



Defense Information Systems Agency  
Joint Interoperability Test Command

# System Entity Structure Advanced Topics

Team NGIT

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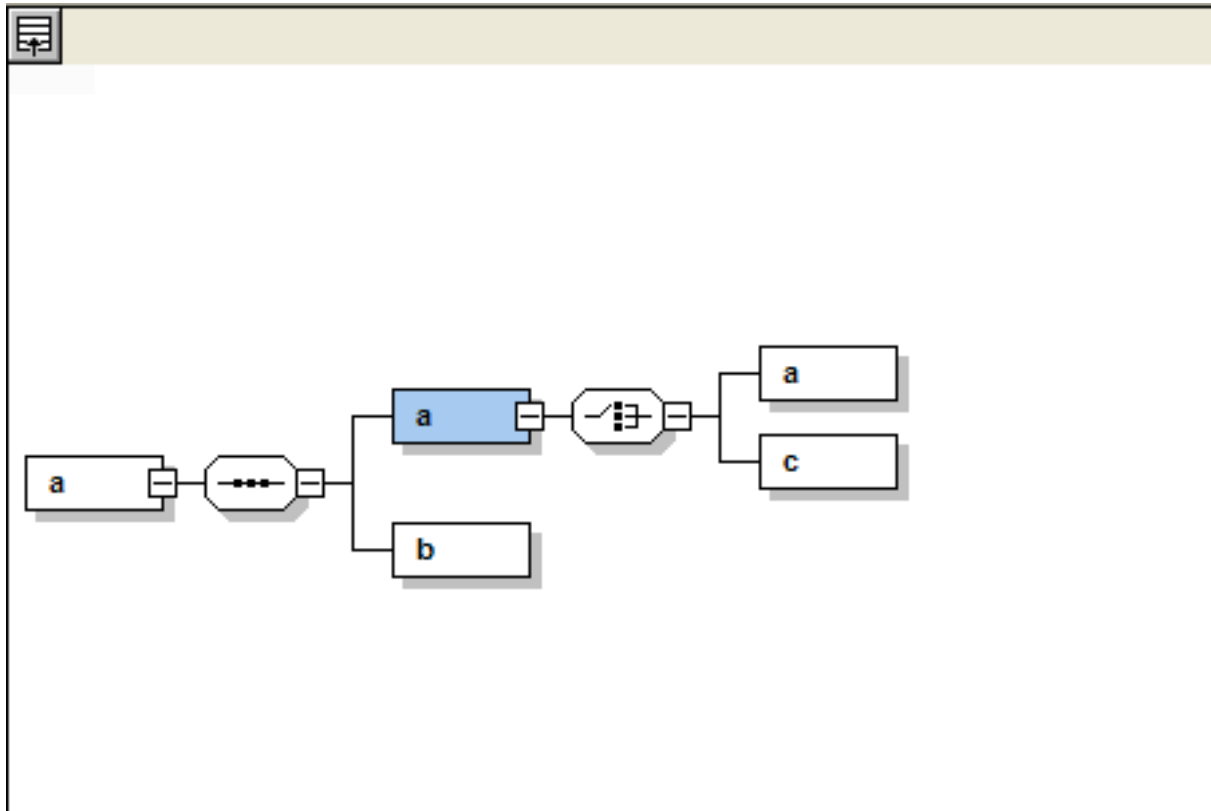
# Chapter 6

# Representation of SES as an XML Schema

p103

SES Item	Maps to XML specification	Comment
entity	<pre>&lt;xs:element name="[entity.name ]"&gt;   &lt;xs:complexType&gt;   &lt;xs:sequence&gt;   ...   ... &lt;/xs:sequence&gt; &lt;/xs:complexType&gt; &lt;/xs:element&gt;</pre>	<p>The substructure of the entity is sandwiched between opening and closing <code>&lt;xs:complexType&gt;</code> and <code>&lt;xs:sequence&gt;</code> tags</p>
aspect	<pre>&lt;xs:element name="[aspect.name]"&gt;   &lt;xs:complexType&gt;   &lt;xs:sequence&gt;   &lt;xs:element name="[child.entity.name]"/&gt;   ... &lt;/xs:sequence&gt; &lt;/xs:complexType&gt; &lt;/xs:element&gt;</pre>	<p>Aspects and multiaspects are collected together into a choice similar to a specialization; each aspect is represented as a <code>&lt;xs:sequence&gt;</code></p>
multiAspect	<pre>&lt;xs:element name="[multiAspect.name]"&gt;   &lt;xs:complexType&gt;   &lt;xs:sequence&gt;   &lt;xs:element name="[entity.name]" minOccurs="[numberComponentsVar.min]"   maxOccurs="[numberComponentsVar.max]"/&gt;   &lt;xs:element&gt;   &lt;xs:sequence&gt;   &lt;/xs:complexType&gt; &lt;/xs:element&gt;</pre>	<p>Within the collected aspects, each multiAspect is represented as a <code>&lt;xs:sequence&gt;</code> with multiply occurring element</p>
specialization	<pre>&lt;xs:element name="[spec.name]"&gt;   &lt;xs:complexType&gt;   &lt;xs:choice&gt;   &lt;xs:element name="[child.entity.name]"/&gt;   ... &lt;/xs:choice&gt; &lt;/xs:complexType&gt; &lt;/xs:element&gt;</pre>	<p>A specializations is represented as <code>&lt;xs:choice&gt;</code></p>
variable	<pre>&lt;xs:complexType&gt; &lt;xs:attribute name="[var.name]" type="xs:[var.rangeSpec]"/&gt; &lt;/xs:complexType&gt;</pre>	<p>A variable is represented as an attribute, where its rangeSpec value determines its data type and restrictions (see below)</p>

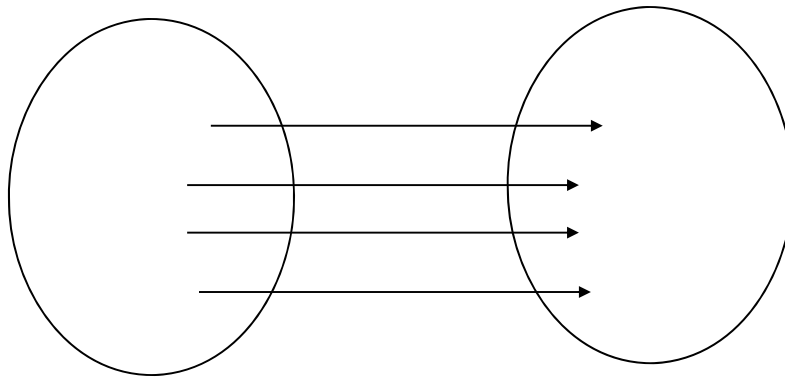
# Schema Properties vs SES Axioms



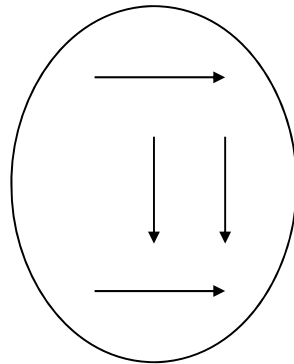
The schema in Figure 6.5 violates uniformity for *a* as well as strict hierarchy, thus it cannot represent an SES. Nevertheless, the Schema is a valid in XML

# Chapter 7

# Transformations and Restructurings

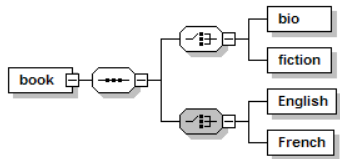
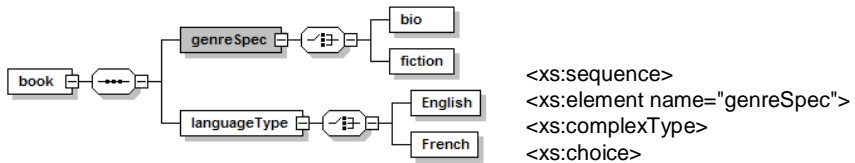


transformation

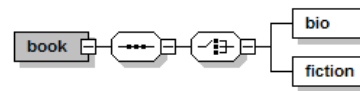


restructuring

# Restructuring of Schema Representation of SES – Space saved, Information Lost

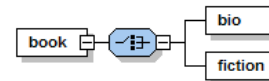


Removing specialization labels



```

<xs:element name = "book">
  <xs:complexType>
    <xs:sequence>
      <xs:choice>
  
```



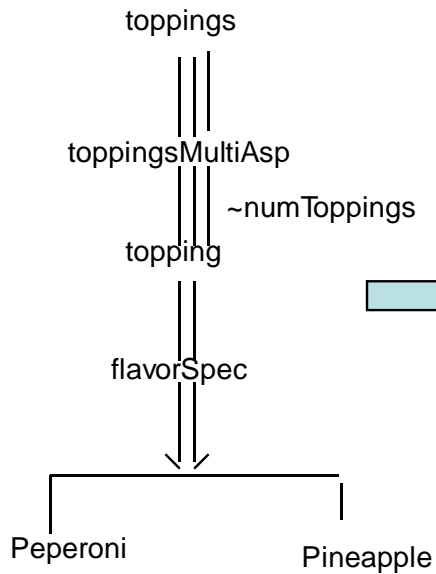
```

<xs:element name = "book">
  <xs:complexType>
    <xs:choice>
  
```

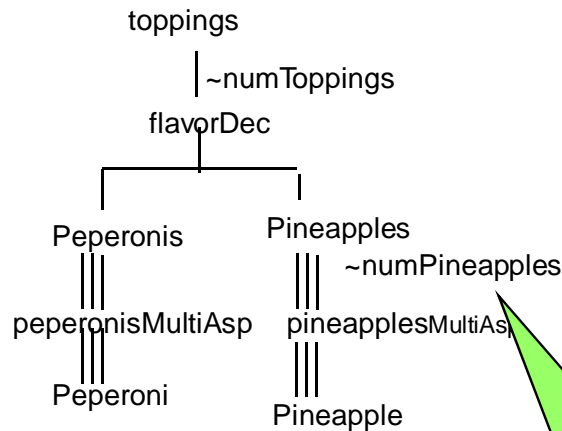
Removing a sequence having only a single choice

# Restructuring of SES

From physical perspective, toppings are made of more than one topping  
 A topping can be Peperoni or Pineapple in flavor



a)



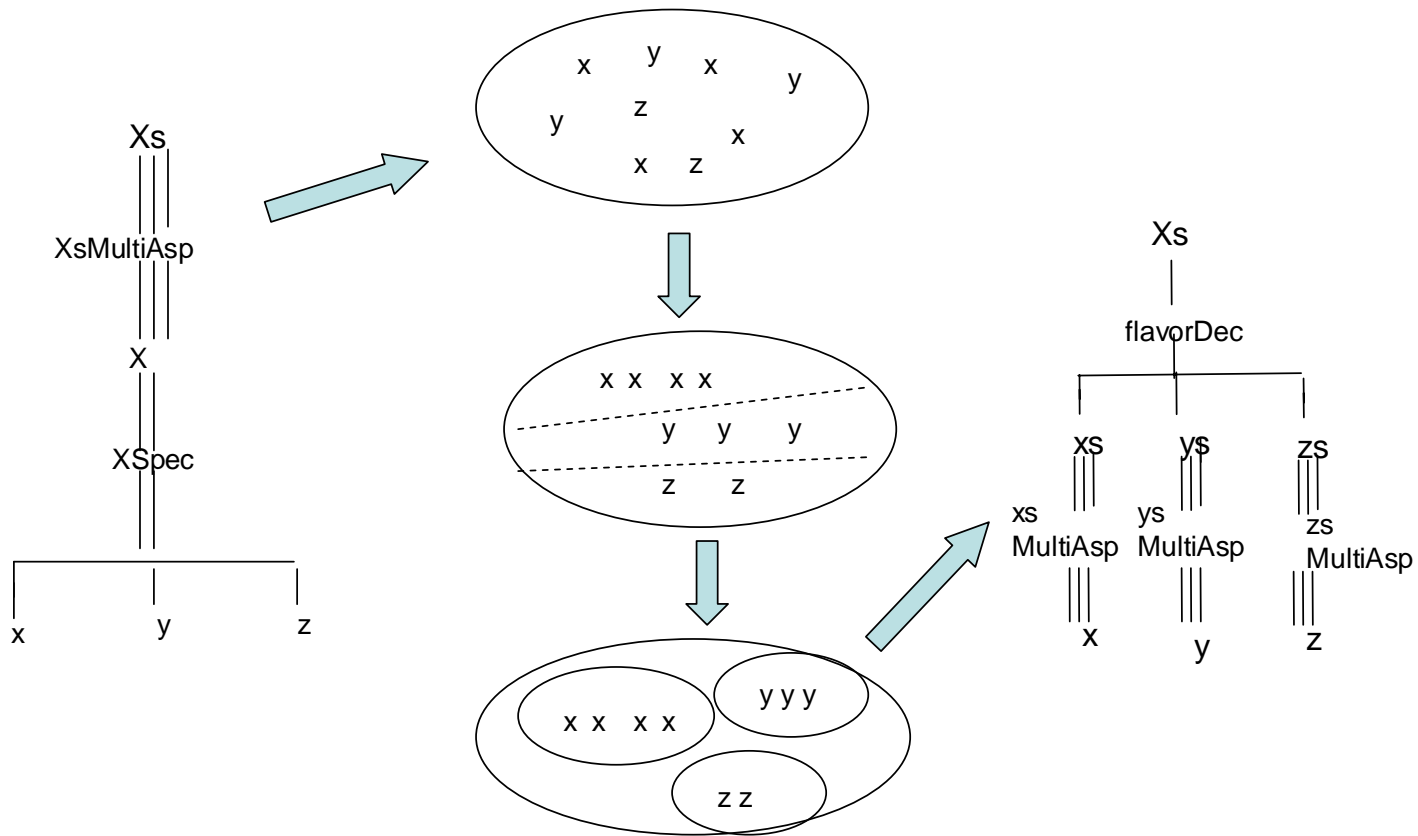
b)

expand multiAspect  
with a specialized  
entity

constraint:  
numToppings should =  
numPineapples+numPeperonis

Expanding a multiAspect

# Illustrating the expansion of a multiAspect



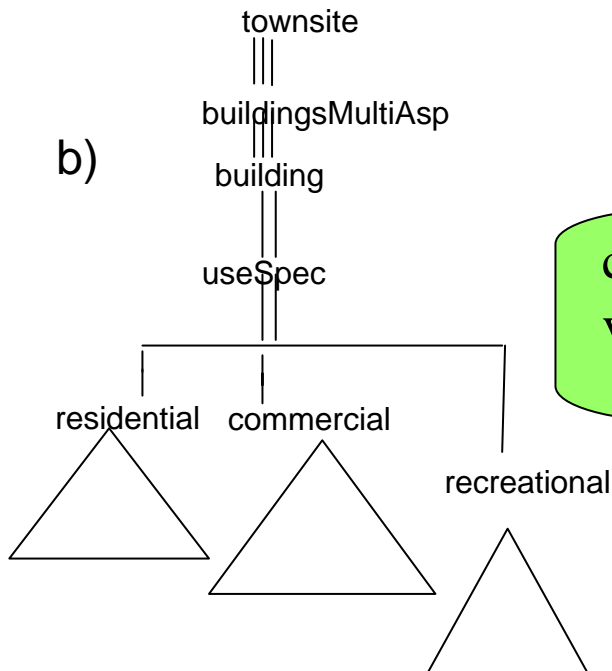
# Restructuring a variable into a specialization

A building has a use

The range of a building's use is string with values residential, commercial, and recreational

building  
 ~use with values  
 [residential, commercial, recreational]

a)



b)



building

useSpec

residential

commercial

recreational

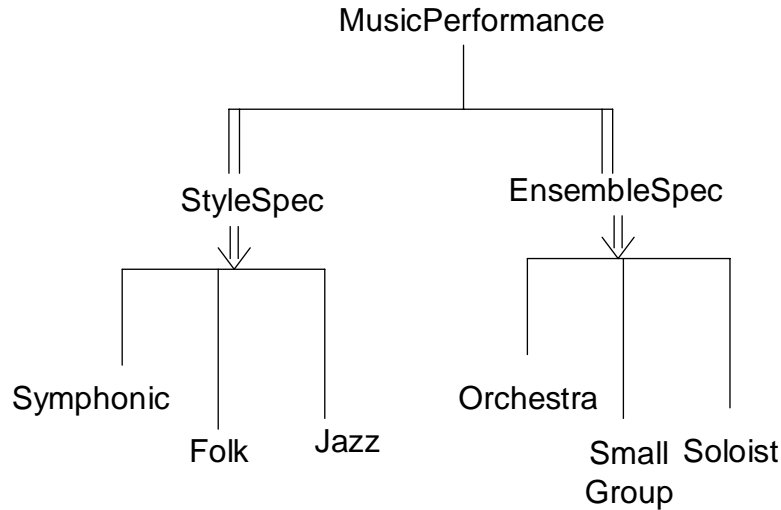
convert variables with discrete values to specializations

# Summary: Restructurings

- expanding multiaspects via their entity specializations,
- replacing a variable by a specialization whose entities represent values in the range set,
- replacing a variable by a specialization whose entities have variables representing subintervals of the range set,
- replacing a group of variables by an aspect whose entities correspond to the variables,
- replacing a specializations by their product specialization, and
- making a specialization more specific and placing it lower down in the structure.

# Chapter 9

# SES for Musical Performance



Symphonic selection rule:

If select Symphonic from StyleSpec  
then must select Orchestra from EnsembleSpec

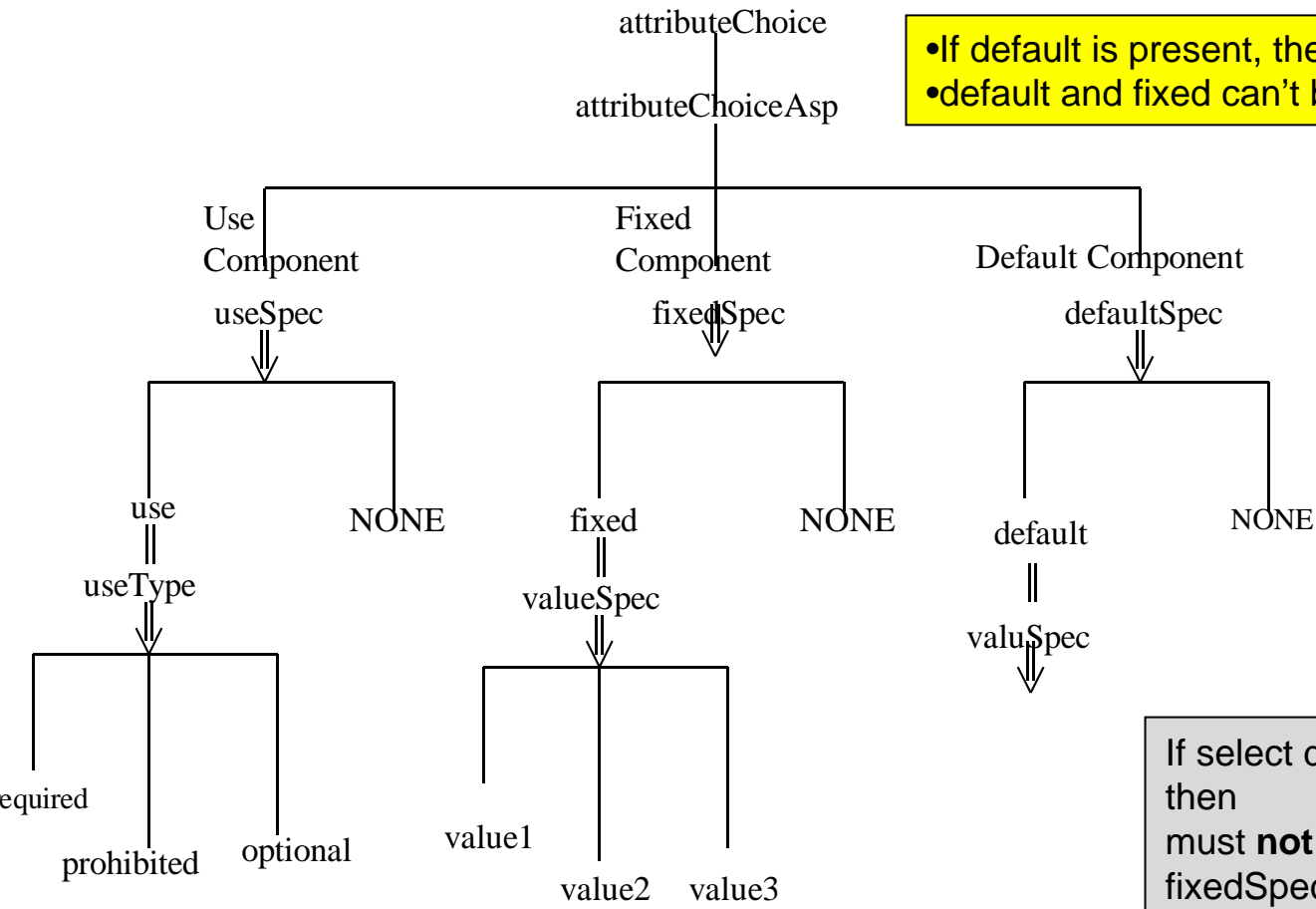
Folk selection rule:

If select Folk from StyleSpec then  
must select SmallGroup or Soloist  
from EnsembleSpec

StyleSpec/ EnsembleSpec	Orchestra	Small Group	Soloist
Symphonic	x		
Folk		x	x
Jazz	x	x	

# SES for Attribute Choice in XML

- If default is present, then use if present, must be optional
- default and fixed can't both be present



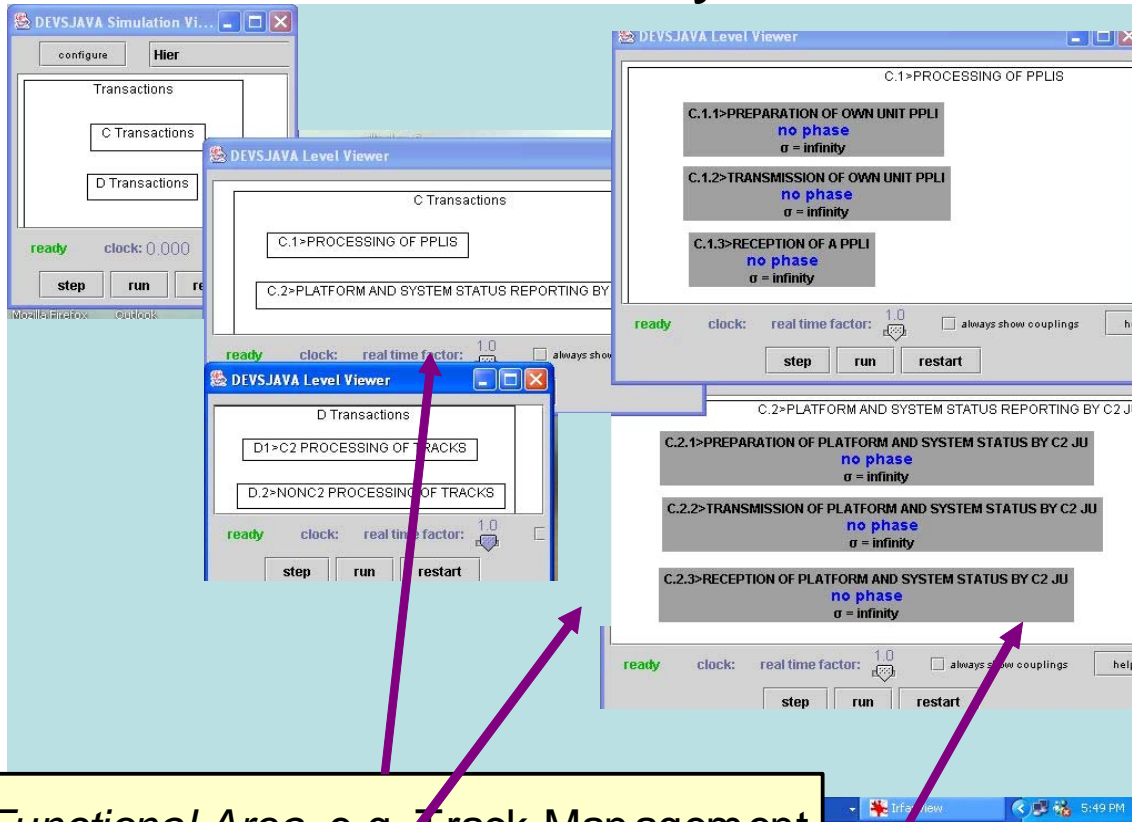
If select default from defaultSpec and select use from useSpec then must select optional from useType

If select default from defaultSpec then must **not** select fixed from fixedSpec

If select fixed from fixedSpec then must **not** select default from defaultSpec

# Chapter 11

# Natural hierarchy of Link16



**Appendix N Functional Area, e.g. Track Management**

**Function** P.N e.g. C2 Drop Track

**Transaction** P.1.N C2 Drop Track Transmit

**Step 1** – Stimuli, Preparation, Constraints

**Step 2** – Processing, Operator Decisions

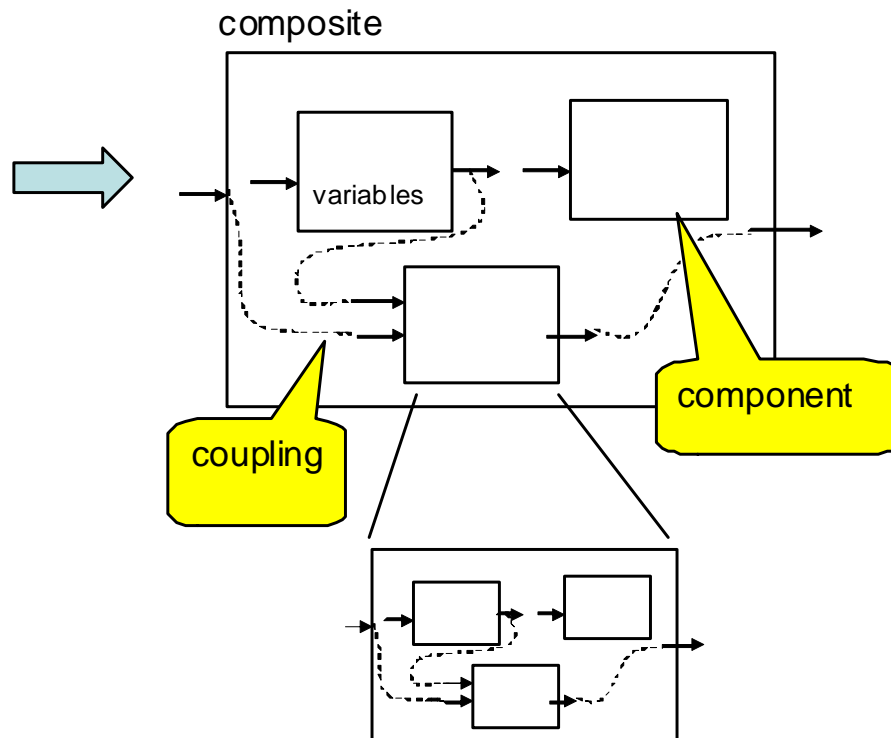
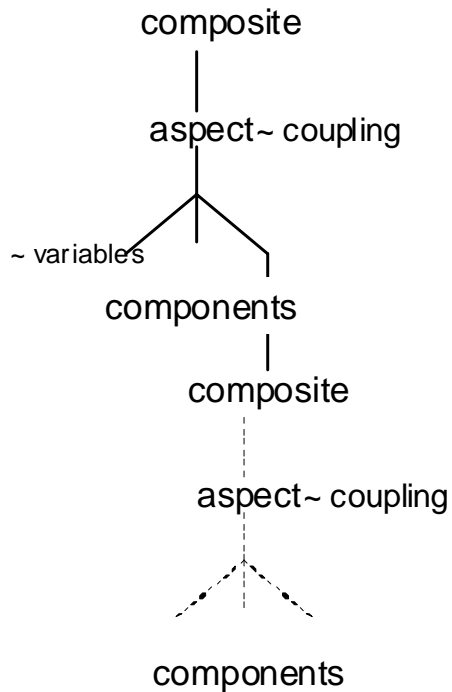
**Step 3** – Update Database, Output



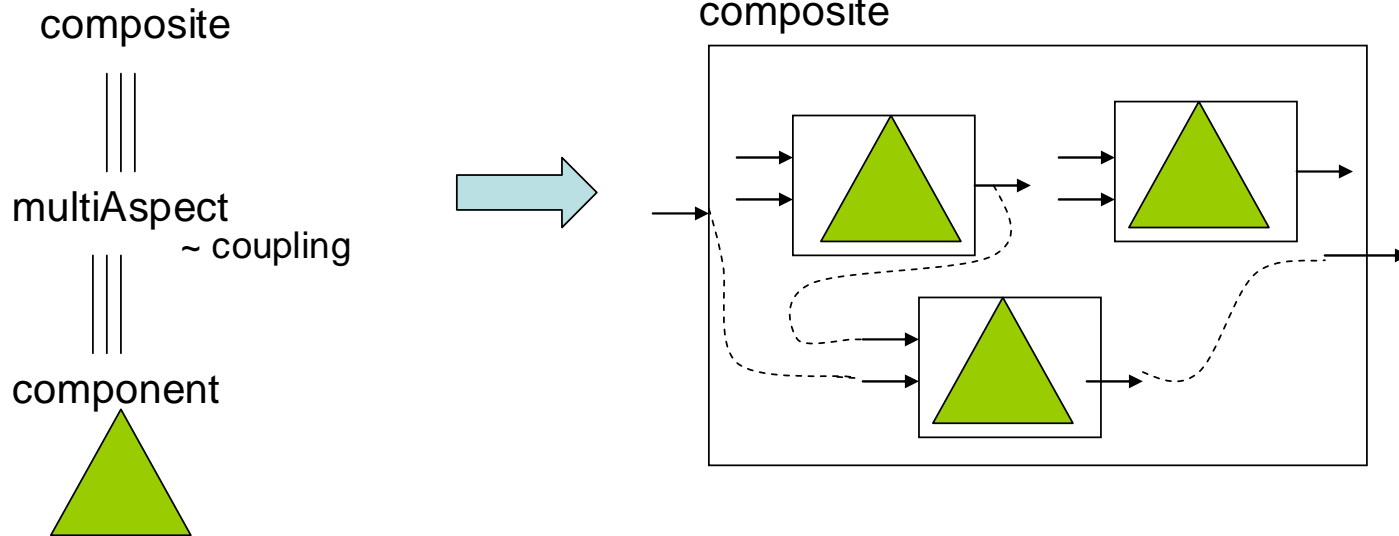
# Mapping SES elements to simulation model elements

SES element	Maps to
entity	component in a composite model
aspect	decomposition of a composite model into components corresponding to the aspect's children
multiAspect	decomposition of a composite model into components, each of which is derived from the aspect's single child entity
coupling of an aspect	specifies the routing paths for information flow among the components corresponding to the aspect's children
specialization	a family of alternative "plug-ins" for a component corresponding to the parent entity
variables of an entity	variables, including state variables and parameters, of the component corresponding to the entity

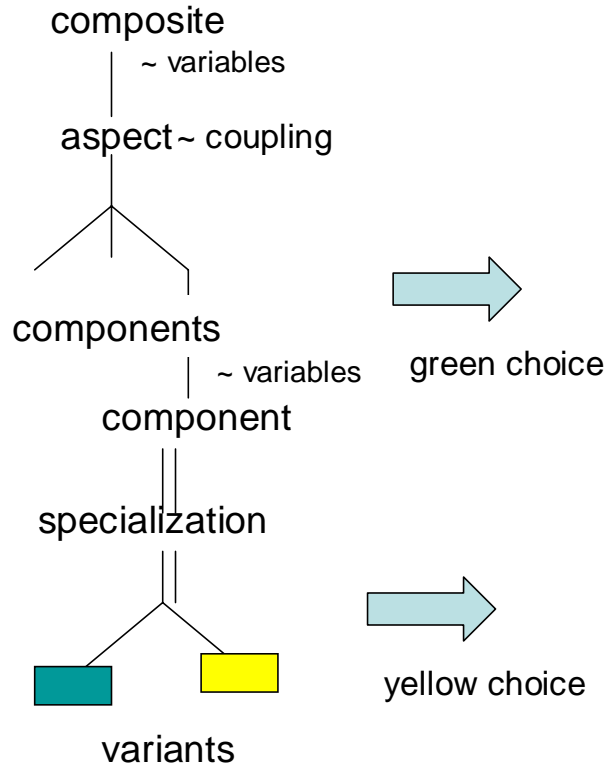
# Mapping aspects to composite models



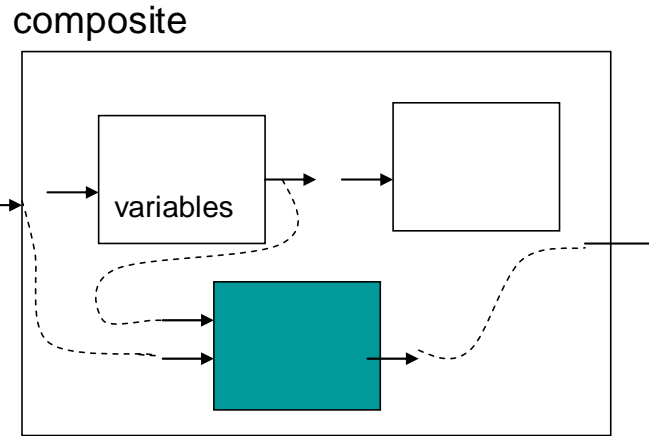
# Mapping multiAspects to composite models



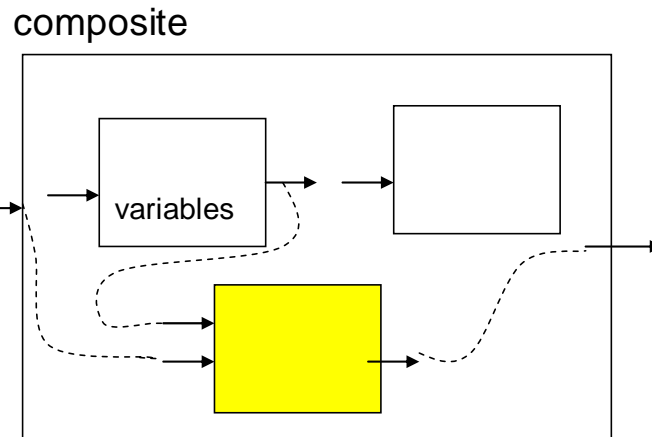
# Mapping Pruned Specializations to PlugNPlay Components



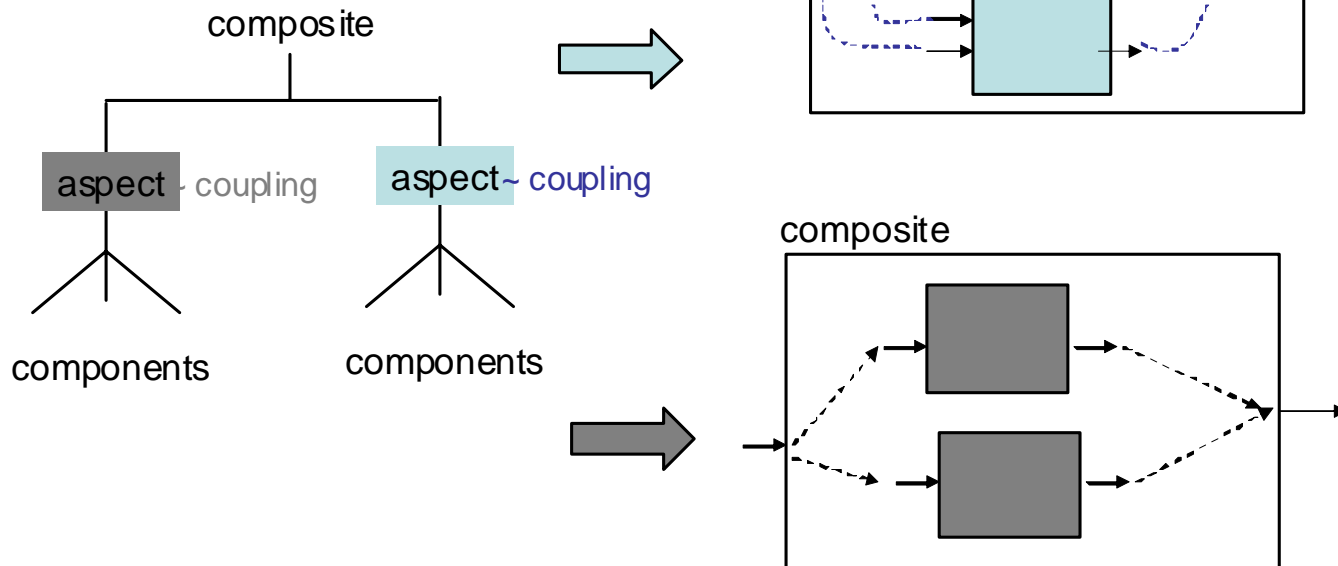
green choice



yellow choice



# Interpreting multiple aspects as alternative decompositions

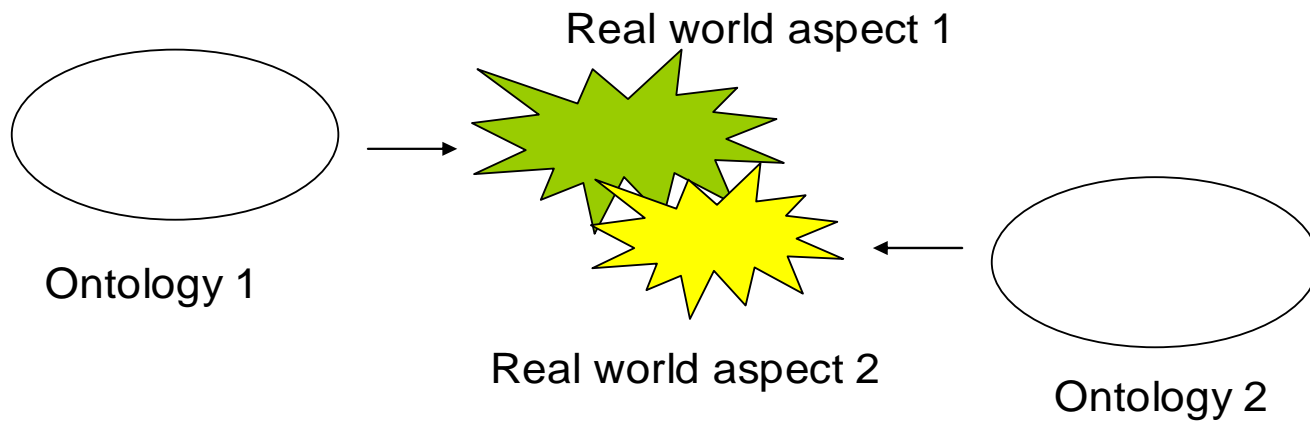


# Chapter 13

# Integration of ontologies: harmonizing and merging

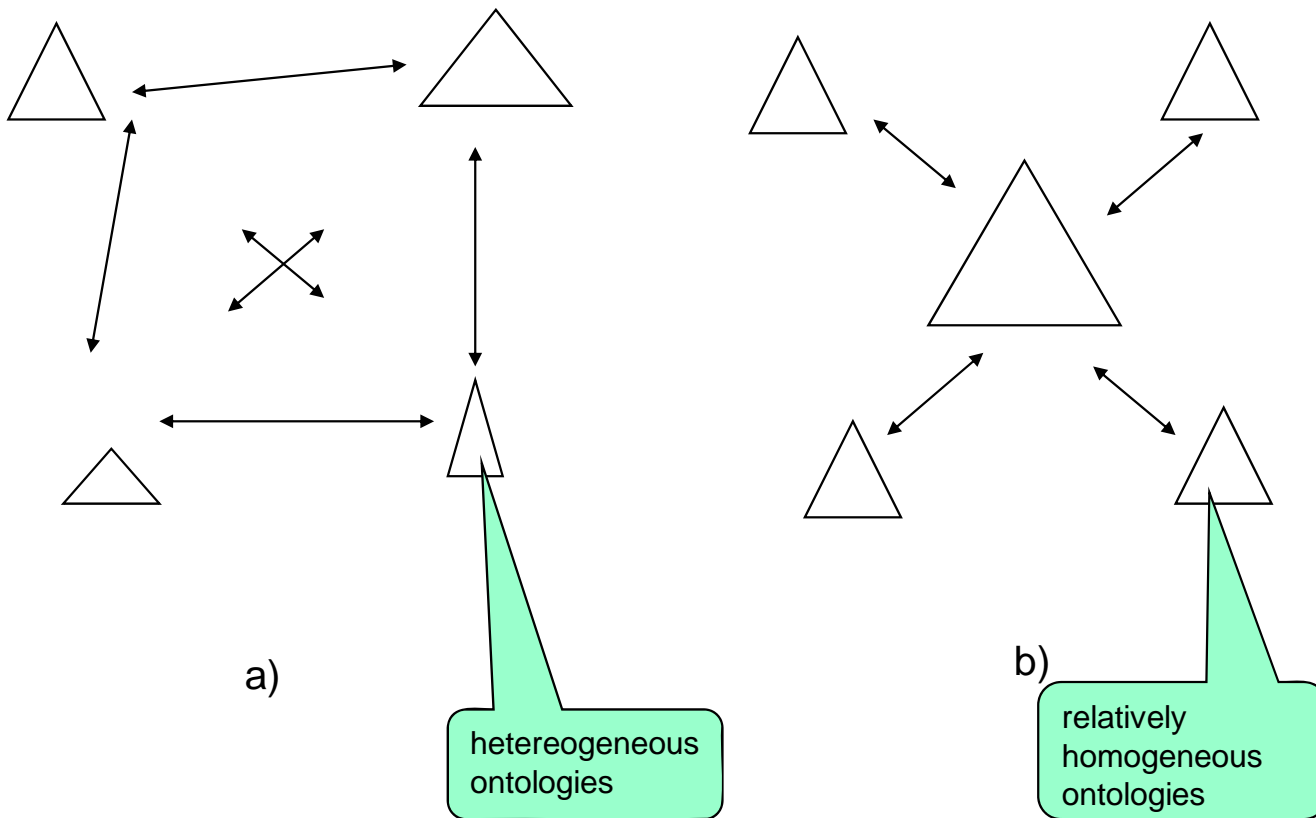


a) harmonizing ontologies



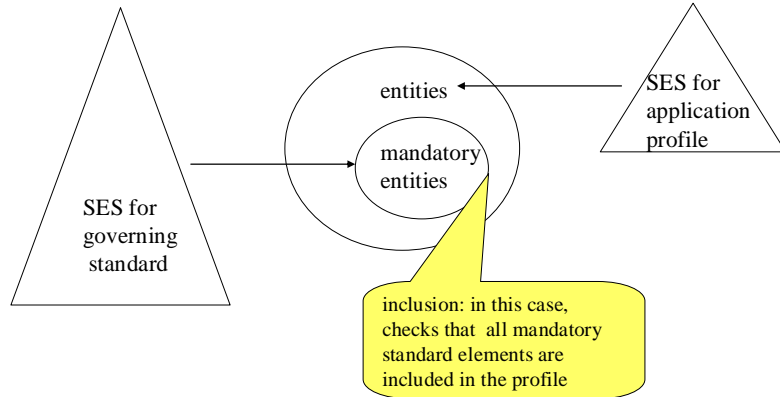
b) merging ontologies

# Two approaches to harmonization



, a) many-to-many alignment, b) many-to-one alignment

# Checking for inclusion of mandatory entities in a profile

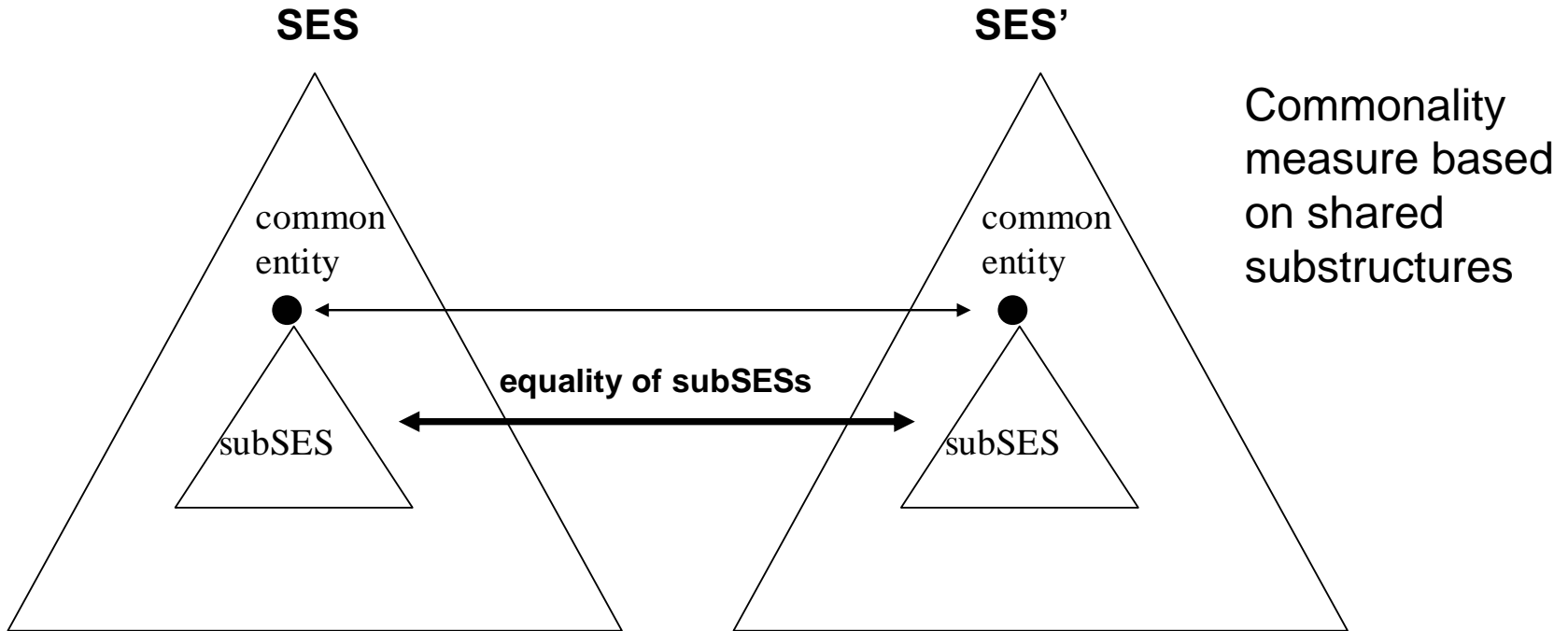


The ISO geospatial standards committees (Chapter 3) require that all application profiles include certain mandatory classes of the standard.

This requires a tool that extracts the mandatory entities from the standard's SES and checks whether this set of entities is included in the set of entities extracted from the profile's SES.

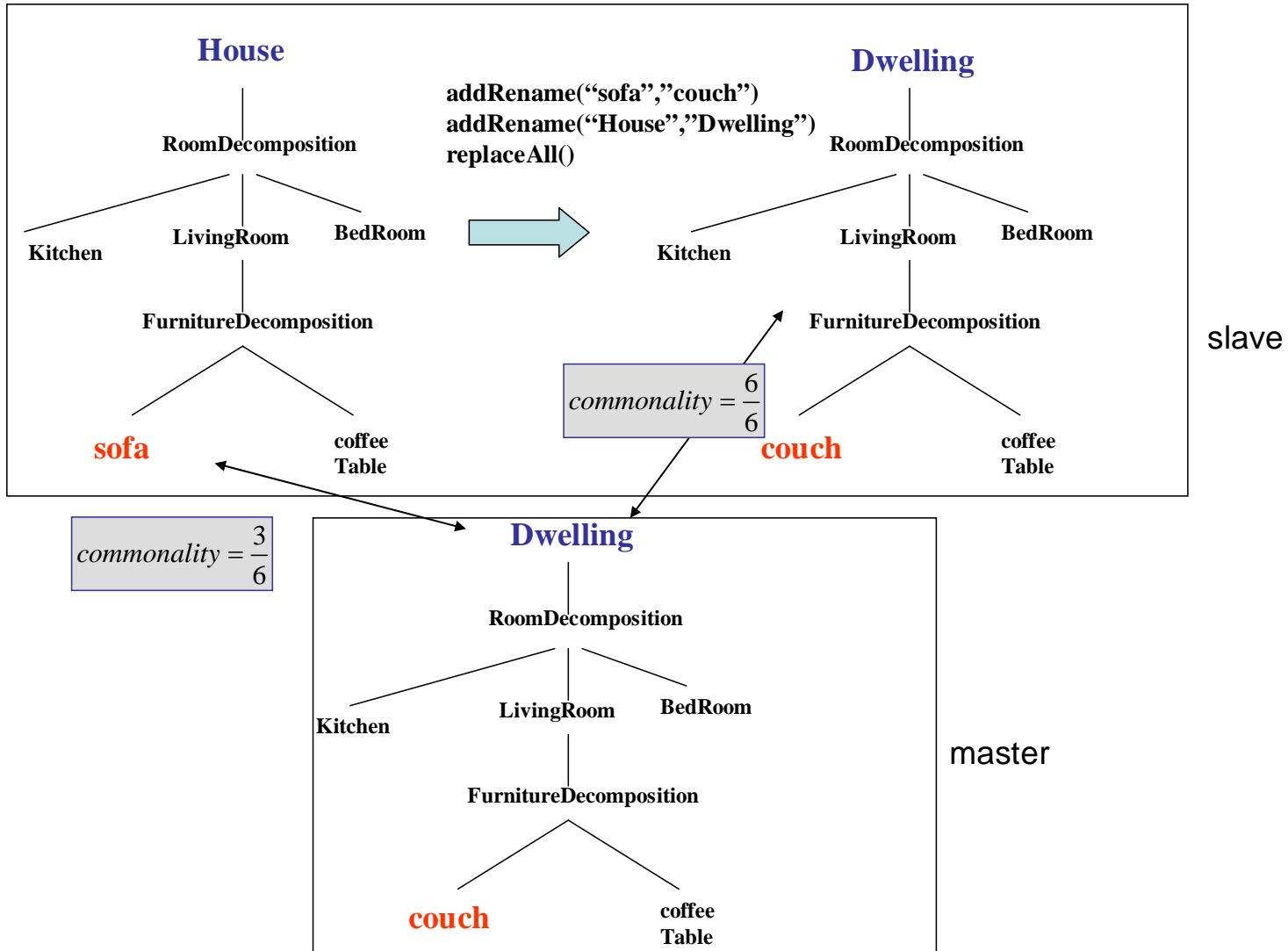
ISO requires that if an optional class is employed in the profile that itself uses a mandatory class, then the latter must also be included in the profile.

# Measuring Commonality

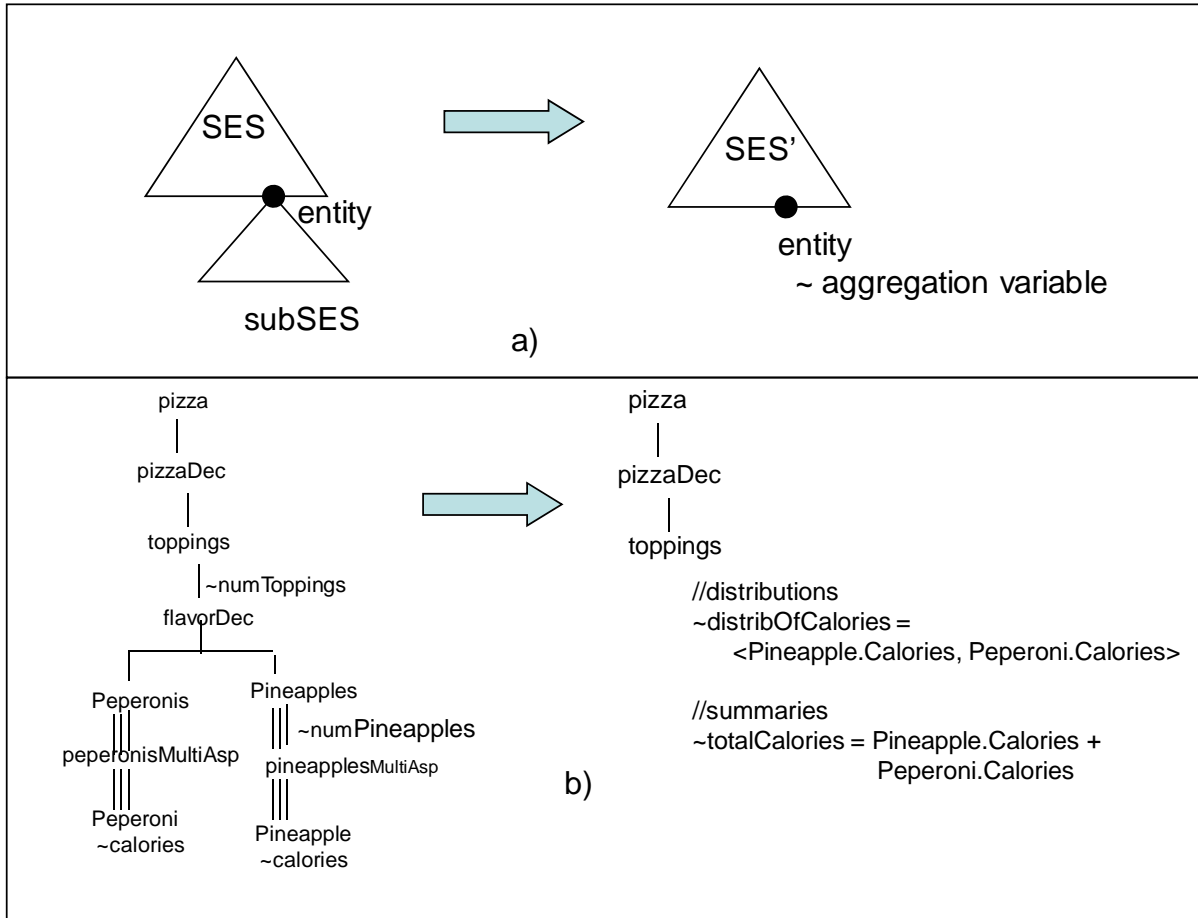


$$\text{commonality} = \frac{\text{number of entities with equal subSES}}{|\text{SES.entityNames} \cup \text{SES'.entityNames}|}$$

# Renaming to increase commonality



# Aggregation restructurings



Aggregation is an information destroying process.

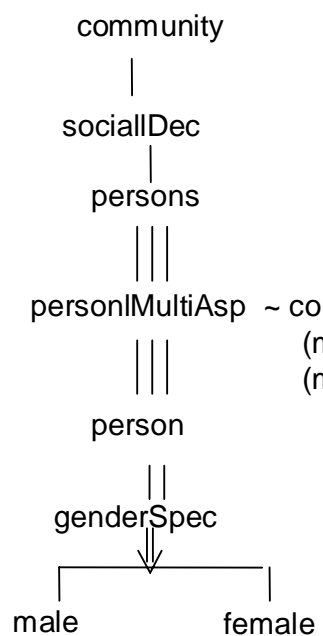
For example, knowing the caloric content of the pizza does not tell us the number of calories contributed by each component

# Examining Standards for Restructuring Clues

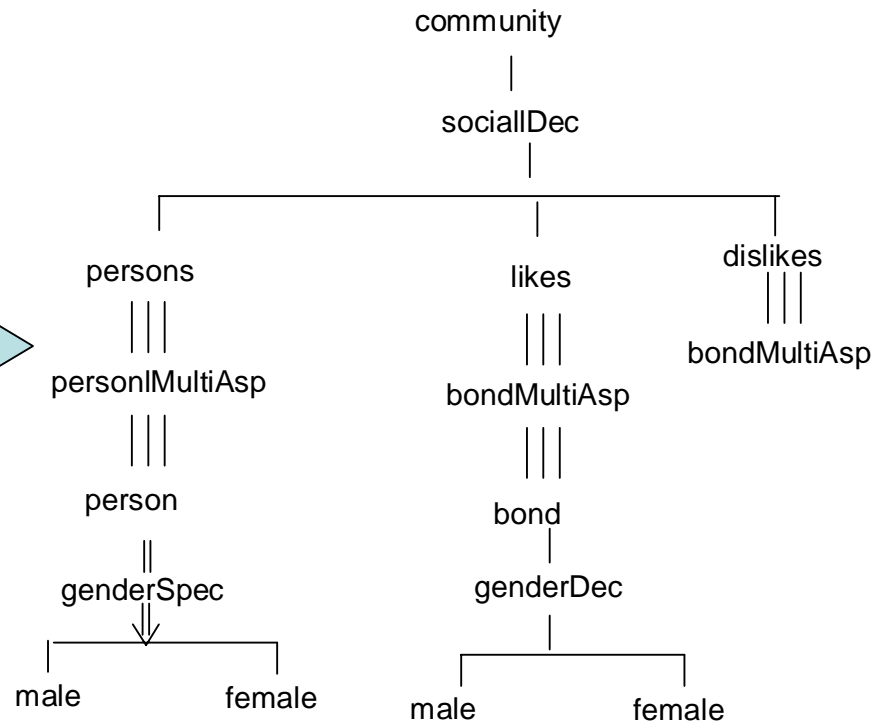
Source Restructuring	In one SES	In the other SES
Expanding multiAspects via their entity specializations	Look for a single multiAspect with a specialization attached to its generating entity	Look for a number of peer multiAspects with different entities
A variable is replaced by a specialization whose entities represent values in the range set	Look for a variable with a discrete range set	Look for a specialization with the entities having the same names as the range set
A variable is replaced by a specialization whose entities have variables representing subintervals of the range set	Look for a variable with a continuous range set	Look for a specialization that appears to cover the range of the variable
A group of variables is replaced by an aspect whose entities correspond to the variables	Look for a group of variables that represent a single concept such as a coordinate system.	Look for an aspect that is reused under many entities (using uniformity)
Specializations are replaced by their product	Look for specializations under the same entity	Look for a single specialization that has values that match the product of the group under the same entity.
Specializations are increased in specificity	Look for a specializations whose entities differ in only a few respects	Look for a specialization that is more specific with fewer entities..
Aggregation	Look for set of variables with a common range set	Look for a single variable whose name suggests a distribution or a summary of such a distribution

# Chapter 19

# Extending the concept of coupling so that horizontal relations can be expressed

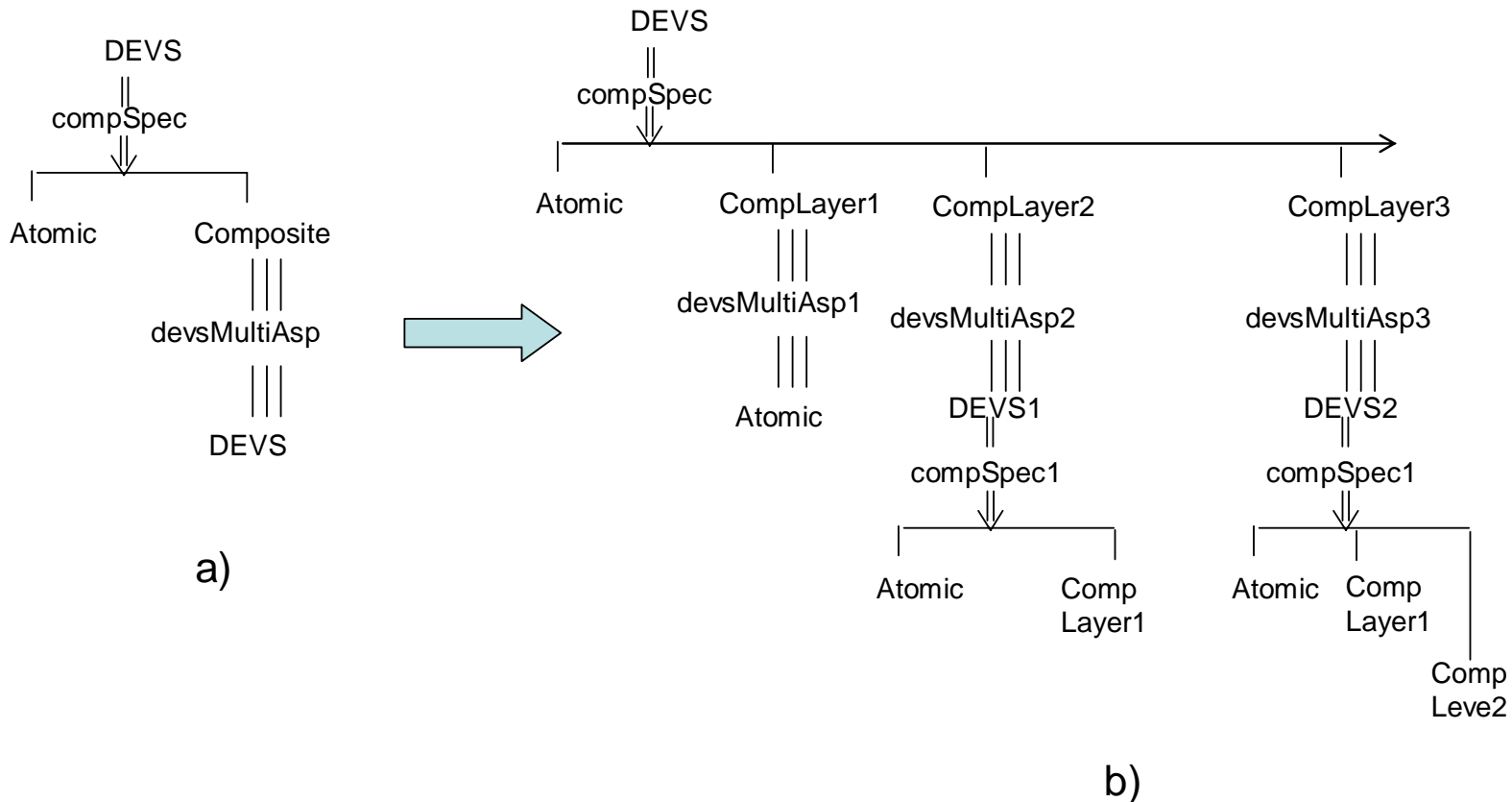


a)



b)

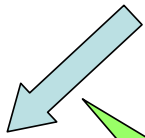
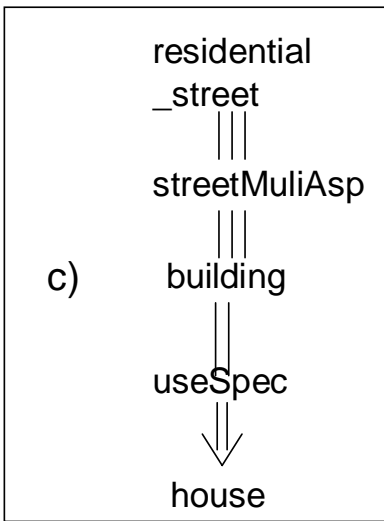
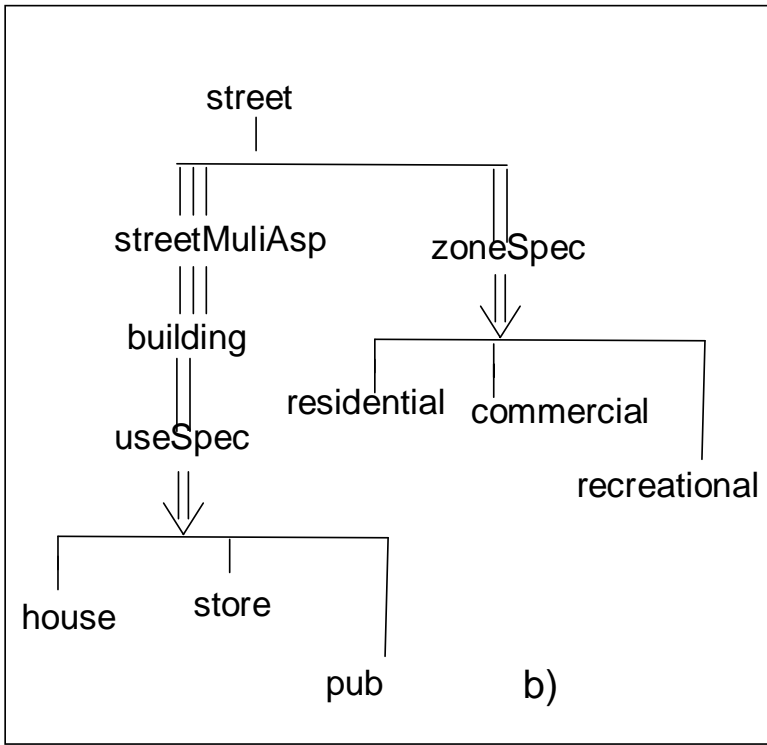
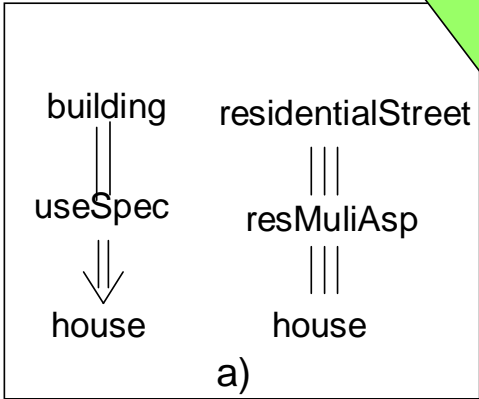
# Living with the Strict Hierarchy Axiom



Limiting the generation of hierarchical models to a maximum depth

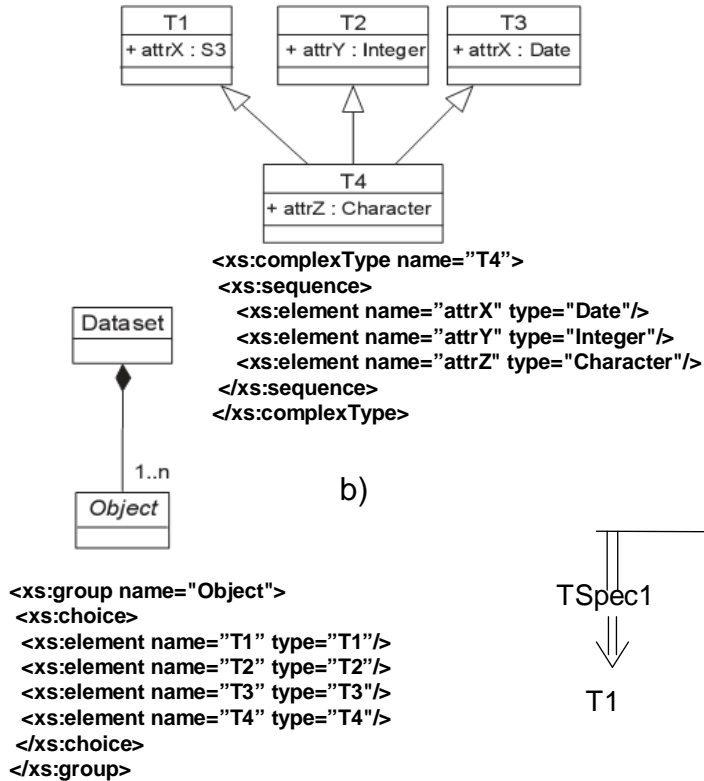
# Illustrating how a partial specification can be completed to the general case

completing the special case representation

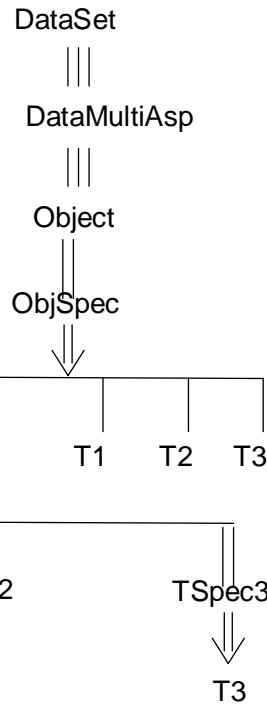


pruning to recover the original special case

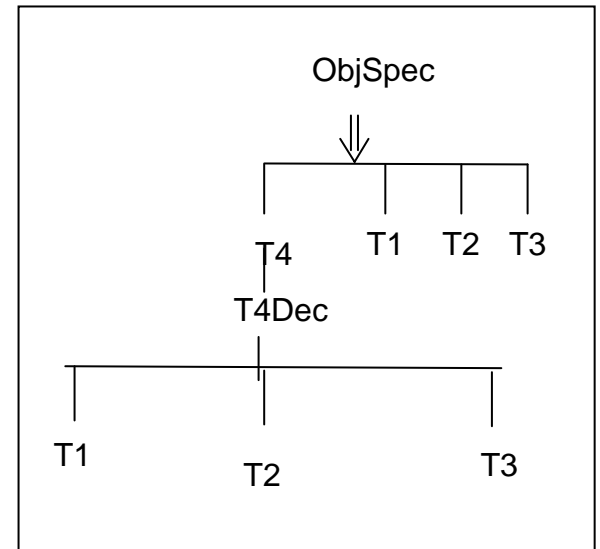
# Illustrating ISO TC/211 multiple inheritance, substitution groups, composition and their SES representation



a)

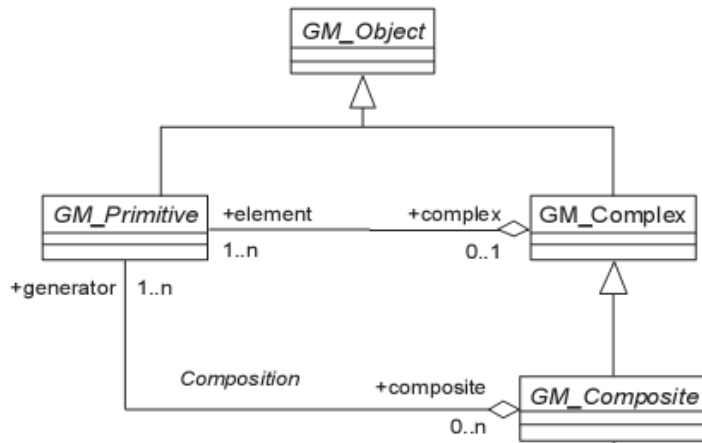


b)

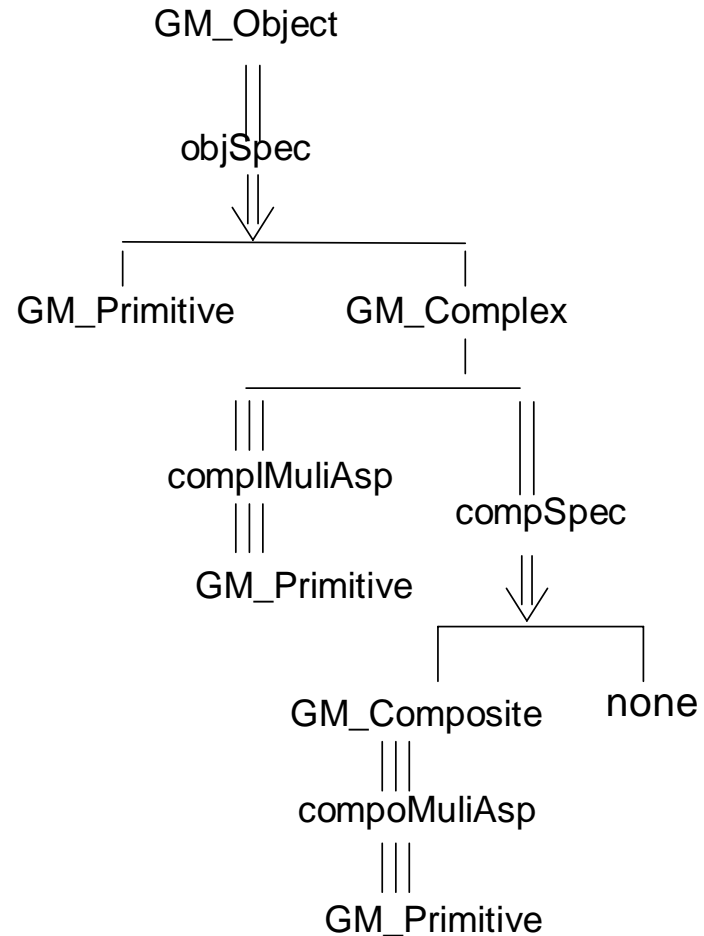


c)

# Composition Hierarchy for GM\_Object and its SES Representation



a)



b)

# Ontology and UML

- Unified Modeling Language (UML [UML]) is a software development language and environment that has found application in geographic information modeling and other data engineering. There is a natural affinity between software and data engineering – both work with software and with modeling.
- Although UML was primarily developed for modeling software components and their interrelations, its object-oriented modeling concepts proved attractive to real world ontology developers.
- Likewise, recently software developers have realized that there are significant benefits from including application domain ontologies in their architectural designs.
- In this light, the Object Modeling Group (OMG) has initiated a process for developing an Ontology Definition Metamodel (ODM) for modeling Semantic Web ontology languages within Model-Driven Architecture (MDA).

# Brief Introduction to OWL

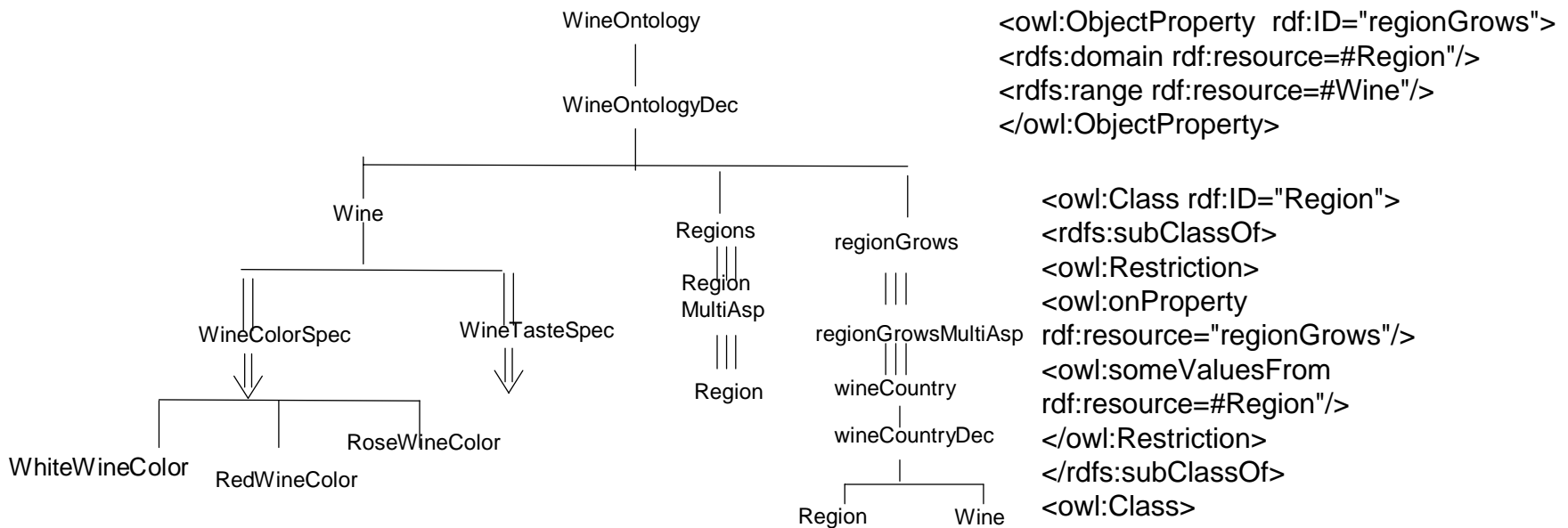
Web Ontology Language (OWL) is a W3C recommended ontology standard under development to support such intelligent queries

The basic ontology framework employs classes, class hierarchies, and binary relation called properties.

```
<owl:Class rdf:ID="Wine">
<owl:equivalentClass>
<owl:Class>
<owl:UnionOf rdf:parseType="Collection">
<owl:Class rdf:about = #WineTaste"/>
<owl:Class rdf:about = #WineColor"/>
</owl:UnionOf>
</owl:Class>
</owl:equivalentClass>
</owl:Class>
```

```
<owl:Class rdf:ID="WineColor">
<rdfs:subClassOf rdf:resource=#Wine"/>
<owl:equivalentClass>
<owl:Class>
<owl:OneOf rdf:parseType="Collection">
<wineColor rdf:about= #Red"/>
<wineColor rdf:about= #White"/>
<wineColor rdf:about= #Rose"/>
</owl:OneOf>
</owl:Class>
</owl:equivalentClass>
</owl:Class>
```

# SES representation of the wine ontology in OWL



```
<owl:ObjectProperty rdf:ID="regionGrows">
  <rdfs:domain rdf:resource=#Region"/>
  <rdfs:range rdf:resource=#Wine"/>
</owl:ObjectProperty>
```

```
<owl:Class rdf:ID="Region">
  <rdfs:subClassOf>
    <owl:Restriction>
      <owl:onProperty
        rdf:resource="regionGrows"/>
      <owl:someValuesFrom
        rdf:resource=#Region"/>
    </owl:Restriction>
  </rdfs:subClassOf>
</owl:Class>
```

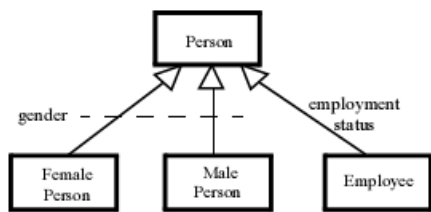
OWL is an extension of an earlier web language RDFS, for describing web resources. This explains the occurrences of tags from both sources.

# The SES Framework and UML 2

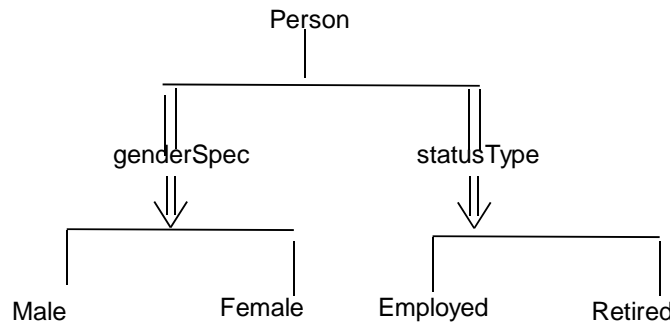
**GeneralizationSet** – allows grouping subclasses into categories. Also called subtype partitions, the concept graduates the IM substitution type into a full fledged class.

**AssociationClass** – generalizes the association feature in old UML in two ways: 1) it is no longer restricted to representing binary relations and 2) it now has the status of both a class and an association.

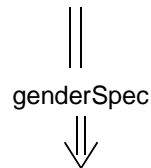
# The UML GeneralizationSet in relation to the SES specialization



a)



electricalConnector



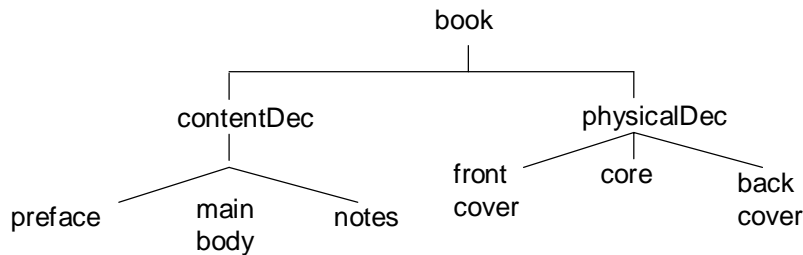
b)

In SES inheritance works from the bottom up, so that both Person and electricalConnector can inherit properties of Male to become Male\_Person and Male\_electricalConnector, respectively.

However, in UML the stand-alone Male class would inherit properties from Person and electricalConnector.

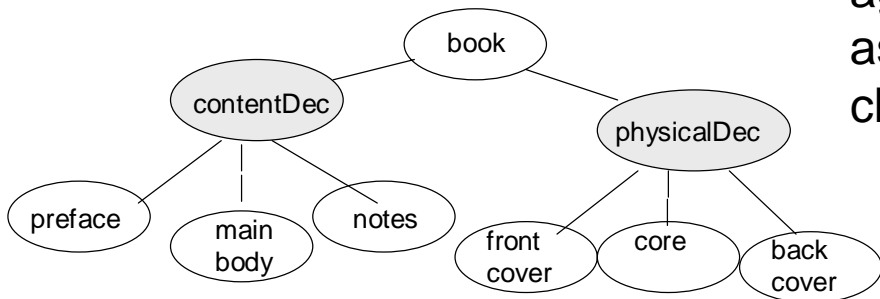
# The UML Association Class in relation to the SES Aspect

In UML2, contentDec and physicalDec can be association classes with multiple end classes.



a)

The interpretation of such associationClasses as aggregations or compositions conflicts with UML2's concept of aggregation since it explicitly insists that aggregation can only be an associationClass with at most two end classes.



b)

# Conclusion: SES and UML

SES Framework and methodology offers structures and methodology for modeling and simulation-based data engineering.

An SES-specific profile in UML would raise the level at which SES models can be integrated with those of other ontologies.

UML vendors have not been eager to support interoperability in general.

In the SES-DEVS framework

- pruning is a critical behavior feature and there is no equivalent concept to pruning of SES instances in the UML
- DEVS is a formalism that intrinsically controls time advances in arbitrarily complex models. UML run time semantics explicitly state that UML does not dictate how time elapses between its events.