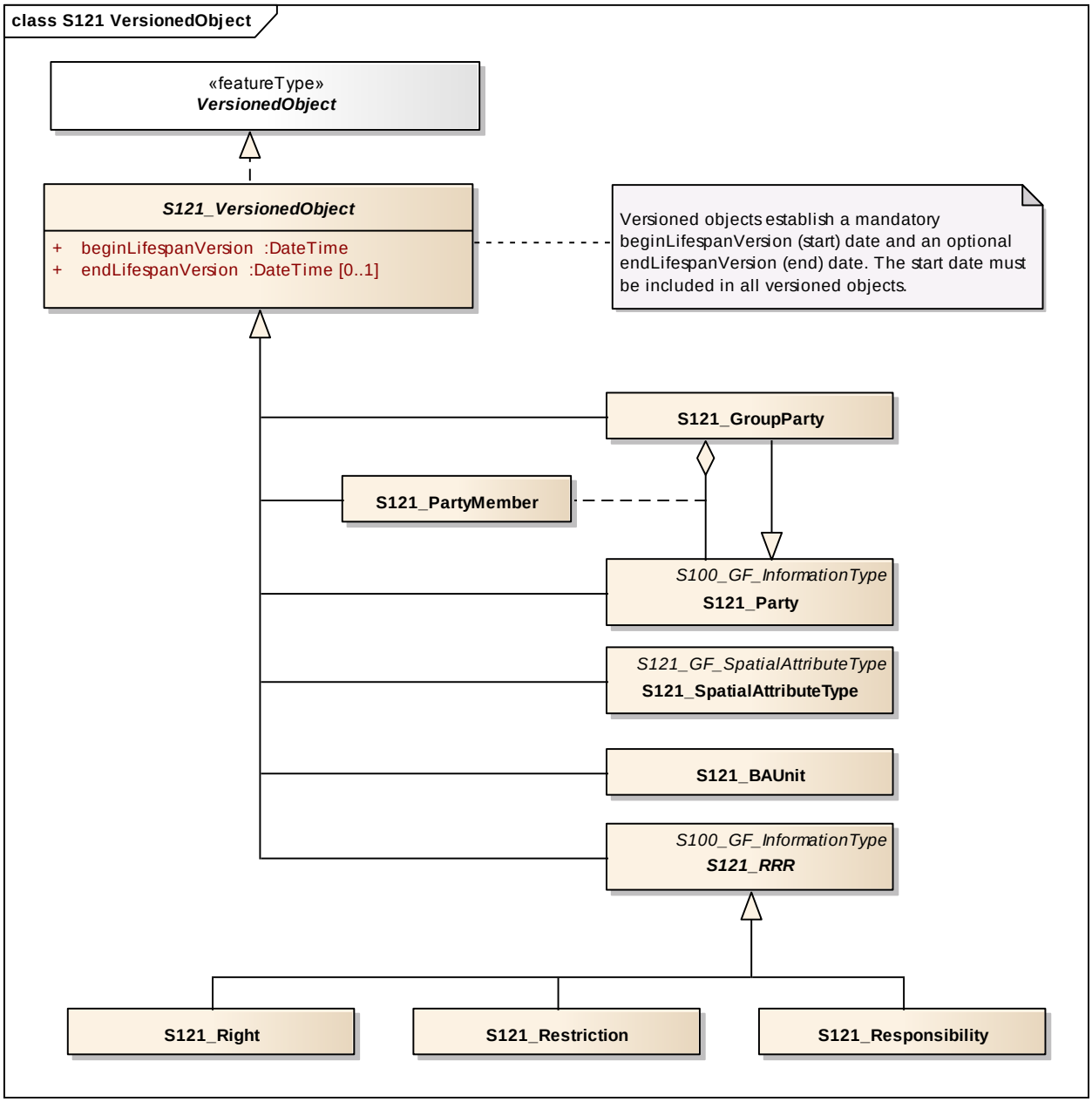


Figure 13- Versioned Objects

Using the LADM Conceptual Model

ISO 19152 is a conceptual model standard. It provides elements that can be used in other standards such as the IHO S-100 standard series to structure data so that communities of interest can communicate using a shared vocabulary. ISO 19152 reflects the social relationship regarding rights, restrictions and responsibilities to a geographic area. This allows legal rights to be expressed.

The implementation of the S121 Party Unit Package and the S121 RRR Administrative Package is done through the use of information objects. These information objects correspond to the classes in the S121 Party Unit Package and the S121 RRR Administrative Package. Each has an object identifier (Oid) so that it can be referenced. This means that for example an S121_RRR versioned object can reference an S121_Party through a pointer implementing the rrrParty relationship (see Fig 13). The other relationships between Party and RRR objects implemented as pointers

between information objects are members relating an S121_Party to an S121_GroupParty, rrrSource relating an S121_RRR information Object to an S121_AdministrativeSource information object and conveyancerSource relating a S121_Party information Object to an S121_AdministrativeSource information object.

These elements are implemented as information objects for two reasons. First of all, the fact that Rights, Responsibilities and Restrictions are information objects allows for the multiplicity available in the ISO 19152 conceptual model. A Feature Type, represented as an S121_BAUnit can reference any number of Rights, Responsibilities and Restrictions or Parties. Also Rights, Responsibilities and Restrictions and Parties can be shared. The same right can apply to many objects. If a restriction changes a new version of the S121_Restriction object can be generated and all of the objects that pointed to the old version of the restriction can be updated together.

Figure 14 shows an example of an information object for the Territorial Sea together with the attribute jurisdiction which is a Right. The Right object references Canada as a Party.

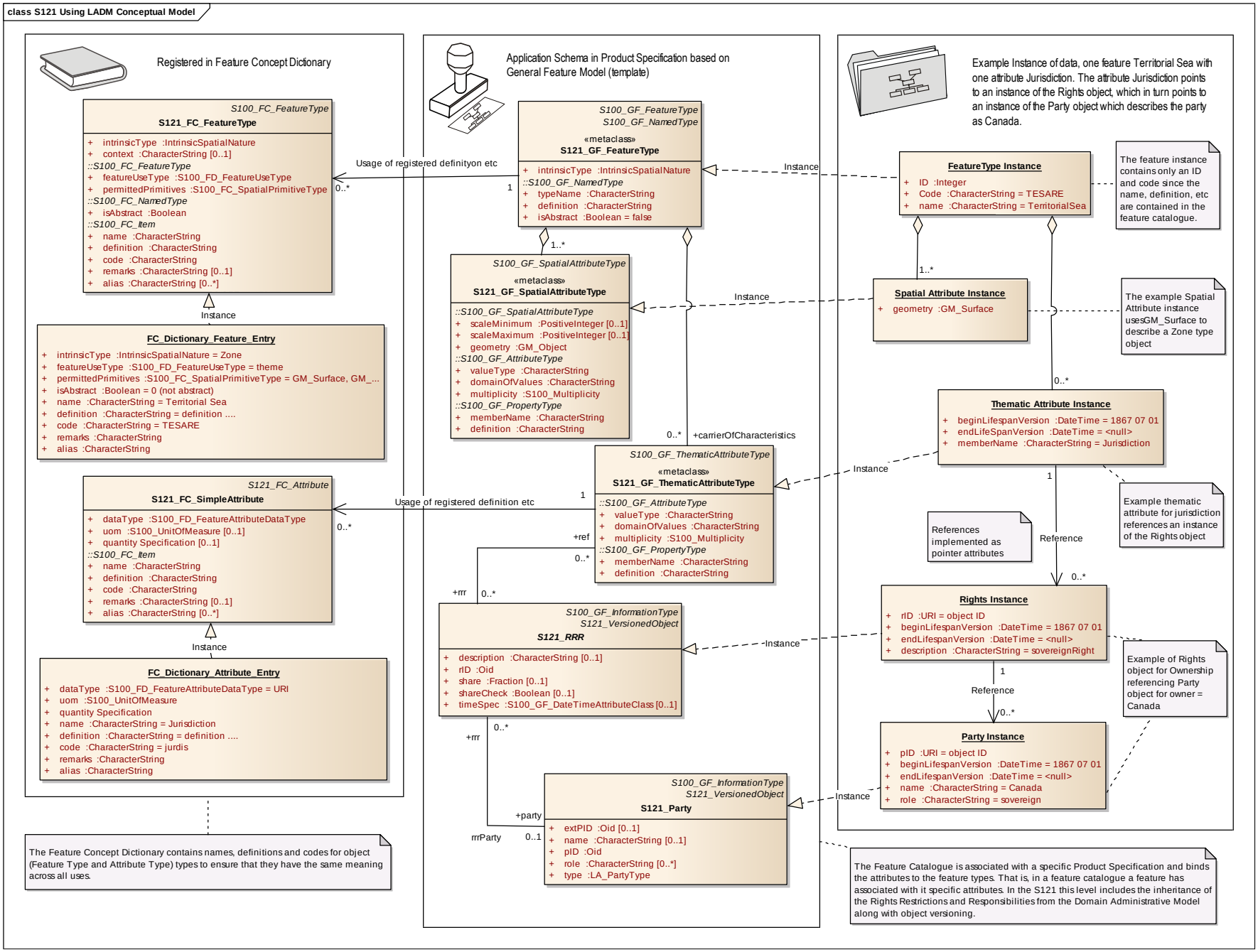


Figure 14- Example of Attribution using RRR

Summary

S-121 is a proposed IHO product specification built upon the Object Oriented structure of S-100 to address MLBs. The S-121 standard is being developed through cooperation between Canada and Australia and will be presented to the IHO for review. The concepts developed form the basis of the S-121 proposal.

Elements defined in S-121 may be used in navigational products such as S-101, even though the MLBs are a separate context area from navigation.

There is an underlying complexity unique to MLBs since they represents state sovereignty and associated jurisdiction, and are the foundation on which marine management relies. The MLBs requires:

- Precise computation
- Accurate portrayal
- Clear definition
- Proper attribution
- Flexible standard

S-121 defines several objects in complete compliance with the General Feature Model defined in the IHO S-100 standard. These features have their definitions contained in the Feature Catalogue Register and the details and binding defined in a Product Specification.

This model is as flexible as the base S-100 model. The flexibility is intended to allow for the direct expression beyond just MLBs to handle any UNCLOS objects or any UNCLOS composed objects.

The intrinsic type of the objects drives the attribution and preserves object logical integrity. As a result, a feature object describing the territorial sea (a zone) could not be used to define the territorial sea outer limit (a Limit), as these have intrinsically two different natures and should have different and specific attributes.

The architecture of S-121 is fundamentally defined by the structures taken from S-100, ISO 19152 LADM and the concept of intrinsic type. The basic structure of the model is there. What is required is a detailed analysis of each object type and each attribute type to determine how the binding between objects and attributes will occur. A major principle is to keep the implementation level of the standard simple so that all countries can implement the minimum level without difficulty.

Figure 15 is an example showing the Canada US border between Maine and Quebec with the boundary shown separating two zones where the zone on the left is associated with the information object “Right” with the type Sovereign Right, and the associated party Canada and the Province of Quebec, and the zone on the right is associated with the information object “Right” with the type Sovereign Right, and the associated party USA and the State of Maine.

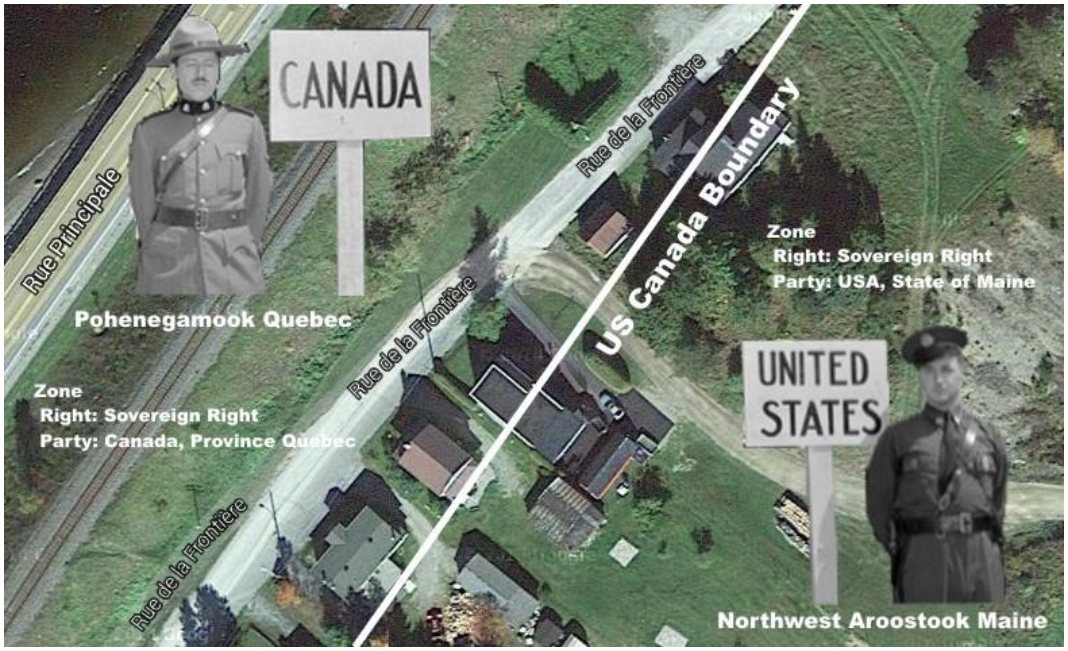


Figure 15- Boundary with Attribution using RRR

Further work is needed on the architectural binding, and on the implementation of the feature catalogue entries and their relation to the objects in the Product Specification.

This document outlines the structure and the plan.

Recommendation

It is recommended that IHO adopt the use of the ISO 19152 LADM as the mechanism for representing legal and sovereign rights attributes using the Rights, Restrictions, Responsibilities and Parties approach in the manner described in this document.

Action Required of HSSC

The HSSC has previously agreed to the creation of the S-121 Working Group on Marine Limits and Boundaries.

1. The HSSC is requested to agree with the activation of the S-121 WG.
2. The S-100 WG (previously TSMAD) has already allowed for the inclusion of multiple themes within the IHO Register. The HSSC is requested to endorse the integration of these other applications domain such as S-121 at this time within the associated IHO registers and dictionaries. Their proper management and maintenance is key to ensuring the cohesions and interoperability between the S-100 based standards.
3. The HSSC is requested to agree to create an MLB domain theme within the IHO Register to support the S-121 standard. Currently the themes (Hydro, NPUBS, ICE, MIO, InlandENC, PENC, AIS, AtoNs, VTS, and WXO) are defined. This would add the theme MLB. In the future other themes will be required to address other areas such as Marine Protected Areas MPA, and Marine Cadastre MC.
4. The S-100 WG is requested to add "context" as a field in the Feature Concept Dictionary. Currently some features such as TESARE (Territorial Sea) are defined in the HYDRO theme. These objects also have use in the MLB theme. The "Context" field in the Feature Concept Dictionary can be used to identify the difference in meaning between entries the FCD that have varying meanings in different contexts.
5. The HSSC is requested to support the use of the ISO 19152 LADM standard as the basis of the attribute definitions in S-121.

Note: Changes to the FCD to support S-121 (and other contexts) can be done in the next version of S-100 (i.e. V3)