S101 PT-INF3

Paper for Consideration by S-100 WG TSM8

Roles in Feature Catalogues

Submitted by:	S-101 PT
Executive Summary:	Clarification of the use of association roles in Feature Catalogues.
Related Documents:	S-100 maintenance proposal
Related Projects:	S-100; S-101, S-122, and other product specifications that use feature associations

Introduction / Background

Feature catalogues developed to date may not properly designate the type of an association end, for example, which of the two objects in a composition is playing the role of "containee" and which is playing the role of "container." For example, in the S-100 1.0.0 Feature Catalogue, the TrafficSeparationSchemeAggregation feature bindings use the same role type in both feature bindings.

In TrafficSeparationScheme:

```
<S100FC:featureBinding roleType="aggregation">
  <S100FC:multiplicity>
    <S100Base:lower>0</S100Base:lower>
    <S100Base:upper xsi:nil="true" infinite="true"/>
  </S100FC:multiplicity>
  <S100FC:association ref="TrafficSeparationSchemeAggregation"/>
  <S100FC:role ref="consistsOf"/>
  <S100FC:featureType ref="TrafficSeparationSchemeLanePart"/>
</S100FC:featureBinding>
```

In TrafficSeparationSchemeLanePart:

```
<S100FC:featureBinding roleType="aggregation">
  <S100FC:multiplicity>
    <S100Base:lower>0</S100Base:lower>
    <S100Base:upper xsi:nil="false" infinite="false">1</S100Base:upper>
  </S100FC:multiplicity>
  <S100FC:association ref="TrafficSeparationSchemeAggregation"/>
  <S100FC:role ref="componentOf"/>
  <S100FC:featureType ref="TrafficSeparationScheme"/>
</S100FC:featureBinding>
```

In the above case, systems need to hard code the determination of which class is "container" and which "containee" based on the value of Role (e.g., consistsOf/componentOf, supports/supportedBy, etc.). This does not follow the guidance of S-100, and requires additional product-specific coding or data files. Adding new roles to the feature catalog will require software updates under this regime.

Feature catalogues affected by this issue should be corrected.

Further, S-100 4.0.0 clauses 5-4.2.5.2 (Feature Bindings) and Table 5a-19 should be clarified to ensure that the role type is properly coded in feature catalogues.

References

ISO 19110:2005, Geographic Information – Methodology for feature cataloguing.

Discussion/Analysis

Clarification of Clause 5-4.2.5.2

For machine readability, the role type in feature catalogues should indicate which end has the aggregation/composition and which end is the simple association.

While S-100 clause 5-4.2.5.2 (reproduced below) does require that the role types at opposite ends of aggregations and compositions are different, this clause is inconsistent. It appears to require that the feature catalogue give the name and multiplicity of one end of the relationship together with the role type of the other.

5-4.2.5.2 Feature Bindings

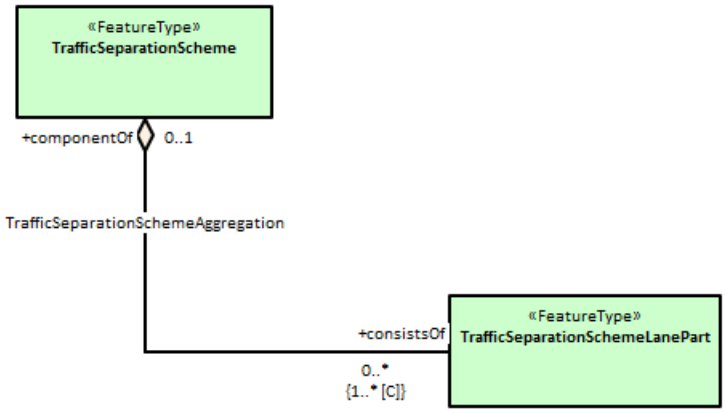
The feature binding describes the association between two feature types. Both the feature association and the association role are specified together with the target feature type. Furthermore the Multiplicity and the role type are defined. The latter describes the nature of the role.

EXAMPLE The role 'Lane' used by a traffic separation scheme to associate its lane parts will have the role type Aggregation, whereas the role "Scheme" used from the lane part to the TSS has the role type Association.

This clause should be clarified to:

- correct the wording so that the name, multiplicity, and role type are mutually consistent;
- add examples of UML diagrams and feature bindings in feature catalogues.

The example UML diagram is below:



The example:

In TrafficSeparationScheme:

```
<S100FC:featureBinding roleType="association">
  <S100FC:multiplicity>
    <S100Base:lower>0</S100Base:lower>
    <S100Base:upper xsi:nil="true" infinite="true"/>
  </S100FC:multiplicity>
  <S100FC:association ref="TrafficSeparationSchemeAggregation"/>
  <S100FC:role ref="consistsOf"/>
  <S100FC:featureType ref="TrafficSeparationSchemeLanePart"/>
</S100FC:featureBinding>
```

In TrafficSeparationSchemeLanePart:

```
<S100FC:featureBinding roleType="aggregation">
  <S100FC:multiplicity>
    <S100Base:lower>0</S100Base:lower>
    <S100Base:upper xsi:nil="false" infinite="false">1</S100Base:upper>
  </S100FC:multiplicity>
  <S100FC:association ref="TrafficSeparationSchemeAggregation"/>
  <S100FC:role ref="componentOf"/>
  <S100FC:featureType ref="TrafficSeparationScheme"/>
</S100FC:featureBinding>
```

Revision or clarification of enumeration S100_FC_RoleType

The role type definitions in ISO 19110 (Table.11) are given below. "Member role" in the definition is confusing because "member role" would appear to refer to the "containee" in an composition association, but in UML it is the "container" end that is decorated with the diamond and designated aggregationKind=composite. A similar problem arises for "part role" and aggregations.

Table B.11 — Role type code list

No.	Concept name (English)	Code	Definition
11	Class FC_RoleType	—	code list for the classification of roles
11.1	Ordinary	ordinary	indicates an ordinary association
11.2	Aggregation	aggregation	indicates a UML aggregation (part role)
11.3	Composition	composition	indicates a UML composition (member role)

The role types in S-100 are listed in Table 5-A-19:

Table 5-A-19 — S100_FC_RoleType

Role Name	Name	Description	Remarks
Enumeration	S100_FC_RoleType	Defines the type of a role	
Literal	association	An association is used to describe a relationship between two feature types that involves connections between their instances	
Literal	aggregation	An aggregation association is a relationship between two feature types, in which one of the feature types plays the role of a container and the other plays the role of a containee	
Literal	composition	A composition association is a strong aggregation. In a composition association, if a container object is deleted then all of its containee objects are deleted as well. In other words containee objects cannot exist without the container object	

The ISO definitions refer to association roles ("part role" and "member role") while the S-100 definitions describe the associations themselves. The S-100 defintions should be revised to make it clear that they describe the association **ends**.

While using "aggregation" and "composition" for association ends as well as associations appears to be a source of confusion, this paper is NOT recommending defining different literals for associations ends (for example, "none", "shared", "composite", as in the UML specification) because this requires a modification of the feature catalogue model.

Alternative approaches: Modifying the encoding of associations and roles in the S-100 feature catalogue model

S-100 models feature associations differently from ISO 19110. Modifying the S-100 feature catalogue model to conform more closely to ISO 19110 offers another path to resolving the problem. This approach has both theoretical and implementation benefits compared to the current FC model. After discussion, this approach is not being proposed at this time due to potential difficulties with updating the FC builder, viewers and other applications under development that use the current S-100 FC model.

Conclusion

At this time, only clarifications to S-100 Edition 4.0.0 Part 5 should be applied for S-100 Edition 5.0.0.

Updates to the feature catalogue model should be tabled for action for a later edition of S-100.

Feature catalogues for product specifications should be reviewed to change the roles in feature bindings in accordance with this paper.

The feature catalogue builder should be checked to ensure that feature catalogues can be created in accordance with the proposed clarifications.

Recommendations

(1) Feature catalogues that include feature associations should be reviewed and corrected if necessary. DCEGs will also need to be updated.
(2) S-100 5-4.2.5.2 (Feature Bindings) should be clarified to ensure that product specification developers know how to encode role types in feature catalogues and DCEGs.
(3) S-100 4.0.0 Table 5-A-19 should be revised to ensure that associations are not confused with their **ends** ("roles"). This would involve revising the definitions for S100_FC_RoleType literals.
(4) S-100 should use the role type literals in a way that is consistent with UML instead of reversing the meanings for the purposes of feature catalogues.
(5) The functioning of the feature catalogue builder should be checked to ensure it can construct feature catalogues consistent with the proposed clarifications.

Actions Requested

The TSM is invited to endorse the recommendations of this paper and the accompanying maintenance proposal.

Title: Roles in Feature Catalogues

S-100 Maintenance - Change Proposal Form (Draft)

Organisation	Raphael Malyankar	**Date**	07-Feb-2021.
Contact	Raphael Malyankar	**Email**	raphaelm@portolansciences.com

Change Proposal Type *(Select only one option)*

1.Clarification	2.Correction	3.Extension
X		

Location (*Identify all change proposal locations)*

S-100 Version No.	Part No.	Section No.	Proposal Summary
4.0.0	5	4.2.5.2	Clarification of the use of roles in feature bindings.
		4.2.5.3	Clarification of the use of roles in information bindings.
		App 5-A	Clarify the definitions to make it clear that the roles refer to association ends and not the whole associations.

Change Proposal

The change proposal for clause 4.2.5.2 revises the wording and adds an examples in the form of a UML figure and corresponding extract from an XML feature catalogue.

The changes Table 5-A-19 revises the definitions of the literals to make it clear that they refer to association ends and not the whole association.

5-4.2.5.2 Feature bindings

[Replace the contents of clause 5-4.2.5.2 with the following.]

The feature binding describes the association between two feature types. Each feature binding is contained within the type definition for a “source” feature type in the feature catalogue, and describes the relation of a feature type (the “target”) to the source feature type. A feature binding specifies:

- the name of the feature association;
- the target feature type;
- the role of the target feature type in relation to the source feature (the “role” is the name of the association end at the target);
- the type of association end at the target (ordinary association, aggregation, or composition);
- the multiplicity of the target feature type.

EXAMPLE: The **TrafficSeparationScheme** feature type is associated to the **TrafficSeparationSchemeLanePart** feature by the ***TrafficSeparationSchemeAggregation*** association. This association is an aggregation and is depicted in the UML diagram below:

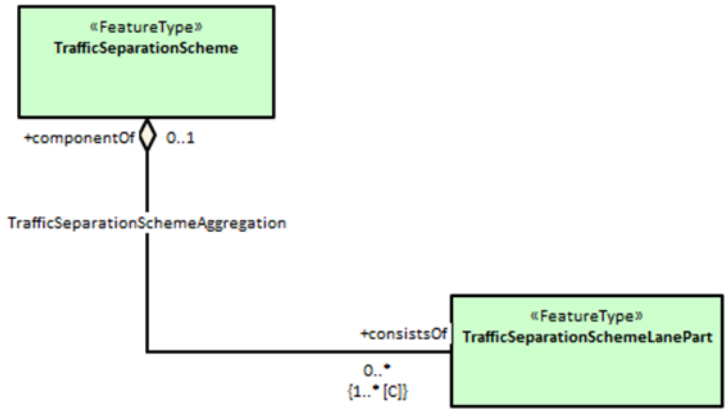


Figure X.X - UML diagram of the TrafficSeparationSchemeAggregation association between TrafficSeparationScheme and TrafficSeparationSchemeLanePart feature classes.

In accordance with UML conventions, the diamond at the TrafficSeparationScheme end means that TrafficSeparationScheme is the "whole" or "container" in the association and TrafficSeparationSchemeLanePart is the "part" or "containee". The feature bindings in the respective feature types in the XML feature catalogue are:

In TrafficSeparationScheme:

```
<S100FC:featureBinding roleType="association">
  <S100FC:multiplicity>
    <S100Base:lower>0</S100Base:lower>
    <S100Base:upper xsi:nil="true" infinite="true"/>
  </S100FC:multiplicity>
  <S100FC:association ref="TrafficSeparationSchemeAggregation"/>
  <S100FC:role ref="consistsOf"/>
  <S100FC:featureType ref="TrafficSeparationSchemeLanePart"/>
</S100FC:featureBinding>
```

In TrafficSeparationSchemeLanePart:

```
<S100FC:featureBinding roleType="aggregation">
  <S100FC:multiplicity>
    <S100Base:lower>0</S100Base:lower>
    <S100Base:upper xsi:nil="false" infinite="false">1</S100Base:upper>
  </S100FC:multiplicity>
  <S100FC:association ref="TrafficSeparationSchemeAggregation"/>
  <S100FC:role ref="componentOf"/>
  <S100FC:featureType ref="TrafficSeparationScheme"/>
</S100FC:featureBinding>
```

Note that Product Specifications or data formats may impose constraints on whether bindings are actually encoded in either of the participating feature instances in datasets.

5-4.2.5.3 Information bindings

[Replace the contents of clause 5-4.2.5.3 with the following.]

The information binding describes the association between a feature and information type or between two information types. Each information binding is contained within the type definition for a "source" feature or information type in the feature catalogue, and describes the relation of an information type (the "target") to the source type. An information binding specifies:

- the name of the information association;
- the target information type;
- the role of the target information type in relation to the source feature or information type (the "role" is the name of the association end at the target);
- the type of association end at the target (ordinary association, aggregation, or composition);
- the multiplicity of the target information type.

The structure of the feature catalogues is similar to the example in clause 5-4.2.5.3 except that one

or both of the types will be an information type and the XML will be for “informationBinding” instead of “featureBinding”.

As for feature bindings, Product Specifications or data formats may impose constraints on whether bindings are actually encoded in either of the participating feature instances in datasets (for example, S-101 specifies that for an information association linking a feature to an information type, the binding is encoded only in the feature instance and therefore the S-101 feature catalogue may not include the binding in the information type, only in the feature type).

Table 5-A-19:
[Replace this table with the following table, and add the note following.]

Role Name	Name	Description	Remarks
Enumeration	S100_FC_RoleType	Defines the type of an association end (i.e., a “role”)	
Literal	association	The association end is an ordinary linkage. (In UML terms, the role type is “aggregationKind=ordinary” and the link in a diagram does not have a diamond.)	The object at this end may be participating in an ordinary association, an aggregation, or a composition.
Literal	aggregation	The association end is a UML aggregation. (In UML terms, the role type is “aggregationKind=aggregation” and the link in a diagram has an unfilled diamond at this association end.)	The object at this end is the “owner”, “whole” or “container” in an aggregation association.
Literal	composition	The association end is a UML aggregation. (In UML terms, the role type is “aggregationKind=composition” and the link in a diagram has a filled diamond at this association end.)	The object at this end is the “owner”, “whole” or “container” in an composition association.

NOTE: If one end of the association is “aggregation” or “composition”, the other end must be coded as “association”.

Change Proposal Justification

Feature catalogues developed to date may not properly designate the type of an association end, for example, which of the two objects in a composition is playing the role of “containee” and which is playing the role of “container.” This proposal clarifies the treatment of roles in feature bindings so that feature catalogues properly designate the roles of the two objects partipating in a feature or information association.

What parts of the S-100 Infrastructure will this proposal affect?

- ☐ S-100 Feature Concept Dictionary Interface or Database
- ☐ S-100 Portrayal Register
- ☐ S-100 Feature Catalogue Builder X - may need checking
- ☐ S-100 Portrayal Catalogue Builder
- ☐ S-100 UML Models

Please send completed forms and supporting documentation to the secretary S-100WG.