# Considerations for S-121
Marine Limits and Boundaries

Origins of S-100

- The original S-57 was a standard for the exchange of a fixed set of hydrographic data between nations.

- In S-57 version 3 it was extended to support the Electronic Nautical Chart Product and became a rigid ENC specification.

- S-100 reintroduced the ability to support all types of hydrographic data with ENC (S-101) as one product specification.

- S-100 is built upon the ISO TC211 suite of Geographic Information Standards.

- S-100 inherits classes from ISO TC211 and establishes a set of registers (in a Registry) that support different product specifications.

- Each product specification has its own Application Schema.
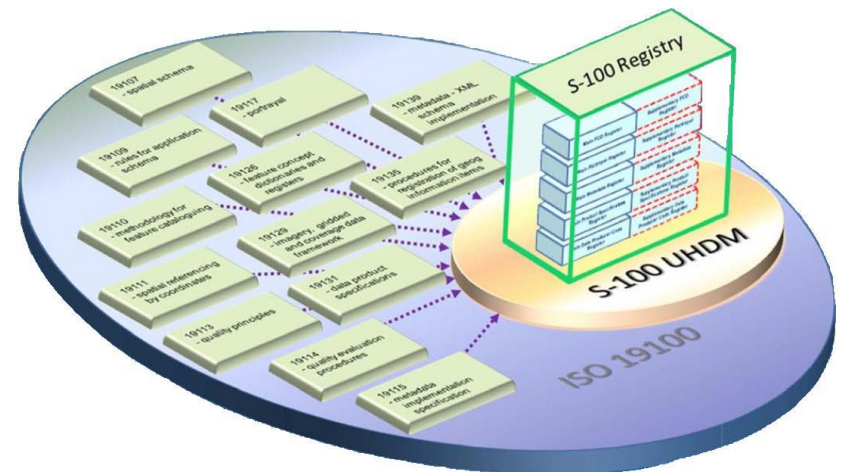
S-100 as a Base

- S-100 is the necessary base for all IHO standards. All IHO product specifications must use, realize, instantiate or extend the base classes in S-100.

- S-121 may make use of other sources for information structures but it must use the S-100 Feature Concept Dictionary and S-100 General Feature Model (which derive from the ISO FCD and ISO GFM).

Marine Cadastre context

eNavigation context

Maritime Limits and Boundaries context
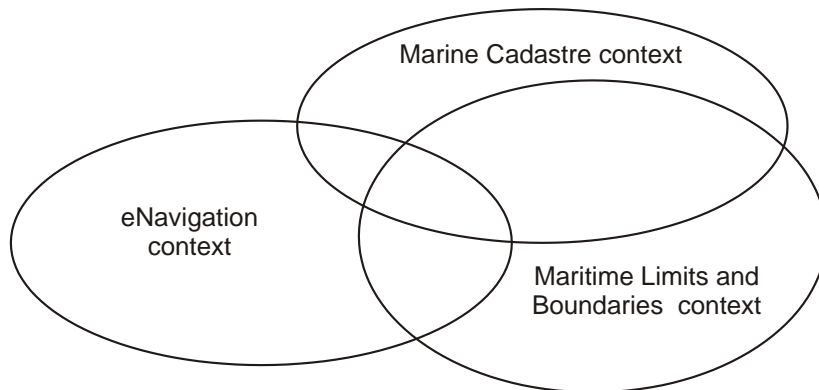
- This is required if S-121 data is to interwork with any other IHO product sets.

- There are a number of separate contexts which overlap.

- It is expected that a Marine Cadastre will make use of MLB objects.

Context Independent Objects

- The ISO standard 19101 defines a feature as an "abstraction of real world phenomena".
- A feature object is established by its definition which is based on the true physical nature of the real world phenomena.
- 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 the Territorial Sea, 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,
                                      limit,
                                      zone or
                                      volume.
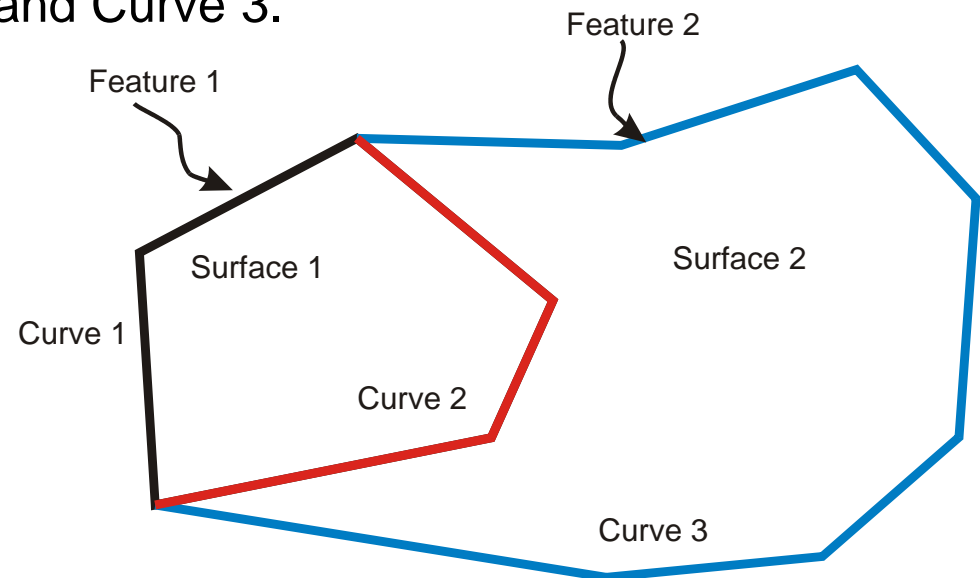
Context for S-121 MLB

Types of Topology

- S-100 is flexible and allows many types of geometry and related topology.

- The four topology types identified in S-57 are:
  - Spaghetti (all edges independent)
  - Chain-Node (edges go from node to node)
  - Planar graph (edges must not cross)
  - Full topology (planar graph with faces)

- The "Skin of the Earth" group or "Layer" has the Planar Graph constraint.

- S-100 allows mixed topologies per ISO 19107.

Context for S-121 MLB

Shared Geometry

- Features are objects that point to the geometric elements that compose them. Depending on the type of topology they may share geometric elements.

    - Feature 1 has the geometric area, Surface 1 and is bounded by Curve 1 and Curve 2.

    - Feature 2 has the geometric area, Surface 2 and is bounded by Curve 2 and Curve 3.

    - Curve 2 is shared.

Context for S-121 MLB

Limited Spatial types in S-100

- The ISO 19107 Spatial Schema standard is extremely flexible. It allows over 50 different spatial primitive types including special types for purposes such as highway construction.

- S-100 deliberately limits the number of primitives available. This makes it easier for portrayal and for the implementation of systems.

- Encoding standards such as GML also limit the number of primitives for encoding purposes.
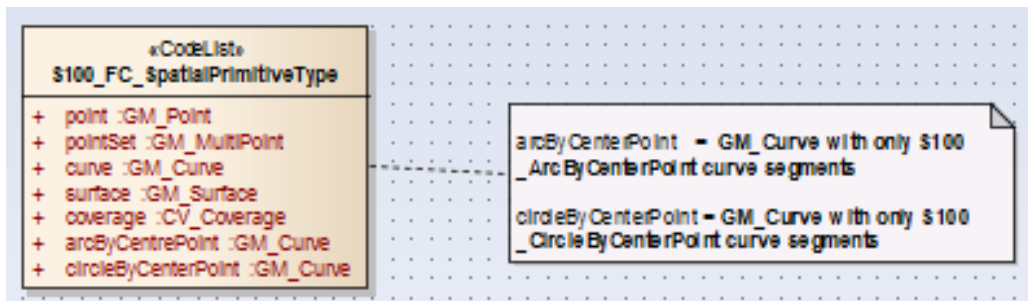
- S-121 can extend the number of primitives it wants to use but in doing so will become incompatible with conventional charting software.

«CodeList»
S100_FC_SpatialPrimitiveType

+ point :GM_Point
+ pointSet :GM_MultiPoint
+ curve :GM_Curve
+ surface :GM_Surface
+ coverage :CV_Coverage
+ arcByCentrePoint :GM_Curve
+ circleByCenterPoint :GM_Curve

arcByCenterPoint = GM_Curve with only S100 _ArcByCenterPoint curve segments

circleByCenterPoint = GM_Curve with only S100 _CircleByCenterPoint curve segments

Purpose of S-121

- The proposal for S-121 identifies two use cases:

  - "to provide a suitable format for the exchange of digital vector data pertaining to maritime boundaries";   and
  - "to be suitable for lodging digital maritime boundary information with the United Nations for purposes related to UNCLOS"

- A third use case that can be identified is to provide official maritime boundary information to support other applications such as boundaries shown on charts and possibly for a Marine Cadastre.

- Australia identified that "digital datasets … should consist of strings of vertices rather than curve types (e.g. geodesics) between turning points".

Use Cases for S-121 MLB

Criteria S-121

- Australian also identified that the exchange format should be simple so that there is no need for specialized software for developing nations to be able to create and maintain their own data sets. This is a strong criteria because some nations may only use the simplest of systems.

- However, the UN, a national government or whatever body is collecting and managing MLB data needs to have a sophisticated management system because the data is legal in nature and sovereign rights are at stake.

- The exchange format used will also need to be widely implemented so that special tools are not required.

Structure of S-121 MLB
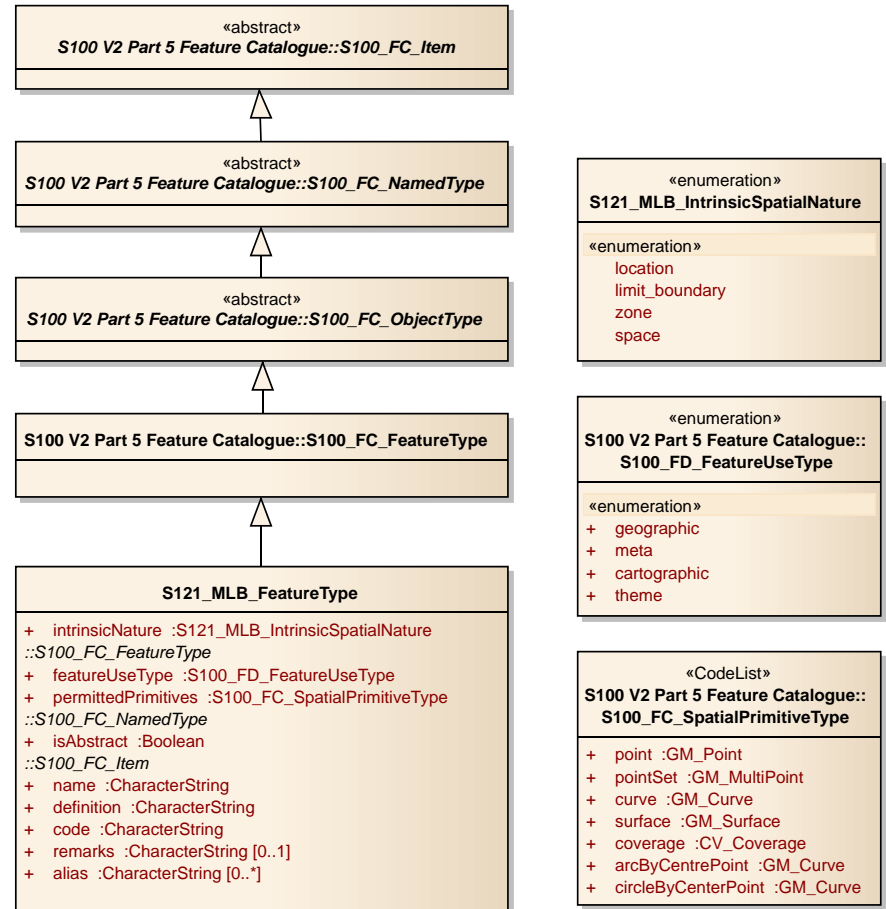
Information and Exchange

- To satisfy these requirements there needs to be a flexible model that can be used in both a simple and a sophisticated way.

- There needs to be two levels, an information model and an exchange model. This follows the basic premise of ISO TC211 of the separation of the "carrier from the content".

- The information model is the basis, and several exchange models may be used.

- Simple exchange model that may be used are:
    - GML (structured for easy display and interpretation)
    - KML (easy display and an overlay on an existing map)
    - XML (can be read into a simple tool such as a spread sheet)
    - TDF (Tab delimited file – very very simple)
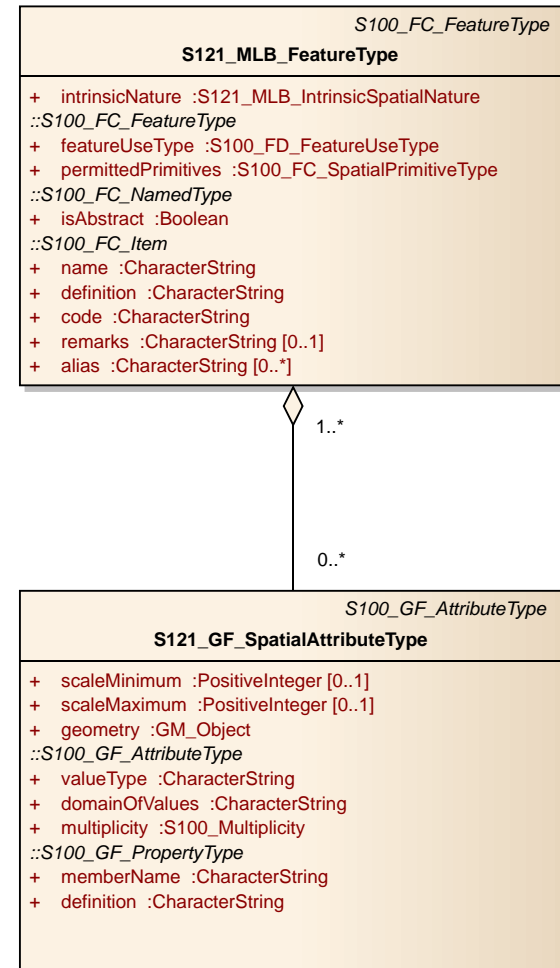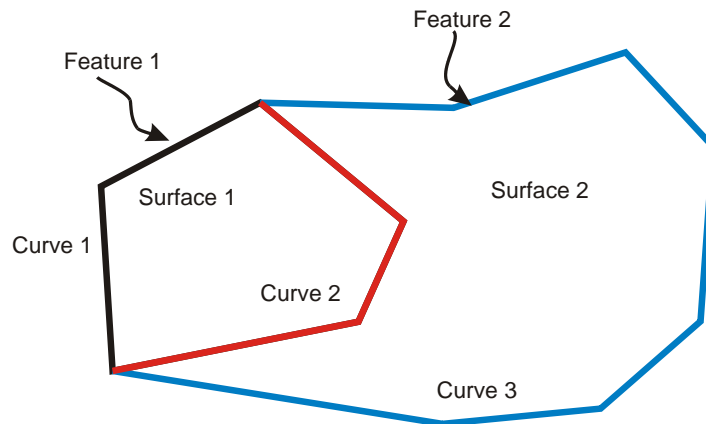
Structure of S-121 MLB

Information Model

- The exchange format carries the information defined in the information model. What is important is to have a simple information model.

- The information model needs to derive from S-100. This means that we will have a feature with spatial attributes.

- The attribute intrinsicNature enforces the intrinsic type and is the only thing added beyond S-100.

«abstract»
S100 V2 Part 5 Feature Catalogue::S100_FC_Item

«abstract»
S100 V2 Part 5 Feature Catalogue::S100_FC_NamedType

«abstract»
S100 V2 Part 5 Feature Catalogue::S100_FC_ObjectType

S100 V2 Part 5 Feature Catalogue::S100_FC_FeatureType

S121_MLB_FeatureType

+ intrinsicNature :S121_MLB_IntrinsicSpatialNature
::S100_FC_FeatureType
+ featureUseType :S100_FD_FeatureUseType
+ permittedPrimitives :S100_FC_SpatialPrimitiveType
::S100_FC_NamedType
+ isAbstract :Boolean
::S100_FC_Item
+ name :CharacterString
+ definition :CharacterString
+ code :CharacterString
+ remarks :CharacterString [0..1]
+ alias :CharacterString [0..*]

«enumeration»
S121_MLB_IntrinsicSpatialNature

«enumeration»
   location
   limit_boundary
   zone
   space

«enumeration»
**S100 V2 Part 5 Feature Catalogue::
S100_FD_FeatureUseType**

«enumeration»
+ geographic
+ meta
+ cartographic
+ theme

«CodeList»
**S100 V2 Part 5 Feature Catalogue::
S100_FC_SpatialPrimitiveType**

+ point :GM_Point
+ pointSet :GM_MultiPoint
+ curve :GM_Curve
+ surface :GM_Surface
+ coverage :CV_Coverage
+ arcByCentrePoint :GM_Curve
+ circleByCenterPoint :GM_Curve

Structure of S-121 MLB

Information Model + Geometry

- Every feature has a geometry attribute that locates it and gives it shape (in accordance with its intrinsic nature).

- A single feature may have multiple geometric spatial objects bounding it.

- A single spatial object may be shared by one or more features (Shared Geometry).

S100_FC_FeatureType

S121_MLB_FeatureType

+   intrinsicNature :S121_MLB_IntrinsicSpatialNature
::S100_FC_FeatureType
+   featureUseType :S100_FD_FeatureUseType
+   permittedPrimitives :S100_FC_SpatialPrimitiveType
::S100_FC_NamedType
+   isAbstract :Boolean
::S100_FC_Item
+   name :CharacterString
+   definition :CharacterString
+   code :CharacterString
+   remarks :CharacterString [0..1]
+   alias :CharacterString [0..*]

1..*

0..*

S100_GF_AttributeType

S121_GF_SpatialAttributeType

+   scaleMinimum :PositiveInteger [0..1]
+   scaleMaximum :PositiveInteger [0..1]
+   geometry :GM_Object
::S100_GF_AttributeType
+   valueType :CharacterString
+   domainOfValues :CharacterString
+   multiplicity :S100_Multiplicity
::S100_GF_PropertyType
+   memberName :CharacterString
+   definition :CharacterString

Feature 2

Feature 1

Surface 1

Surface 2

Curve 1

Curve 2

Curve 3

- This is the essence of the model and it is completely in line with S-100.

Structure of S-121 MLB

Exchange Model

- The exchange model carries instances of the information model.
- All that is needed is a simple feature class with limited attributes.
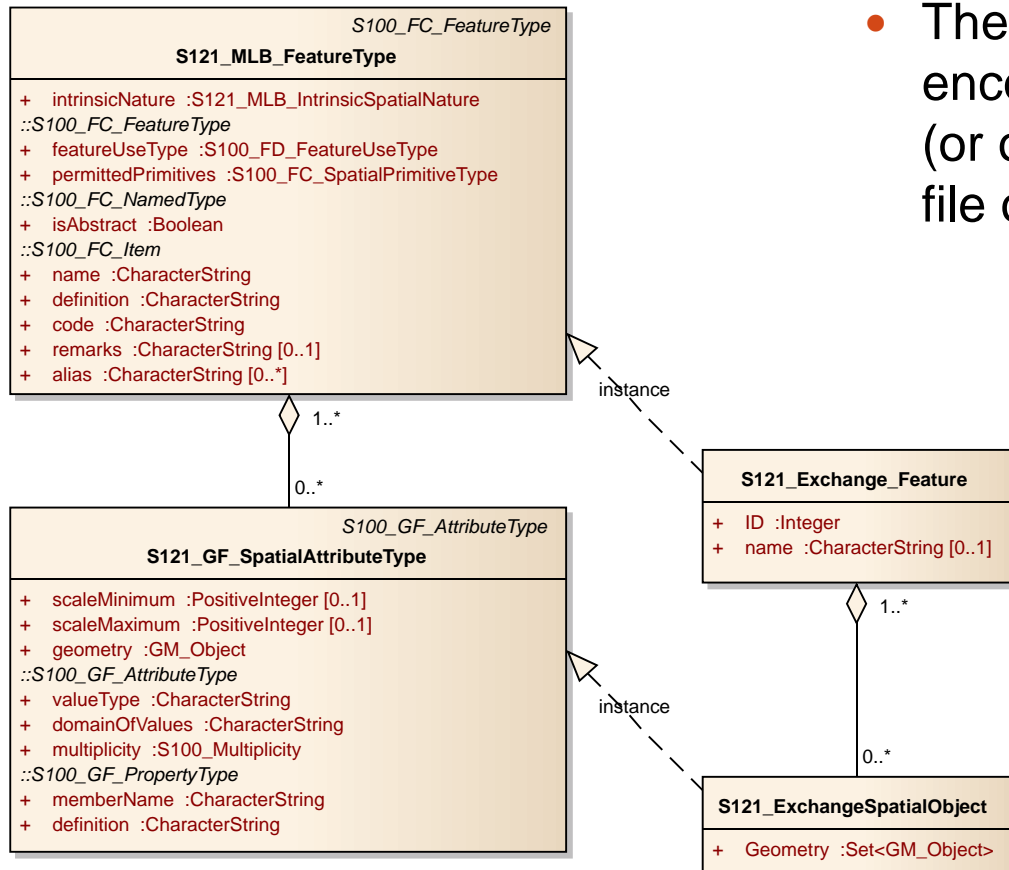
- The exchange objects get encoded in GML, KML, or XML (or other such as ESRI Shape file objects).

Structure of S-121 MLB

Relation to ISO 19152

- The ISO 19152 LADM standard "is interested in rights, responsibilities and restrictions affecting land (or water), and the geometrical (geospatial) components thereof" [ISO 19152 Introduction].

- ISO 19152 "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). It provides an abstract, conceptual model with four packages related to:
  - 1) parties (people and organizations);
  - 2) basic administrative units, rights, responsibilities, and restrictions (ownership rights);
  - 3) spatial units (parcels, and the legal space of buildings and utility networks);
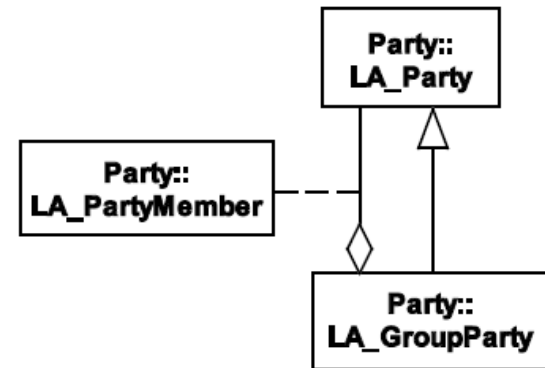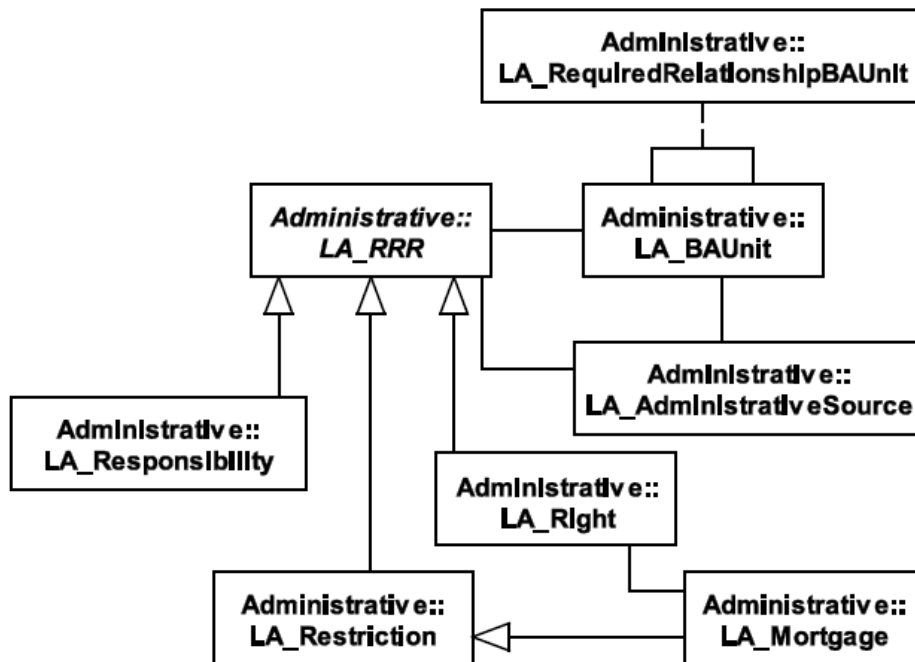 - 4) spatial sources (surveying), and spatial representations (geometry and topology);"
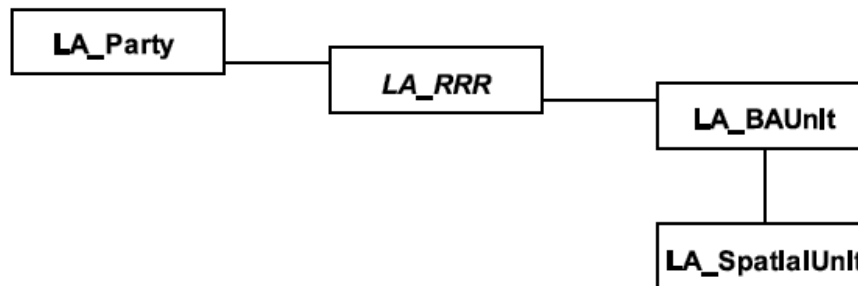
Relation to ISO 19152

- There are several aspects of LADM that are useful in S-121.

- The Administrative Package
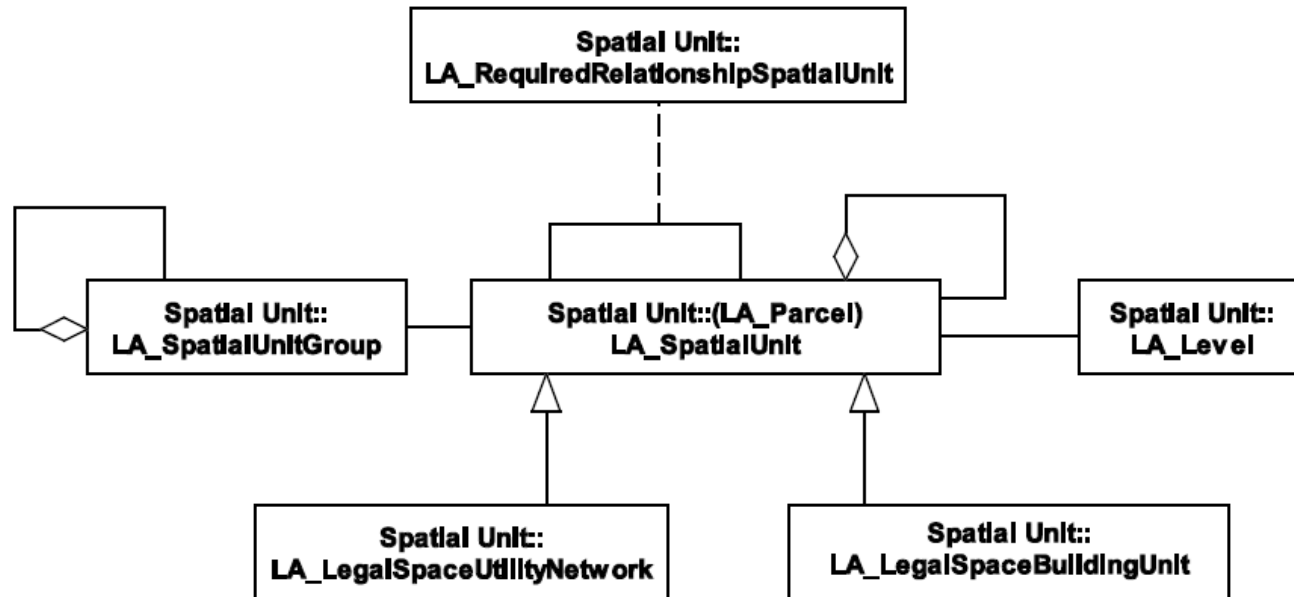
- The Party Model

- New subtypes of the administrative objects are defined to support S-121 requirements.

Structure of S-121 MLB

Relation to ISO 19152

- ISO 19152 LADM has an interesting Spatial Unit Package that allows some structures that will be useful in S-121.

- The trouble is that the 19152 objects do not derive from S-100 and are loosely connected to ISO 19107.
- There are no simple implementations.

Future work

Upcoming miles stones

- Update S-121 IHO Standard Draft
  - Examine object inheritance from ISO 19152 and sub-typing
  - UML Model
  - Information model definition
  - Exchange specifications
  - Use annexes to integrate different marine sectorial uses
  - Prepare revised draft product specification
  - Prepare status report for HSSC
- Generate test examples
  - Canadian and Australian data
  - Integrate other States' data
- Create associated guidelines and recommendations
- Communicate all milestone achievements to the UN
- Deliver draft version 2.0 of S-121 to IHO