

Paper for Consideration by the S-101PT12

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| Submitted by: | SevenCs GmbH, Nautical Dimensions |
| Executive Summary: | <i>In S-100, feature bindings and information bindings are used to model association roles. Inconsistencies were detected in the S-101 FC.</i> |
| Related document(s): | DCEG 1.1.0, DCEG 1.2.0 (Draft), S-101 FC 1.1.0, S-101 FC 1.2.0 (Draft) |
| References: | S-101PT10_2023_07.7_EN_AssociationRolesInTheFC |

Introduction / Background

In S-101, *Information associations* are used to define the relationship between a feature and an information type. Also, *Feature associations* are used to define the relationship between two different features.

Different types of association exist, depending on the nature of the relationship between the two items. Each type of association has a defined code and a name (along with a textual definition). Also specified is the *role* that a partner of such a relationship has.

Examples of S-101 associations:

| | | |
|------------------------------------------|----------------------------|------------------------|
| Information association | | |
| <i>AdditionalInformation association</i> | | |
| Main feature | role | Associated item |
| <i>LateralBuoy</i> | <i>providesInformation</i> | <i>ContactDetails</i> |

| | | |
|---------------------------------------|-----------------|---------------------------|
| Feature association | | |
| <i>StructureEquipment association</i> | | |
| Main feature | role | Associated feature |
| <i>LateralBuoy</i> | <i>supports</i> | <i>LightAllAround</i> |

Feature Bindings and Information Bindings in the Feature Catalogue

In the XML S-101 Feature Catalogue, an individual feature type is basically defined by the following elements:

name
definition
code
attributeBinding
featureBinding
informationBinding
permittedPrimitives

Associations are modelled in the S-101 Feature Catalogue as well. The *featureBinding* and *informationBinding* elements (in **bold**) are used to define the association(s) that a specific feature type can have. In UML, the information within a *featureBinding* or *informationBinding* tag is called an “association end”.

featureBinding FC elements

Multiple instances of the *featureBinding* element (and their sub-elements) are used to describe how relationships between the main feature and other feature types (in UML this is the other *association end*) can be defined. In the following, we use the *StructureEquipment* association as an example.

Each individual *featureBinding* element references the codes of all other feature types that the main feature can have a relationship with. According to the *StructureEquipment* association, the *LateralBuoy* main feature, for instance, can have a relationship to other features of the following types: *Daymark*, *DistanceMark*, *FogSignal*, *LightAllAround*, etc. (see image below).

Lateral Buoy as example: *featureBinding* elements to model a *StructureEquipment* association

```
<S100FC:featureBinding roleType="composition">
  <S100FC:multiplicity>
    <S100Base:lower>0</S100Base:lower>
    <S100Base:upper xsi:nil="true" infinite="true"/>
  </S100FC:multiplicity>
  <S100FC:association ref="StructureEquipment"/>
  <S100FC:role ref="supports"/>
  <S100FC:featureType ref="Daymark"/>
  <S100FC:featureType ref="DistanceMark"/>
  <S100FC:featureType ref="FogSignal"/>
  <S100FC:featureType ref="LightAllAround"/>
  <S100FC:featureType ref="LightEggDetector"/>
  <S100FC:featureType ref="SignalStationTraffic"/>
  <S100FC:featureType ref="SignalStationWarning"/>
</S100FC:featureBinding>
```

role, as the sub-element of the feature binding (called *supports* in this case), provides more information about the nature of the relationship between two associated items and how they interact - one of them *supports* (i.e. carries) the other one.

| StructureEquipment association (featureBinding) | | |
|--------------------------------------------------------|-----------------|---------------------------|
| Main feature | role | Referenced feature |
| <i>LateralBuoy</i> | <i>supports</i> | <i>LightAllAround</i> |

informationBinding FC elements

Multiple instances of the *informationBinding* element (and their sub-elements) are used to describe how relationships between the main feature and information types can be defined. In the following, we use the *AdditionalInformation* association as an example.

Each individual *informationBinding* element references the codes of all information types that the main feature can have a relationship with. According to the *AdditionalInformation* association, the *LateralBuoy* main feature, for instance, can have a relationship to the *ContactDetails* and *NauticalInformation* information types respectively (see image below).

Lateral Buoy as example: *informationBinding* element to model an *AdditionalInformation* association

```
<S100FC:informationBinding roleType="association">
  <S100FC:multiplicity>
    <S100Base:lower>0</S100Base:lower>
    <S100Base:upper xsi:nil="false" infinite="false">1</S100Bas
  </S100FC:multiplicity>
  <S100FC:association ref="AdditionalInformation"/>
  <S100FC:role ref="providesInformation"/>
  <S100FC:informationType ref="ContactDetails"/>
  <S100FC:informationType ref="NauticalInformation"/>
</S100FC:informationBinding>
```

role, as the sub-element of the information binding (called *providesInformation* in this case), explains the nature of the relationship between two associated items and how they interact - one of them *providesInformation* about the other one.

| AdditionalInformation association (informationBinding) | | |
|---------------------------------------------------------------|----------------------------|---------------------------|
| Main feature | role | Referenced feature |
| <i>LateralBuoy</i> | <i>providesInformation</i> | <i>ContactDetails</i> |

Analysis/Discussion

As described above, the S-101 Feature Catalogue uses the *featureBinding* element and the *informationBinding* element. It does this to model associations between the main feature and the referenced items (i.e. other features or information types), and to state the association role. However, it is not clear whether the *role* is supposed to define the function of the main feature or define the function of the referenced feature.

If we look at the above examples again, when comparing the FC definitions an inconsistency between *featureBindings* and *informationBindings* can be detected.

| StructureEquipment association (featureBinding) | | |
|--------------------------------------------------------|-----------------|------------------------|
| Main feature | role | Referenced item |
| <i>LateralBuoy</i> | <i>supports</i> | <i>LightAllAround</i> |

Here the role apparently belongs to the **Main feature**: *LateralBuoy* supports *LightAllAround* (to correctly understand what is intended, the reader reads from **left to right**).

| AdditionalInformation association (informationBinding) | | |
|---------------------------------------------------------------|----------------------------|------------------------|
| Main feature | role | Referenced item |
| <i>LateralBuoy</i> | <i>providesInformation</i> | <i>ContactDetails</i> |

By contrast, in this example the role belongs to the **Referenced item**: *ContactDetails* *providesInformation* for *LateralBuoy*

(to correctly understand what is intended, the reader reads from **right to left**).

The same inconsistency can be found in the Data Classification and Encoding Guide (DCEG 1.1 and DCEG 1.2)

| <p>IHO Definition: STRUCTURE/EQUIPMENT. A feature association for the binding between a navigation aid equipment feature and the structure that supports it.</p> <p>Remarks:</p> <ul style="list-style-type: none"> • A Structure/Equipment composition binds a single “Supported by” feature to at least one “Supports” feature. | | | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Role Type | Role | Associated With | Multiplicity |
| Composition | Supported by | Bridge, Building, Crane, Cardinal Beacon, Cardinal Buoy, Conveyor, Dolphin, Emergency Wreck Marking Buoy, Fishing Facility, Floating Dock, Fortified Structure, Hulk, Installation Buoy, Isolated Danger Beacon, Isolated Danger Buoy, Landmark, Lateral Beacon, Lateral Buoy , Light Float, Light Vessel, Mooring Buoy, Offshore Platform, Pile, Pipeline Overhead, Pontoon, Pylon/Bridge Support, Safe Water Beacon, Safe Water Buoy, Shoreline Construction, Silo/Tank, Span Fixed, Span Opening, Special Purpose/General Beacon, Special Purpose/General Buoy, Wind Turbine, Wreck | 0,1 |
| | Supports | Daymark, Distance Mark, Fog Signal, Light All Around , Light Fog Detector, Physical AIS Aid to Navigation, Radar Transponder Beacon, Retroreflector, Signal Station Traffic, Signal Station Warning | 0,* {1,* [C]} |

Lateral Buoy Supports Light All Around

In this example the role (*Supports*) belongs to the item in the **previous row** of the table (*Lateral Buoy*).

| <p>IHO Definition: ADDITIONAL INFORMATION. A feature association for the binding between at least one instance of a geo feature and an instance of an information type.</p> <p>Remarks:</p> <ul style="list-style-type: none"> • The features comprising an Additional Information association must include at least one of any of the geo features included in the following lists associated to one or more of the corresponding information types. | | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Role Type | Role | Associated With | Multiplicity |
| Association | Provides information | Contact Details, Non-Standard Working Day, Service Hours, Nautical Information | 0,1 |
| | | Airport/Airfield, Anchor Berth, Anchorage Area, Berth, Bridge, Building, Checkpoint, Coast Guard Station, Conveyor, Crane, Dock Area, Dry Dock, Floating Dock, Gate, Helipad, Landmark, Lock Basin, Mooring Area, Production/Storage Area, Radio Calling-In Point, Runway, Seaplane Landing Area, Span Fixed, Span Opening | 0,* {1,* [C]} |
| Role Type | Role | Associated With | Multiplicity |
| Association | Provides information | Contact Details , Nautical Information | 0,1 |
| | | Administration Area, Cable Area, Cable Overhead, Cable Submarine, Cardinal Beacon, Cardinal Buoy, Daymark, Dolphin, Emergency Wreck Marking Buoy, Fishing Facility, Fog Signal, Harbour Area (Administrative), Harbour Facility, Installation Buoy, Isolated Danger Beacon, Isolated Danger Buoy, Land Region, Lateral Beacon, Lateral Buoy , Light All Around, Light Float, Light Sector, Light Vessel, Marine Farm/Culture, Mooring Buoy, Mooring Trest, Offshore Platform | 0,* {1,* [C]} |

Contact Details Provides information [for] Lateral Buoy

In this example the role (*Provides information*) belongs to the item in the **same row** of the table (*Contact Details*).

Role names

During the analysis of the problem the author recognized that the syntax of role names is not consistent (*provides information; defines, defined for; updates, identifies; positions, identifies; component of, consists of; has auxiliary, auxiliary to*). Currently role names do not follow a defined convention - they are formed by different kinds of verb types (intransitive, transitive, linking, or passive verbs) or nouns. This is a potential source of confusion during the implementation process.

The introduction of a naming convention for role names (nouns only) is proposed in a separate paper.

Conclusions

There are inconsistencies in the modelling of roles in the S-101 Feature Catalogue and in the DCEG. There are instances where the role belongs to the main feature type and others where the role belongs to the referenced feature type.

This makes it impossible for applications to automatically correctly interpret how associated items are related to one another and how they should interact. There is a risk that implementations lead to wrong results.

It is worth mentioning, that in UML, the information within a `featureBinding` or `informationBinding` tag is called an "association end". The association end contains the related feature and the role of the related feature.

Recommendations

It is recommended that the S-101 Feature Catalogue and the DCEG are reviewed, to detect all cases where association roles are incorrectly defined, and that all inconsistencies are fixed. For *featureBinding* and *informationBinding* elements, the referenced `featureType` or `informationType` and the role need to refer to the same association end.

Action Required by the S-101 PT

The S-101PT is invited to:

- a. Note this paper.
- b. Discuss the paper.
- c. Take action to correct the errors and update S-101 accordingly.