

FHIR RDF Sample side by side comparisons

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Legend

Most of the RDF is generated by verbatim logic (e.g. An unidentified element becomes an anonymous individual - blank node).

Where RDF is generated by special transformation it is **marked in red**

Where RDF is inferred by a reasoner it is **marked in green**.

36

37 **1 Default Mapping**

38 In general the mapping between types, elements in XML and Classes, individuals in RDF is generally the same.
39 This section defines that default mapping and other section describe deviations from the default mapping.

40 **1.1 Instance mapping**

41 In XML the element instances are nested using tags.

42 **1.1.1 Element**

43 An XML element corresponds to a RDF/OWL individual. In many cases unless the element has identity the
44 mapping is to an anonymous individual. Where identity has been given to the element then it maps to a named
45 individual.

46 **1.1.2 XML Tag**

47 The XML tag is mapped to an Object Property Assertion of the Object Property defined for the tag name.

48 **1.1.3 XML Attribute**

49 An XML attribute represents a simple type and in FHIR is always “value”. FHIR datatypes have attributes of XSD
50 datatypes.

51 fhir:CodingBase.display [a fhir:string; fhir:value "Admin"] ;

52 Shows an anonymous individual in [] of datatype fhir:string with value data property “Admin”.

53 **1.2 Type mapping**

54 **1.2.1 Complex type to Class**

55 A Complex type in XSD maps to an owl:Class. The elements of the Complex type map to Object Properties.

56 Sequences do not get represented in RDF/OWL but the ordering can be declared with annotation properties
57 (see later section on ordering).

58 **1.2.2 Nested elements**

59 An XML tag is unique within the namespace that it is declared in. FHIR does not use global declarations. The XML
60 tag is mapped to an Object Property where the name is prefixed with the Class name in which it was declared. A
61 tag “bar” declared in a complex type “Foo” would become an Object Property “Foo.bar”. This is aligned with the
62 structural definition mechanism in FHIR.

63 **1.2.3 Datatypes**

64 In RDF the value attribute of a datatype is a Data Property named “value” with undefined range. Each FHIR data
65 type has a restriction on the range of the Data Property (see section on Datatypes).

66 **2 Message and Resource identity**

67 **2.1 XML Identity**

68 **2.1.1 XML File identity**

69 The read RESTful interaction

70 `GET [base]/[type]/[id] {?_format=[mime-type]}`

71 Causes a return of the mime type file which has an identity of [base]/[type]/[id].[mime-type] These four parts
72 form the dereferenceable URI and the identity of that file.

73 **2.1.2 XML Resource identity**

74 The XML Root tag binds the root element to a Complex Type. In FHIR the tag and the Complex Type have the
75 same value however this is not always true in XML.

```
76 <AllergyIntolerance xmlns="http://hl7.org/fhir" >
77   <id value="1"/>
78   <text>
79     </text>
80   <!-- the date that this entry was recorded -->
81   <recordedDate value="2010-03-01"/>
82   <!-- the patient that actually has the risk of adverse reaction -->
83   <patient>
84     <reference value="http://record/Patient/PeterPatient"/>
85     <display value="Peter Patient"/>
86   </patient>
87   <!-- substance, coded from SNOMED CT-->
88   <substance>
89     <coding>
90       <system value="http://snomed.info/id/" />
91       <code value="90614001"/>
92       <display value="beta-Lactam antibiotic"/>
93     </coding>
94   </substance>
95   <status value="confirmed"/>
96   <criticality value="high"/>
97   <category value="medication"/>
98 </AllergyIntolerance>
```

99 The id value represents only a segment of the identifier. The type is taken from the root element and the base is
100 not included in the Resource so it is not clear in FHIR that the Resource can be clearly disambiguated.

101 **2.2 RDF/OWL identities**

```
102 @prefix owl: <http://www.w3.org/2002/07/owl#> .
103 @prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
104 @prefix xml: <http://www.w3.org/XML/1998/namespace> .
105 @prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
106 @prefix fhir: <http://hl7.org/fhir/> .
107 @prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
108 <http://record/AllergyIntolerance/1> rdf:type owl:Ontology ; owl:imports <http://hl7.org/fhir> .
109
110 <http://record/AllergyIntolerance/1> rdf:type <http://PatientSafetyProfile/AllergyIntolerance> ,
111 owl:NamedIndividual ;
112   fhir:Resource.id [ rdf:type fhir:id ; fhir:value "1" ] ;
113   fhir:AllergyIntolerance.status [ rdf:type fhir:code ;
114     fhir:ConceptBase.coding [ fhir:CodingBase.code [ fhir:value "confirmed" ] ] ]
115   ] ;
116   fhir:AllergyIntolerance.patient [ rdf:type fhir:Reference ;
117     fhir:Reference.reference [ fhir:value "http://record/Patient/PeterPatient" ] ;
118     fhir:Reference.display [ fhir:value "Peter Patient" ] ;
119   ] ;
120   fhir:AllergyIntolerance.substance [ rdf:type fhir:CodeableConcept , <http://snomed.info/id/90614001>;
121     fhir:ConceptBase.coding [ rdf:type fhir:CodingBase ;
122       fhir:CodingBase.code [ rdf:type fhir:codeBase ; fhir:value "90614001" ] ;
123       fhir:CodingBase.system [ rdf:type fhir:uri ; fhir:value "http://snomed.info/sct" ] ;
124       fhir:CodingBase.display [ rdf:type fhir:string ; fhir:value "beta-lactam (antibiotic)" ] ]
125     ] ;
126     fhir:ConceptBase.text [ rdf:type fhir:string ; fhir:value "beta-lactam (antibiotic)" ]
127   ] .
```

128

129 **2.2.1 RDF File identity**

130 The identity of the RDF file is its file name (e.g. <http://record/AllergyIntolerance/1.ttl>)

131 The first three segment (without the mime-type) are the name of the Ontology.

```
132 <http://record/AllergyIntolerance/1> rdf:type owl:Ontology ;
```

133 The file is an ontology. This is required since there appears to be a restriction on import statements importing
134 the same ontology more than once. This is independent of prefixes of the elements.

135 **2.2.2 RDF Individual identity**

136 The name of the individual is derived from the URL identity of the resource. The class of the individual is
137 declared using rdf:type:

```
138 <http://record/AllergyIntolerance/1> rdf:type <http://PatientSafetyProfile/AllergyIntolerance>,
139 owl:NamedIndividual ;
```

140 In simple resources the identity of the message is mapped to the identity of the root element. However they
141 may have different types.

142 In this case the name of the individual is the same as the name of the ontology. This appears to work.

143 In Bundles the identity of the message (bundle) is different from the identities of contained resources.

144 Note that the type of the resource is qualified by the profile which is obtained from Meta.profile (see Profile
145 section later).

146 **2.2.3 Ontology triples**

147 The ontology identity is linked to the import predicate which links to the fhir ontology:

148 <[http://hl7.org/fhir](http://record>AllergyIntolerance/1> rdf:type owl:Ontology ; owl:imports < .

149 The import statement is required for Turtle files so that the loading can distinguish between Object Properties

150 and Annotation Properties.

151

152 3 Datatypes (section 1.18.0.1)

153 Difference in the treatment of datatypes code, string and uri as classes with primitive values as rdf:Datatypes.

154 Datatypes are transformed into OWL Classes where the value is expressed as a an OWL DataProperty with
155 restrictions (facets etc).

156 3.1 Id

157 3.1.1 Id instance

158 3.1.2 Id schema

```
159 fhir:id rdf:type owl:Class ;
160   rdfs:subClassOf fhir:Element ,
161     [ rdf:type owl:Restriction ;
162       owl:onProperty fhir:value ;
163       owl:allValuesFrom [ rdf:type rdfs:Datatype ;
164         owl:onDatatype xsd:string ;
165         owl:withRestrictions ( [ xsd:pattern "[A-Za-z0-9\\-\\.]{1,64}" ] )
166       ]
167     ] ,
168     [ rdf:type owl:Restriction ;
169       owl:onProperty fhir:value ;
170       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
171       owl:onDataRange xsd:string
172     ] ;
173   rdfs:comment "Any combination of letters, numerals, '-' and '.' with a length limit of 64 characters.
174 (This might be an integer, an unprefixed OID, UUID or any other identifier pattern that meets these constraints.)
175 Ids are case-insensitive." .
```

176 Note that since id is case insensitive but RDF is caes sensitive, the id containing letters should be converted to
177 lower case.

178 3.2 Decimal

179 Decimal has an additional DataProperty fhir:fractionDigits which allows the explicit declaration of scale.

180 3.2.1 Decimal OWL instance

```
181 [ a fhir:decimal ; fhir:value 123.4 ; fhir:fractionDigits 3 ]
```

182 3.2.2 Decimal OWL Schema

```
183 fhir:decimal rdf:type owl:Class ;
184   rdfs:subClassOf fhir:Element ,
185     [ rdf:type owl:Restriction ;
186       owl:onProperty fhir:fractionDigits ;
187       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
188       owl:onDataRange xsd:nonNegativeInteger
189     ] ,
190     [ rdf:type owl:Restriction ;
191       owl:onProperty fhir:fractionDigits ;
192       owl:allValuesFrom xsd:nonNegativeInteger
193     ] ,
194     [ rdf:type owl:Restriction ;
195       owl:onProperty fhir:value ;
196       owl:allValuesFrom xsd:decimal
197     ] ,
198     [ rdf:type owl:Restriction ;
199       owl:onProperty fhir:value ;
200       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
201       owl:onDataRange xsd:decimal
202     ] ;
203   rdfs:comment "A rational number with implicit precision" .
```

205 **3.3 FHIR CodeableConcept and Coding Structure Definition**

206 **3.3.1 FHIR XML**

```
207 <code>
208   <coding>
209     <system value="http://example.org/local"/>
210     <code value="admin"/>
211     <display value="Admin"/>
212   </coding>
213 </code>
```

214 CodeableConcept Structural Definition

```
215 <[name] xmlns="http://hl7.org/fhir">
216   <!-- from Element: extension -->
217   <coding><!-- 0..* Coding Code defined by a terminology system --></coding>
218   <text value="[string]" /><!-- 0..1 Plain text representation of the concept -->
219 </[name]>
```

220

221 Coding Structural Definition

```
222 <[name] xmlns="http://hl7.org/fhir">
223   <!-- from Element: extension -->
224   <system value="[uri]" /><!-- 0..1 Identity of the terminology system -->
225   <version value="[string]" /><!-- 0..1 Version of the system - if relevant -->
226   <code value="[code]" /><!-- 0..1 Symbol in syntax defined by the system -->
227   <display value="[string]" /><!-- 0..1 Representation defined by the system -->
228   <primary value="[boolean]" /><!-- 0..1 If this code was chosen directly by the user -->
229 </[name]>
```

230

231 **3.3.2 RDF Data for Coding Instance**

232 The RDF variant for fhir:Code, fhir:Coding and fhir:CodeableConcept are not straight translations of the FHIR
233 representation. 3 new additional classes are introduced – codeBase, CodingBase and ConceptBase.

```
234 xxx.code [ a fhir:CodeableConcept ;
235   ConceptBase.coding [ rdf:type fhir:CodingBase ;
236     fhir:CodingBase.system [ a fhir:uri; "fhir:value http://example.org/local" ] ;
237     fhir:CodingBase.code [ a fhir:codeBase ; fhir:value "admin" ] ;
238     fhir:CodingBase.display [ a fhir:string; fhir:value "Admin" ] ;
239   ] ;
240 ] ;
```

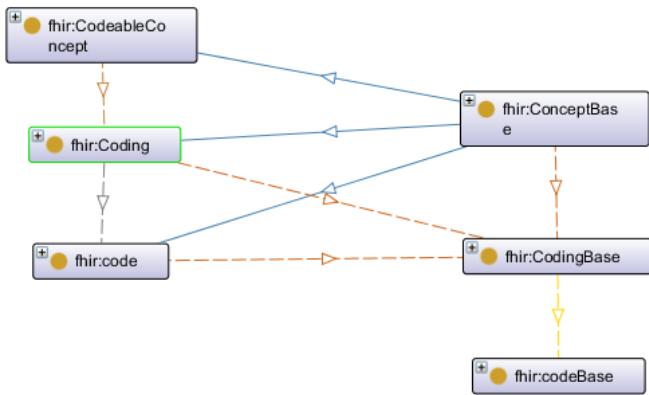
241

242 The fhir:CodeableConcept type assertion (as a marker) allows round trip back to the original XML type. The same
243 approach will be taken for fhir:Coding and fhir:code.

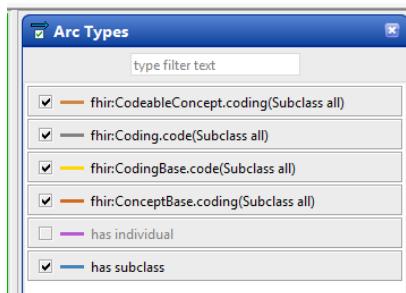
244 This approach will be implemented by creating ConceptBase, CodingBase and codeBase individuals as blank
245 nodes.

246 3.3.3 FHIR OWL Schema

247 ConceptBase has subclasses fhir:CodeableConcept, fhir:Coding and fhir:code.



248



249

```
250 [ rdf:type owl:AllDisjointClasses ;
251   owl:members ( fhir:CodingBase
252                 fhir:ConceptBase
253                 fhir:codeBase
254                 )
255 ] .
```

256

```
257 #####
258 #  Classes
259 #####
260
261 ###  http://hl7.org/fhir/ConceptBase
262
263 fhir:ConceptBase rdf:type owl:Class ;
264   rdfs:subClassOf fhir:Datatype ,
265     [ rdf:type owl:Restriction ;
266       owl:onProperty fhir:ConceptBase.coding ;
267       owl:allValuesFrom fhir:CodingBase
268     ] ,
269     [ rdf:type owl:Restriction ;
270       owl:onProperty fhir:ConceptBase.text ;
271       owl:maxCardinality "1"^^xsd:nonNegativeInteger
272     ] ,
273     [ rdf:type owl:Restriction ;
274       owl:onProperty fhir:ConceptBase.text ;
275       owl:allValuesFrom fhir:string
276     ]
277 .
278 .
```

```

279
280    ### http://hl7.org/fhir/CodingBase
281    fhir:CodingBase rdf:type owl:Class ;
282        rdfs:subClassOf fhir:Element ,
283            [ rdf:type owl:Restriction ;
284                owl:onProperty fhir:CodingBase.system ;
285                owl:allValuesFrom fhir:uri
286            ] ,
287            [ rdf:type owl:Restriction ;
288                owl:onProperty fhir:CodingBase.system ;
289                owl:maxCardinality "1"^^xsd:nonNegativeInteger
290            ] ,
291            [ rdf:type owl:Restriction ;
292                owl:onProperty fhir:CodingBase.version ;
293                owl:allValuesFrom fhir:string
294            ] ,
295            [ rdf:type owl:Restriction ;
296                owl:onProperty fhir:CodingBase.version ;
297                owl:maxCardinality "1"^^xsd:nonNegativeInteger
298            ] ,
299            [ rdf:type owl:Restriction ;
300                owl:onProperty fhir:CodingBase.code ;
301                owl:allValuesFrom fhir:codeBase
302            ] ,
303            [ rdf:type owl:Restriction ;
304                owl:onProperty fhir:CodingBase.code ;
305                owl:maxCardinality "1"^^xsd:nonNegativeInteger
306            ] ,
307            [ rdf:type owl:Restriction ;
308                owl:onProperty fhir:CodingBase.display ;
309                owl:allValuesFrom fhir:string
310            ] ,
311            [ rdf:type owl:Restriction ;
312                owl:onProperty fhir:CodingBase.display ;
313                owl:maxCardinality "1"^^xsd:nonNegativeInteger
314            ] ,
315            [ rdf:type owl:Restriction ;
316                owl:onProperty fhir:CodingBase.primary ;
317                owl:maxCardinality "1"^^xsd:nonNegativeInteger
318            ] ,
319            [ rdf:type owl:Restriction ;
320                owl:onProperty fhir:CodingBase.primary ;
321                owl:allValuesFrom fhir:boolean
322            ] .
323
324    fhir:codeBase rdf:type owl:Class ;
325        rdfs:subClassOf fhir:Element ,
326            [ rdf:type owl:Restriction ;
327                owl:onProperty fhir:value ;
328                owl:allValuesFrom xsd:token
329            ] ,
330            [ rdf:type owl:Restriction ;
331                owl:onProperty fhir:value ;
332                owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
333                owl:onDataRange xsd:token
334            ] .

```

335 The concrete subclasses of ConceptBase apply the additional restrictions:

```
336  ### http://hl7.org/fhir/CodeableConcept
337  fhir:CodeableConcept rdf:type owl:Class ;
338      rdfs:subClassOf fhir:ConceptBase ;
339      rdfs:comment "The set of possible coded values this coding was chosen from or constrained by." .
340
```

```
341  ### http://hl7.org/fhir/Coding
342  fhir:Coding rdf:type owl:Class ;
343      rdfs:subClassOf fhir:ConceptBase ,
344          [ rdf:type owl:Restriction ;
345              owl:onProperty fhir:ConceptBase.text ;
346              owl:maxCardinality "0"^^xsd:nonNegativeInteger
347          ] ,
348          [ rdf:type owl:Restriction ;
349              owl:onProperty fhir:ConceptBase.coding ;
350              owl:cardinality "1"^^xsd:nonNegativeInteger
351          ] .
```

```
352
353  fhir:code rdf:type owl:Class ;
354      rdfs:subClassOf fhir:ConceptBase , [ rdf:type owl:Restriction ;
355          owl:onProperty fhir:ConceptBase.coding ;
356          owl:allValuesFrom [ rdf:type owl:Class ;
357              owl:intersectionOf ( fhir:CodingBase
358                  [ rdf:type owl:Restriction ;
359                      owl:onProperty fhir:CodingBase.code ;
360                      owl:cardinality "1"^^xsd:nonNegativeInteger
361                  ] ,
362                  [ rdf:type owl:Restriction ;
363                      owl:onProperty fhir:CodingBase.display ;
364                      owl:maxCardinality "0"^^xsd:nonNegativeInteger
365                  ] ,
366                  [ rdf:type owl:Restriction ;
367                      owl:onProperty fhir:CodingBase.primary ;
368                      owl:maxCardinality "0"^^xsd:nonNegativeInteger
369                  ] ,
370                  [ rdf:type owl:Restriction ;
371                      owl:onProperty fhir:CodingBase.system ;
372                      owl:maxCardinality "1"^^xsd:nonNegativeInteger
373                  ] ,
374                  [ rdf:type owl:Restriction ;
375                      owl:onProperty fhir:CodingBase.version ;
376                      owl:maxCardinality "1"^^xsd:nonNegativeInteger
377                  ]
378              )
379          ]
380      ] ,
381      [ rdf:type owl:Restriction ;
382          owl:onProperty fhir:ConceptBase.coding ;
383          owl:cardinality "1"^^xsd:nonNegativeInteger
384      ] .
```

385

386 **4 Terminology**

387 **4.1 Code system**

388 A code system is a namespace which makes its codes unique. A Code system may contain Concepts. You can
389 have many concept hierarchies in the same code system (e.g. SNOMED) you can have one concept hierarchy in a
390 code system (e.g. HL7 internal codes).

391 **4.1.1 HL7 FHIR Internal Code System XML example**

392 A definition of a code system, inlined into the value set (as a packaging convenience).

```
393 <codeSystem>
394   <extension url="http://hl7.org/fhir/StructureDefinition/valueset-oid">
395     <valueUri value="urn:oid:2.16.840.1.113883.4.642.1.50"/>
396   </extension>
397   <system value="http://hl7.org/fhir/allergy-intolerance-status"/>
398   <version value="1.0.0"/>
399   <caseSensitive value="true"/>
400   <concept>
401     <code value="active"/>
402     <display value="Active"/>
403     <definition value="An active record of a reaction to the identified Substance."/>
404     <concept>
405       <code value="confirmed"/>
406       <display value="Confirmed"/>
407       <definition value="A high level of certainty about the propensity for a reaction to the identified Substance,
408         which may include clinical evidence by testing or rechallenge."/>
409     </concept>
410   </concept>
411 </codeSystem>
```

412

413 **4.1.2 RDF CodeSystemURI declaration**

414 A code system will have one named individual representing the code system. This is a member of class:
415 fhir:CodeSystemURI. CodeSystemURI is a subclass of fhir:uri and allows named individuals to represent the URI.
416 The properties are added to it as annotation properties.

417 Thus the reference to a system in CodingBase.system can have a value e.g. <<http://snomed.info/sct>> and not
418 have to declare a further anonymous individual.

419 **4.1.2.1 HL7 Internal Code system URI example**

```
420 ### http://hl7.org/fhir/cs/allergy-intolerance-status
421
422 fhircs:allergy-intolerance-status rdf:type fhir:CodeSystemURI , owl:NamedIndividual ;
423   fhir:caseSensitive "true"^^xsd:boolean ;
424   fhir:valueset-oid "urn:oid:2.16.840.1.113883.4.642.1.50" ;
425   fhir:value "http://hl7.org/fhir/cs/allergy-intolerance-status" ;
426   fhir:prefix "http://hl7.org/fhir/allergy-intolerance-status#" ;
427   fhir:version "1.0.2" .
```

428 Note that since this acts as a namespace it has the case sensitivity indicator and a prefix to prepend the concepts
429 to make them unique.

430 **4.1.2.2 SNOMED Code System URI example**

```
431    ##### http://snomed.info/sct  
432  
433 <http://snomed.info/sct> rdf:type fhir:CodeSystemURI , owl:NamedIndividual ;  
434   fhir:value "http://snomed.info/sct"^^xsd:anyURI .  
435   fhir:caseSensitive "false"^^xsd:boolean ;  
436   fhir:prefix "http://snomed.info/id/"^^xsd:string ;  
437   fhir:valueset-oid "2.16.840.1.113883.6.96" ;  
438   fhir:version "US1000124_20140301" .
```

439 Code systems are published at <http://hl7-fhir.github.io/terminologies-systems.html> and the URI identifier is
440 used for FHIR/RDF rather than the OID.

441 **4.1.2.3 Code System Version**

442 Version of code system as part of the name is TBD.

443 **4.2 Concept**

444 **4.2.1 HL7 FHIR Concept XML**

445 The following fragment from Allergy Intolerance Status found at <http://hl7-fhir.github.io/valueset-allergy-intolerance-status.html>

447 In FHIR, Code System contains ValueSet.codeSystem.concept elements.

448 ValueSet.codeSystem.concept have code, abstract, display, definition, designation and nested
449 Valueset.Concepts.

```
450 <codeSystem>  
451   <extension url="http://hl7.org/fhir/StructureDefinition/valueset-oid">  
452     <valueUri value="urn:oid:2.16.840.1.113883.4.642.1.50"/>  
453   </extension>  
454   <system value="http://hl7.org/fhir/allergy-intolerance-status"/>  
455   <version value="1.0.0"/>  
456   <caseSensitive value="true"/>  
457   <concept>  
458     <code value="active"/>  
459     <display value="Active"/>  
460     <definition value="An active record of a reaction to the identified Substance."/>  
461     <concept>  
462       <code value="confirmed"/>  
463       <display value="Confirmed"/>  
464       <definition value="A high level of certainty about the propensity for a reaction to the identified Substance,  
465         which may include clinical evidence by testing or rechallenge."/>  
466     </concept>  
467   </concept>  
468 </codeSystem>  
469 </ValueSet>
```

470 The nesting of <concept> represents general to specific concepts although the structure does not indicate that
471 semantic but rather a containment.

472 **4.2.2 RDF Concept Definition**

473 A Concept in RDF/OWL is a named Class which has a restriction for CodingBase individuals associated with that
474 concept. A specific Concept is a named subclass of the fhir:Concepts class or it is a subclass of another Concept.
475 Where the restrictions are defined on the Concept they are the intersection of the restriction on
476 ConceptBase.coding and CodingBase.code and CodingBase.system.

477 Concepts may have one or more CodingBase restrictions. The FHIR valueset resource structure definition only
478 allows one but the RDF equivalent will relax that cardinality. A Concept which has multiple Codes associated
479 with it, have a union of multiple CodingBase.code restrictions.

480 ***4.2.2.1 FHIR internal XML Concept mapping***

481 The RDF Concept is a named Class which maps to the components of the ValueSet.codeSystem.concept element
482 in FHIR Valueset Resource.

- 483 • System maps to the restriction on CodingBase.system
- 484 • Code maps to the restriction on CodingBase.code
- 485 • Display maps to rdfs:label
- 486 • Definition maps to fhir:concept_definition annotation
- 487 • Nesting maps to subclass assertions (as a default)
- 488 • An abstract Concept (ValueSetConcept.abstract = “true”) has no restriction on CodingBase.code just a
489 position in the class hierarchy.
- 490 • Designation will probably transform into annotation language (e.g. @en) or type.

491 4.2.2.2 *HL7 Internal Concept RDF Example*

```
492    #### http://hl7.org/fhir/allergy-intolerance-status#Concept
493
494    allergy-intolerance-status:Concept rdf:type owl:Class ;
495     rdfs:label "Allergy Intolerance Status Concept" ;
496     rdfs:subClassOf fhir:Concepts ;
497     fhir:concept_definition "Assertion about certainty associated with a propensity, or potential risk, of a reaction to the
498     identified Substance." .
499
500    #### http://hl7.org/fhir/allergy-intolerance-status#active
501
502    allergy-intolerance-status:active rdf:type owl:Class ;
503     rdfs:label "Active" ;
504     rdfs:subClassOf allergy-intolerance-status:Concept ;
505     fhir:concept_definition "An active record of a reaction to the identified Substance" .
506
507    [ rdf:type owl:Restriction ;
508     rdfs:subClassOf allergy-intolerance-status:active ; owl:onProperty fhir:ConceptBase.coding ;
509     owl:someValuesFrom [ rdf:type owl:Class ;
510       owl:intersectionOf ( [ rdf:type owl:Restriction ;
511         owl:onProperty fhir:CodingBase.code ;
512         owl:allValuesFrom [ rdf:type owl:Restriction ;
513           owl:onProperty fhir:value ;
514           owl:hasValue "active"
515         ]
516       ]
517       [ rdf:type owl:Restriction ;
518         owl:onProperty fhir:CodingBase.system ;
519         owl:hasValue fhircs:allergy-intolerance-status
520       ]
521     )
522   ]
523 ]
524
525    #### http://hl7.org/fhir/allergy-intolerance-status#confirmed
526
527    allergy-intolerance-status:confirmed rdf:type owl:Class ;
528     rdfs:label "Confirmed@en" ;
529     rdfs:subClassOf allergy-intolerance-status:active ;
530     fhir:concept_definition "A high level of certainty about the propensity for a reaction to the identified Substance, which may
531     include clinical evidence by testing or rechallenge." .
532
533    [ rdf:type owl:Restriction ;
534     rdfs:subClassOf allergy-intolerance-status:confirmed ; owl:onProperty fhir:ConceptBase.coding ;
535     owl:someValuesFrom [ rdf:type owl:Class ;
536       owl:intersectionOf ( [ rdf:type owl:Restriction ;
537         owl:onProperty fhir:CodingBase.code ;
538         owl:allValuesFrom [ rdf:type owl:Restriction ;
539           owl:onProperty fhir:value ;
540           owl:hasValue "confirmed"
541         ]
542       ]
543       [ rdf:type owl:Restriction ;
544         owl:onProperty fhir:CodingBase.system ;
545         owl:hasValue fhircs:allergy-intolerance-status
546       ]
547     )
548   ]
549 ]
550
551
```

552 **4.2.2.3 External Concept RDF Example**
553 An external terminology is treated differently in that it is assumed that the ontology provided by the external
554 organization cannot be changed. A bridging ontology is therefore provided which allows the expressions to be
555 added to bind to the FHIR CodingBase instances.

556 The bridging ontology is constructed to add the expressions to categorize FHIR CodingBase individuals. This
557 binding occurs at both code/system and concepts. Direct use of the declared SNOMED concept identifier is
558 shown here but it is also possible to make an equivalent class if needed.

559 **4.2.2.3.1 External SNOMED Ontology**

560 The following example from the SNOMED OWL extraction shows the two top Concepts referenced in the
561 valueset substance-code:

```
562    ### http://snomed.info/id/105590001  
563    <http://snomed.info/id/105590001> rdf:type owl:Class ;  
564         rdfs:label "Substance (substance)" ;  
565         rdfs:subClassOf <http://snomed.info/id/138875005> .  
566  
567    ### http://snomed.info/id/373873005  
568    <http://snomed.info/id/373873005> rdf:type owl:Class ;  
569         rdfs:label "Pharmaceutical / biologic product (product)" ;  
570         rdfs:subClassOf <http://snomed.info/id/138875005> .  
571  
572
```

573 Notice there is no description and the display value is in rdfs:label. Concept 138875005 is the top level SNOMED
574 CT concept.

575 The extensions of the value set beyond substance-code are defined in SNOMED:

```
576    ### http://snomed.info/id/160244002  
577    <http://snomed.info/id/160244002> rdf:type owl:Class ;  
578         rdfs:label "No Known Allergies" ;  
579         rdfs:subClassOf <http://snomed.info/id/138875005> .  
580  
581    ### http://snomed.info/id/409137002  
582    <http://snomed.info/id/409137002> rdf:type owl:Class ;  
583         rdfs:label "No Known Drug Allergies" ;  
584         rdfs:subClassOf <http://snomed.info/id/138875005> .  
585  
586    ### http://snomed.info/id/428607008  
587    <http://snomed.info/id/428607008> rdf:type owl:Class ;  
588         rdfs:label "No Known Environmental Allergy" ;  
589         rdfs:subClassOf <http://snomed.info/id/138875005> .  
590  
591    ### http://snomed.info/id/429625007  
592    <http://snomed.info/id/429625007> rdf:type owl:Class ;  
593         rdfs:label "No Known Food Allergies" ;  
594         rdfs:subClassOf <http://snomed.info/id/138875005> .  
595  
596    597  
598
```

599 These are shown as subclasses of the top concept which is incorrect.

600 **4.2.2.3.2 Bridging Ontology**

601 The FHIR SCTBridge ontology imports both fhir and snomed ontologies so it can see both:

```
602    <http://hl7.org/fhirSCTBridge> rdf:type owl:Ontology ;  
603         owl:imports <http://hl7.org/fhir> ,  
604                    <http://snomed.info/id> .
```

605 The SNOMED ontology is named <http://snomed.info/id> which makes the concept URI construction natural.

606 The restrictions on the Concepts to CodingBase individuals are made through general class axioms in the same
607 way as internal code systems:

```
[ rdf:type owl:Restriction ;
  rdfs:subClassOf <http://snomed.info/id/90614001> ;
  owl:onProperty fhir:ConceptBase.coding ;
  owl:someValuesFrom [ rdf:type owl:Class ;
    owl:intersectionOf ( [ rdf:type owl:Restriction ;
      owl:onProperty fhir:CodingBase.code ;
      owl:allValuesFrom [ rdf:type owl:Restriction ;
        owl:onProperty fhir:value ;
        owl:hasValue "90614001"
      ]
    ]
    [ rdf:type owl:Restriction ;
      owl:onProperty fhir:CodingBase.system ;
      owl:hasValue <http://snomed.info/sct>
    ]
  )
] .
```

626 This example shows that the Concept “Beta lactam antibiotic” is inferred when the ConceptBase.coding has a
627 CodingBase where CodingBase.code has a code of 90614001 and CodingBase.system has value
628 <<http://snomed.info/sct>>.

629 **4.2.3 Relationship of Concept to Code SystemURI**

630 The concept defines its CodeSystemURI through ConceptBase.system restriction.

631 The CodeSystemURI being an individual has no relationship to the Concepts in the Code system which are
632 Classes.

633 **4.3 ValueSets**

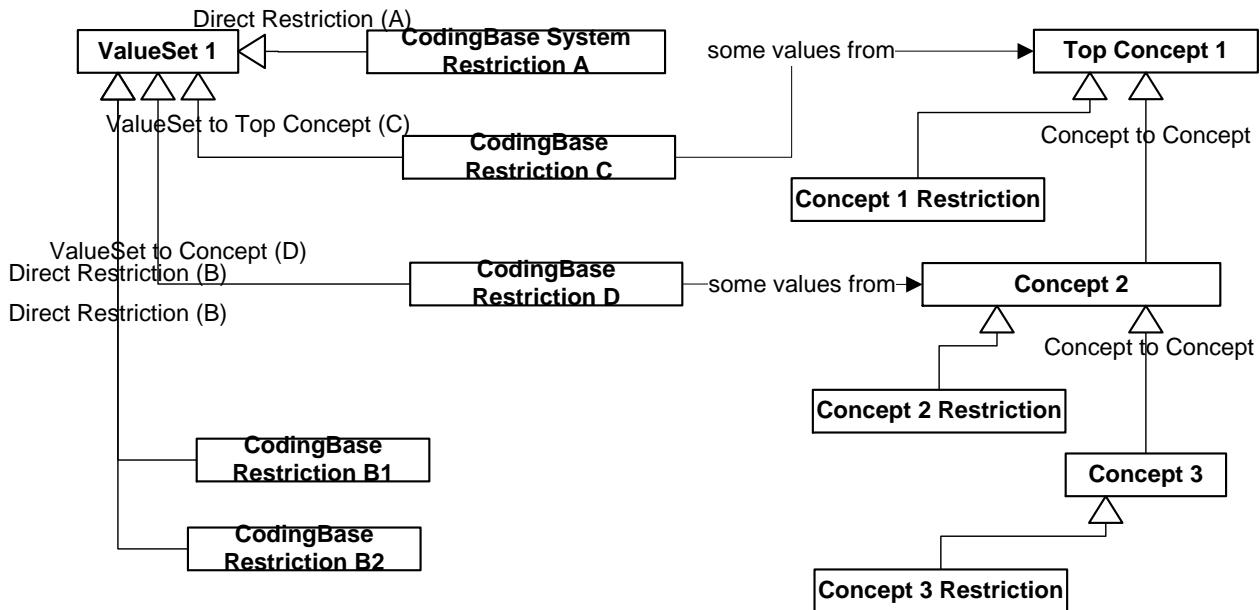
634 A ValueSet in RDF is a specific Class which defines the CodingBase individuals which are members of it.

635 There are two ways of declaring the ValueSet in RDF –

- 636 • ValueSets are named Classes with direct restrictions on CodingBase individuals (system + code)
- 637 • ValueSets are named Classes representing sets of CodingBase restrictions via Concept restrictions.

638 See the later section for more detailed consideration of the flexibility of ValueSet definitions. These definitions
639 will be mapped into the two ways above.

640 The following diagram shows the subclass relationships between the classes:



641

A

642 valueset defines a subset of CodingBase individuals which meet the constraints of that ValueSet.

643 Four cases are explored A & B are the direct restrictions and C & D are indirect via concepts:

- 644 A. Aligned ValueSet with Code system (all codes from).
- 645 B. Unaligned ValueSet direct restriction on CodingBase
- 646 C. Aligned ValueSet with Top Concept (all concepts from)
- 647 D. Unaligned ValueSet restriction on Concepts

4.3.1 FHIR Schema definition

4.3.1.1 Allergy Intolerance Status Structural Definition

```

650 <element>
651   <path value="AllergyIntolerance.status"/>
652   <short value="active | unconfirmed | confirmed | inactive | resolved | refuted | entered-in-error"/>
653   <definition value="Assertion about certainty associated with the propensity, or potential risk, of a reaction
654     to the identified Substance."/>
655   <comments value="Decision support would typically raise alerts for 'Unconfirmed', 'Confirmed', and 'Resolved'
656     and ignore a 'Refuted' reaction. In particular, 'Refuted' may be useful for reconciliation of the Adverse Reaction
657     List. Some implementations may choose to make this field mandatory."/>
658   <alias value="State"/>
659   <min value="0"/>
660   <max value="1"/>
661   <type>
662     <code value="code"/>
663   </type>
664   <isModifier value="true"/>
665   <isSummary value="true"/>
666   <binding>
667     <strength value="required"/>
668     <description value="Assertion about certainty associated with a propensity, or potential risk, of a reaction
669       to the identified Substance."/>
670   <valueSetReference>
671     <reference value="http://hl7.org/fhir/ValueSet/allergy-intolerance-status"/>
672   </valueSetReference>
673 </binding>
674 <mapping>
675   <identity value="v2"/>
676   <map value="IAM-17"/>
677 </mapping>
678 <mapping>
679   <identity value="w5"/>
680   <map value="status"/>
681 </mapping>
682 </element>
```

4.3.1.2 AllergyIntolerance.substance Structural Definition

```

684 <element>
685   <path value="AllergyIntolerance.substance"/>
686   <short value="Substance, (or class) considered to be responsible for risk"/>
687   <definition value="Identification of a substance, or a class of substances, that is considered to be responsible
688     for the adverse reaction risk."/>
689   <comments value="It is strongly recommended that the substance be coded with a terminology, where possible.
690     For example, some terminologies used include RxNorm, SNOMED CT, DM+D, NDFRT, ICD-9, IDC-10,
691     UNI, ATC and CPT. Plain text should only be used if there is no appropriate terminology
692     available. Additional details about a substance can be specified in the text."/>
693   <alias value="Agent"/>
694   <min value="1"/>
695   <max value="1"/>
696   <type>
697     <code value="CodeableConcept"/>
698   </type>
699   <isSummary value="true"/>
700   <binding>
701     <strength value="example"/>
702     <description value="Type of the substance and Negation codes for reporting no known allergies."/>
703   <valueSetReference>
704     <reference value="http://hl7.org/fhir/ValueSet/allergyintolerance-substance-code"/>
705   </valueSetReference>
706 </binding>
707 <mapping>
708   <identity value="v2"/>
709   <map value="AL1-3 / IAM-3"/>
710 </mapping>
711 <mapping>
712   <identity value="w5"/>
713   <map value="what"/>
714 </mapping>
715 </element>
```

4.3.2 OWL Schema Definition

717 **4.3.2.1 Allergy Intolerance Class**

718 The OWL schema fragment for the class and object properties is shown here:

```
719    ##### http://hl7.org/fhir/AllergyIntolerance
720    fhir>AllergyIntolerance rdf:type owl:Class ;
721
722                 rdfs:subClassOf fhir:DomainResource ,
723                         [ rdf:type owl:Restriction ;
724                         owl:onProperty fhir>AllergyIntolerance.status ;
725                         owl:allValuesFrom fhirvs:allergy-intolerance-statusA
726                         ] ,
727                         [ rdf:type owl:Restriction ;
728                         owl:onProperty fhir>AllergyIntolerance.status ;
729                         owl:maxCardinality "1"^^xsd:nonNegativeInteger
730                         ] ,
731                         [ rdf:type owl:Restriction ;
732                         owl:onProperty fhir>AllergyIntolerance.patient ;
733                         owl:allValuesFrom fhir:Reference
734                         ] ,
735                         [ rdf:type owl:Restriction ;
736                         owl:onProperty fhir>AllergyIntolerance.patient ;
737                         owl:maxCardinality "1"^^xsd:nonNegativeInteger
738                         ] ,
739                         [ rdf:type owl:Restriction ;
740                         owl:onProperty fhir>AllergyIntolerance.substance ;
741                         owl:allValuesFrom fhir:CodeableConcept
742                         ] ,
743                         [ rdf:type owl:Restriction ;
744                         owl:onProperty fhir>AllergyIntolerance.substance ;
745                         owl:maxCardinality "1"^^xsd:nonNegativeInteger
746                         ] ,
747
748                 .....
749
.
```

750

751 It shows that:

- 752 • AllergyIntolerance.status is restricted to the set defined by fhirvs:allergy-intolerance-statusA.
753 • AllergyIntolerance.substance is not restricted to the set defined by
754 fhirvs:allergyintolerance-substance-code but purely to the CodeableConcept since the binding is
755 “example”.

756 However due to OWA approaches by the reasoner (HermiT) an inconsistency is not detected.

757 **4.3.2.2 AllergyIntolerance.status Object Property definition**

```
758    ##### http://hl7.org/fhir/AllergyIntolerance.status  
759  
760    fhir:AllergyIntolerance.status rdf:type owl:ObjectProperty ;  
761     fhir:binding.valueSetReference "http://hl7.org/fhir/ValueSet/allergy-intolerance-status"^^xsd:anyURI ;  
762     fhir:isModifier "true"^^xsd:boolean ;  
763     fhir:isSummary "true"^^xsd:boolean ;  
764     rdfs:comment "Decision support would typically raise alerts for 'Unconfirmed', 'Confirmed', and 'Resolved' and ignore a 'Refuted' reaction. In particular, 'Refuted' may be useful for reconciliation of the Adverse Reaction List. Some implementations may choose to make this field mandatory." ;  
765     fhir:short "active | unconfirmed | confirmed | inactive | resolved | refuted | entered-in-error" ;  
766     fhir:binding.description "Assertion about certainty associated with a propensity, or potential risk, of a reaction to the identified Substance." ;  
767     fhir:concept_definition "Assertion about certainty associated with the propensity, or potential risk, of a reaction to the identified Substance." ;  
768     fhir:binding.strength "required" ;  
769     rdfs:domain fhir:AllergyIntolerance ;  
770     rdfs:range fhir:code ;  
771     rdfs:subPropertyOf fhir:objectProperty .  
772  
773  
774  
775
```

776 **4.3.2.3 AllergyIntolerance.substance Object Property**

```
777    ##### http://hl7.org/fhir/AllergyIntolerance.substance  
778  
779    fhir:AllergyIntolerance.substance rdf:type owl:ObjectProperty ;  
780     fhir:isSummary "true"^^xsd:boolean ;  
781     fhir:binding.valueSetReference "http://hl7.org/fhir/ValueSet/allergyintolerance-substance-code" ;  
782     fhir:short "Substance, (or class) considered to be responsible for risk" ;  
783     fhir:concept_definition "Identification of a substance, or a class of substances, that is considered to be responsible for the adverse reaction risk." ;  
784     fhir:binding.strength "example" ;  
785     rdfs:comment "It is strongly recommended that the substance be coded with a terminology, where possible. For example, some terminologies used include RxNorm, SNOMED CT, DM+D, NDFRT, ICD-9, IDC-10, UNI, ATC and CPT. Plain text should only be used if there is no appropriate terminology available. Additional details about a substance can be specified in the text." ;  
786     fhir:binding.description "Type of the substance and Negation codes for reporting no known allergies." ;  
787     rdfs:domain fhir:AllergyIntolerance ;  
788     rdfs:range fhir:CodeableConcept ;  
789     rdfs:subPropertyOf fhir:objectProperty .  
790  
791  
792
```

793

794 **4.3.3 Approach to Conformance**

795 Binding strength to a ValueSet determines the conformance of the CodingBase.

796 Almost all of the elements that have a coded data type are bound to a value set. The bindings are associated
797 with various degrees of flexibility as to how closely the value set should be followed:

required	To be conformant, instances of this element SHALL include a code from the specified value set
extensible	To be conformant, instances of this element must include a code from the specified value set if any of the codes within the value set can apply to the concept being communicated. If the valueset does not cover the concept (based on human review), alternate codings (from different code systems, including local ones) or (data type allowing) text) may be included instead.
preferred	Instances are encouraged, to draw from the specified codes for interoperability purposes but are not required to do so to be considered conformant
example	Instances are not expected or even encouraged to draw from the specified value set. The value set merely provides examples of the types of concepts intended to be included

798 The classes that the CodingBase individual belong to, are inferred and the individual must belong to the
799 ValueSet class declared in the schema if its binding strength is “required”.

800 In the example above, the individual ConceptBase has a CodingBase which is a member of **fhirvs:allergy-**
801 **intolerance-statusA** so the ConceptBase individual is conformant to the schema.

802 This implies that a reasoner will work from the values in the CodingBase.system and CodingBase.code to infer
803 the classes. The ValueSet Class must be equivalent or a superclass of the restriction for this to work.

804 Being a member of the Target ValueSet meets the “required” binding strength. Being a member of another
805 ValueSet meets the “extensible” binding strength.

806 Note that the binding strength for AllergyIntolerance.substance is “example”. It is expected that a Profile would
807 strengthen this to “required”.

808 In ORIM, the subclassing of restrictions approach (as a general Class axiom) is taken which avoids complications
809 from propagation. This subclass approach for restrictions and the superclass approach for Concepts will be taken
810 in FHIR/RDF.

811 The testing of the conformance is outside the scope of this paper but is expected to be performed with rules or
812 query languages.

813 4.3.4 HL7 Internal Concept RDF Example

814 4.3.4.1 *CodeSystem and Concept XML*

```
815 <ValueSet xmlns="http://hl7.org/fhir">
816   <id value="allergy-intolerance-status"/>
817   <meta>
818     <lastUpdated value="2015-10-27T02:58:28.599+00:00"/>
819     <profile value="http://hl7.org/fhir/StructureDefinition/valueset-shareable-definition"/>
820   </meta>
821   <text>
822
823   </text>
824   <extension url="http://hl7.org/fhir/StructureDefinition/valueset-oid">
825     <valueUri value="urn:oid:2.16.840.1.113883.4.642.2.50"/>
826   </extension>
827   <url value="http://hl7.org/fhir/ValueSet/allergy-intolerance-status"/>
828   <version value="1.0.2"/>
829   <name value="AllergyIntoleranceStatus"/>
830   <status value="draft"/>
831   <experimental value="false"/>
832   <publisher value="HL7 (FHIR Project)"/>
833   <contact>
834     <telecom>
835       <system value="other"/>
836       <value value="http://hl7.org/fhir"/>
837     </telecom>
838     <telecom>
839       <system value="email"/>
840       <value value="fhir@lists.hl7.org"/>
841     </telecom>
842   </contact>
843   <date value="2015-10-27T02:58:28+00:00"/>
844   <description value="Assertion about certainty associated with a propensity, or potential risk, of a reaction
845     to the identified Substance."/>
846   <codeSystem>
847     <extension url="http://hl7.org/fhir/StructureDefinition/valueset-oid">
848       <valueUri value="urn:oid:2.16.840.1.113883.4.642.1.50"/>
849     </extension>
850     <system value="http://hl7.org/fhir/allergy-intolerance-status"/>
851     <version value="1.0.2"/>
852     <caseSensitive value="true"/>
853     <concept>
854       <code value="active"/>
855       <display value="Active"/>
856       <definition value="An active record of a reaction to the identified Substance."/>
857       <concept>
858         <code value="unconfirmed"/>
859         <display value="Unconfirmed"/>
860         <definition value="A low level of certainty about the propensity for a reaction to the identified Substance."/>
861       </concept>
862     <concept>
863       <code value="confirmed"/>
864       <display value="Confirmed"/>
865       <definition value="A high level of certainty about the propensity for a reaction to the identified Substance,
866         which may include clinical evidence by testing or rechallenge."/>
867     </concept>
868   </concept>
869   <concept>
870     <code value="inactive"/>
871     <display value="Inactive"/>
872     <definition value="An inactive record of a reaction to the identified Substance."/>
873     <concept>
874       <code value="resolved"/>
875       <display value="Resolved"/>
876       <definition value="A reaction to the identified Substance has been clinically reassessed by testing or rechallenge
877         and considered to be resolved."/>
878     </concept>
879   </concept>
880   <concept>
881     <code value="refuted"/>
882     <display value="Refuted"/>
883     <definition value="A propensity for a reaction to the identified Substance has been disproven with a high
884       level of clinical certainty, which may include testing or rechallenge, and is refuted."/>
885   </concept>
886   <concept>
887     <code value="entered-in-error"/>
888     <display value="Entered In Error"/>
889     <definition value="The statement was entered in error and is not valid."/>
```

```
889 </concept>
890 </concept>
891 </codeSystem>
892 </ValueSet>
```

4.3.4.2 RDF Direct Restriction Aligned with a Code System (A)

The first option for value set is where the valueset entry defines the direct restriction on code and system itself without referencing a named concept and when the ValueSet is aligned (all codes from) with the CodingSystem the declaration is simple.

Valueset allergy-intolerance-statusA is defined using general class axiom restriction on CodingBase.system

```
898 #### http://hl7.org/fhir/ValueSet/allergy-intolerance-statusA
899 fhirvs:allergy-intolerance-statusA rdf:type owl:Class ;
900   rdfs:subClassOf fhir:Valuesets .
901
902 [ rdf:type owl:Restriction ;
903   rdfs:subClassOf fhirvs:allergy-intolerance-statusA ;
904   owl:onProperty fhir:CodingBase.system ;
905   owl:hasValue fhircs:allergy-intolerance-status
906 ]
907
908 ] .
```

However, this mechanism does not validate that the coding is actually a member of the Code System which cannot be done without doing an indirect restriction (see C).

4.3.4.3 RDF Direct Restriction Unaligned with a Code System (B)

When the ValueSet is not aligned with the code system, then expressions which represent the allowed code values must be included as shown in allergy-intolerance-statusB. This is the most direct equivalent of the XML example above.

```
916 #### http://hl7.org/fhir/ValueSet/allergy-intolerance-statusB
917 fhirvs:allergy-intolerance-statusB rdf:type owl:Class ;
918   rdfs:subClassOf fhir:CodingBase_in_Valuesets .
919
920 [ rdf:type owl:Class ;
921   rdfs:subClassOf fhirvs:allergy-intolerance-statusB ;
922   owl:intersectionOf ( [ rdf:type owl:Restriction ; owl:onProperty fhir:CodingBase.code ;
923     owl:someValuesFrom [ rdf:type owl:Class ;
924       owl:unionOf ( [ rdf:type owl:Restriction ; owl:onProperty fhir:value ;
925         owl:hasValue "confirmed"
926         ]
927         [ rdf:type owl:Restriction ; owl:onProperty fhir:value ;
928           owl:hasValue "unconfirmed"
929         ]
930       )
931     ]
932   ]
933   [ rdf:type owl:Restriction ; owl:onProperty fhir:CodingBase.system ;
934     owl:hasValue fhircs:allergy-intolerance-status
935   ]
936 ]
937 ]
938 ] .
```

This expression shows the allergy-intolerance-statusB value set including the codes “confirmed” and “unconfirmed” within the Code System fhircs:allergy-intolerance-status . More sophisticated filtering expressions in FHIR will have to be translated into this language but since there is no subclass relationships between the code tokens, all subclass trees must be spelled out as lists of coding restrictions.

944 **4.3.4.4 RDF Aligned ValueSet of CodingBase individuals within Top Concept (C)**

945 Since we can use the set expressions of OWL on classes (Concepts) there is a simplification to the expression of
946 Valuesets subclasses as shown in allergy-intolerance-statusC.

947 The concepts are named classes as shown earlier. The Valuesets subclass can now refer to these named classes
948 avoiding repetitive declaration of anonymous classes.

949 When the valueset is aligned with the code system the ValueSet is a superclass of all the CodingBase individuals
950 which have a type Concept of the top concept (inferred).

```
951     ### http://hl7.org/fhir/ValueSet/allergy-intolerance-statusC
952
953     fhirvs:allergy-intolerance-statusC rdf:type owl:Class ;
954       rdfs:label "Allergy Int Status C" ;
955       rdfs:subClassOf fhir:Valuesets .
956
957     [ rdf:type owl:Restriction ;
958       rdfs:subClassOf fhirvs:allergy-intolerance-statusC ;
959       owl:onProperty fhir:CodingBase.concept ;
960       owl:someValuesFrom allergy-intolerance-status:Concept
961     ] .
```

962 This is entered as a general class axiom as in the other examples.

963 Note the Object Property CodingBase.concept which is the inverse of ConceptBase.coding:

```
964     ### http://hl7.org/fhir/CodingBase.concept
965
966     fhir:CodingBase.concept rdf:type owl:ObjectProperty ;
967       owl:inverseOf fhir:ConceptBase.coding ;
968       rdfs:subPropertyOf fhir:objectProperty .
```

969 The object property is then used in the restriction to say that the CodingBase individual belongs to the Concept
970 as defined in the Concept restriction (in section 4.2.3).

971 **4.3.4.5 RDF CodingBase individuals of specific Concepts (D)**

972 When the value set is not all codes from the code system it can be defined as the union of concepts.

```
973     ### http://hl7.org/fhir/ValueSet/allergy-intolerance-statusD
974
975     fhirvs:allergy-intolerance-statusD rdf:type owl:Class ;
976       rdfs:subClassOf fhir:CodingBase_in_Valuesets .
977
978     [ rdf:type owl:Restriction ;
979       rdfs:subClassOf fhirvs:allergy-intolerance-statusD ;
980       owl:onProperty fhir:CodingBase.concept ;
981       owl:someValuesFrom [ rdf:type owl:Class ;
982               owl:unionOf ( allergy-intolerance-status:confirmed
983                            allergy-intolerance-status:unconfirmed
984                           )
985
986       ] .
```

987 Notice that the prefixes for the code system are shown which makes it readable.

988 This valueset includes all the subclasses of “confirmed” and “unconfirmed” if they exist which is a default “is-a”
989 operator in the filter.

990 This is equivalent to <compose><include/exclude><concept> and <codeSystem><concept> in the FHIR Valueset
991 Resource Structural Definition. (see later discussion of the mapping to RDF).

992 4.3.5 External terminology ValueSets

993 4.3.5.1 All codes from

994 No examples are given where the Valueset is all codes from an external code system since this is generally too
995 broad. If this is required the same process as internal terminologies can be used.

996 4.3.5.2 ValueSet Resource example in XML

997 The valueset “allergyintolerance-substance-code” includes the valueset “substance-code” but adds some
998 additional codes:

```
999 <ValueSet xmlns="http://hl7.org/fhir">  
1000   <id value="substance-code"/>  
1001  
1002   <description value="This value set contains concept codes for specific substances"/>  
1003   <copyright value="This value set includes content from SNOMED CT, which is copyright © 2002+ International  
1004     Health Terminology Standards Development Organisation (IHTSDO), and distributed by agreement  
1005     between IHTSDO and HL7. Implementer use of SNOMED CT is not covered by this agreement"/>  
1006   <compose>  
1007     <include>  
1008       <system value="http://snomed.info/sct"/>  
1009       <filter>  
1010         <property value="concept"/>  
1011         <op value="is-a"/>  
1012         <value value="105590001"/>  
1013       </filter>  
1014     </include>  
1015     <include>  
1016       <system value="http://snomed.info/sct"/>  
1017       <filter>  
1018         <property value="concept"/>  
1019         <op value="is-a"/>  
1020         <value value="373873005"/>  
1021       </filter>  
1022     </include>  
1023   </compose>  
1024 </ValueSet>
```

1025

```
1026 <ValueSet xmlns="http://hl7.org/fhir">  
1027   <id value="allergyintolerance-substance-code"/>  
1028  
1029   <description value="This value set includes concept codes for specific substances and negation codes to specify  
1030     the absence of specific types of allergies." />  
1031   <copyright value="This value set includes content from SNOMED CT, which is copyright © 2002+ International  
1032     Health Terminology Standards Development Organisation (IHTSDO), and distributed by agreement  
1033     between IHTSDO and HL7. Implementer use of SNOMED CT is not covered by this agreement"/>  
1034   <compose>  
1035     <import value="http://hl7.org/fhir/ValueSet/substance-code"/>  
1036     <include>  
1037       <system value="http://snomed.info/sct"/>  
1038       <concept>  
1039         <code value="160244002"/>  
1040         <display value="No Known Allergies"/>  
1041       </concept>  
1042       <concept>  
1043         <code value="429625007"/>  
1044         <display value="No Known Food Allergies"/>  
1045       </concept>  
1046       <concept>  
1047         <code value="409137002"/>  
1048         <display value="No Known Drug Allergies"/>  
1049       </concept>  
1050       <concept>  
1051         <code value="428607008"/>  
1052         <display value="No Known Environmental Allergy"/>  
1053       </concept>  
1054     </include>  
1055   </compose>  
1056 </ValueSet>
```

1057 Notice that allergyintolerance-substance-code extends substance-code with 4 concepts with their code
1058 restrictions and the system restriction at the beginning.

1059 4.3.5.3 *RDF CodingBase Direct Restriction Unaligned with a Code System (B)*

1060 The Valueset substance-codeB is declared in the FHIR ontology with no restrictions:

```
1061    ##### http://hl7.org/fhir/ValueSet/substance-codeB  
1062    fhirvs:substance-codeB rdf:type owl:Class ;  
1063      rdfs:label "Substance Code" ;  
1064      rdfs:subClassOf fhir:Valuesets.  
1065  
1066
```

1067

1068 In the Bridging Ontology, substance-codeB is declared against CodingBase.system and CodingBase.code
1069 restrictions.

```
1070    [ rdf:type owl:Class ;  
1071      rdfs:subClassOf <http://hl7.org/fhir/ValueSet/substance-codeB> ;  
1072      owl:intersectionOf ( [ rdf:type owl:Restriction ; owl:onProperty fhir:CodingBase.code ;  
1073        owl:allValuesFrom [ rdf:type owl:Class ;  
1074          owl:unionOf ( [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "105590001" ]  
1075          [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "373873005" ]  
1076         )  
1077         )  
1078         ]  
1079         [ rdf:type owl:Restriction ; owl:onProperty fhir:CodingBase.system ;  
1080          owl:hasValue <http://snomed.info/sct>  
1081         ]  
1082         )  
1083     )  
1084 ].
```

1085 This will only define the ValueSet as the top code and **does not** include all the subconcepts as codes. In order to
1086 do this an expansion must be made with a filter. See <http://hl7-fhir.github.io/valueset-allergyintolerance-substance-code.html>

1088 The operation <filter><op> declares “is-a” to mean transitive subclassing. However this is not understood by
1089 RDF/OWL. What is understood is the subclassing of the SNOMED Concept ontology itself.

1090 The only solution is to extract all the codes in the hierarchy and explicitly declare them in the Bridging Ontology.
1091 The treatment of allergyintolerance-substance-code is to add the concepts to the enumerated list.

1092 **4.3.5.4 RDF ValueSet binding to Concepts(D)**

1093 The valueset substance-codeD is declared in FHIR as before:

```
1094    ### http://hl7.org/fhir/ValueSet/substance-codeD  
1095    fhirvs:substance-codeB rdf:type owl:Class ;  
1096         rdfs:label "Substance Codes D" ;  
1097         rdfs:subClassOf fhir:Valuesets .
```

1099

1100 The allergyintolerance-substance-code valueset is also declared in FHIR

```
1101    ### http://hl7.org/fhir/ValueSet/allergyintolerance-substance-code  
1102    <http://hl7.org/fhir//ValueSet/allergyintolerance-substance-code> rdf:type owl:Class ;  
1103         rdfs:label "AllergyIntolerance Substance and Negation Codes" ;  
1104         rdfs:subClassOf fhir:CodingBase_in_Valuesets .
```

1106

1107 The bridging ontology declares a general Class axiom which shows the mapping to the Concepts:

```
1108    [ rdf:type owl:Restriction ;  
1109         rdfs:subClassOf <http://hl7.org/fhir/ValueSet/substance-codeD> ;  
1110         owl:onProperty fhir:CodingBase.concept ; owl:someValuesFrom [ rdf:type owl:Class ;  
1111                 owl:unionOf ( <http://snomed.info/id/105590001>  
1112                         <http://snomed.info/id/373873005>  
1113                         )  
1114                 ]  
1115         ].
```

1116

```
1117    [ rdf:type owl:Class ;  
1118         rdfs:subClassOf <http://hl7.org/fhir/ValueSet/allergyintolerance-substance-code> ;  
1119         owl:unionOf ( <http://hl7.org/fhir/ValueSet/substance-codeD>  
1120                 [ rdf:type owl:Restriction ;  
1121                         owl:onProperty fhir:CodingBase.concept ; owl:someValuesFrom [ rdf:type owl:Class ;  
1122                                 owl:unionOf ( <http://snomed.info/id/160244002>  
1123                                         <http://snomed.info/id/409137002>  
1124                                         <http://snomed.info/id/428607008>  
1125                                         <http://snomed.info/id/429625007>  
1126                                 )  
1127                 ]  
1128             )  
1129         ].
```

1131 CodingBase.concept defines the restriction on concepts for the Codingbase.

1132 The display values are redundant and since closure is achieved with these classes, their display as rdfs:label can
1133 be shown at any time in an OWL tool.

1134 4.3.6 Coding Binding to external terminology (section 1.17.3.3.5)

1135 4.3.6.1 FHIR XML

```
1136 <AllergyIntolerance xmlns="http://hl7.org/fhir" >
1137   <id value="1"/>
1138   <text>
1139     </text>
1140   <!-- the date that this entry was recorded -->
1141   <recordedDate value="2010-03-01"/>
1142   <!-- the patient that actually has the risk of adverse reaction -->
1143   <patient>
1144     <reference value="http://record/Patient/PeterPatient"/>
1145     <display value="Peter Patient"/>
1146   </patient>
1147   <!-- substance, coded from SNOMED CT-->
1148   <substance>
1149     <coding>
1150       <system value="http://snomed.info/id"/>
1151       <code value="90614001"/>
1152       <display value="beta-Lactam antibiotic"/>
1153     </coding>
1154   </substance>
1155   <status value="confirmed"/>
1156   <criticality value="high"/>
1157   <category value="medication"/>
1158 </AllergyIntolerance>
```

1159 4.3.6.2 RDF Instance Example

1160 This is the raw instance before processing and after in green for inference and red for specific processing

```
1161 @prefix : <http://record/AllergyIntolerance/> .
1162 @prefix owl: <http://www.w3.org/2002/07/owl#> .
1163 @prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
1164 @prefix sct: <http://snomed.info/id/> .
1165 @prefix xml: <http://www.w3.org/XML/1998/namespace> .
1166 @prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
1167 @prefix fhir: <http://hl7.org/fhir/> .
1168 @prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
1169 @prefix profile: <http://PatientSafetyProfile/> .
1170 @base <http://record/AllergyIntolerance/1> .
1171
1172 <http://record/AllergyIntolerance/> rdf:type owl:Ontology ;
1173   owl:imports <http://PatientSafetyProfile> .
1174
1175 ### http://record/AllergyIntolerance/1
1176
1177 <http://record/AllergyIntolerance/1> rdf:type profile:DomainResource, owl:NamedIndividual ;
1178   fhir:Resource.id [ rdf:type fhir:id ; fhir:value "1" ] ;
1179   fhir:AllergyIntolerance.status [ rdf:type fhir:code , <http://hl7.org/fhir/allergyIntoleranceStatus#confirmed> ;
1180     fhir:ConceptBase.coding [ fhir:CodingBase.code [ fhir:value "confirmed" ] ]
1181   ] ;
1182   fhir:AllergyIntolerance.patient [ rdf:type fhir:Reference ;
1183     fhir:Reference.reference [ fhir:value "http://record/Patient/PeterPatient" ] ;
1184     fhir:Reference.display [ fhir:value "Peter Patient" ] ;
1185     fhir:Reference.link <http://record/Patient/PeterPatient> ;
1186   ] ;
1187   fhir:AllergyIntolerance.substance [ rdf:type fhir:CodeableConcept , <http://snomed.info/id/90614001> ;
1188     rdfs:label "beta-lactam (antibiotic)" ;
1189     fhir:ConceptBase.coding [ rdf:type fhir:CodingBase ;
1190       fhir:CodingBase.code [ rdf:type fhir:codeBase ; fhir:value "90614001" ] ;
1191       fhir:CodingBase.system [ rdf:type fhir:string ; fhir:value "http://snomed.info/sct" ] ;
1192       fhir:CodingBase.display [ rdf:type fhir:string ; fhir:value "beta-lactam (antibiotic)" ]
1193     ] ;
1194     fhir:ConceptBase.text [ rdf:type fhir:string ; fhir:value "beta-lactam (antibiotic)" ]
1195   ] .
```

1196

1197 Note the use of a profile binding through the type “profile:AllergyIntolerance” which then restricts the types of
1198 CodingBase instances.

1199 **4.3.6.3 FHIR Allergy Intolerance OWL Schema**

1200 The schema is abridged to show the topics of interest:

```
1201 ### http://hl7.org/fhir/AllergyIntolerance
1202
1203 fhir:AllergyIntolerance rdf:type owl:Class ;
1204
1205     rdfs:subClassOf fhir:DomainResource ,
1206         [ rdf:type owl:Restriction ;
1207             owl:onProperty fhir:AllergyIntolerance.substance ;
1208             owl:maxCardinality "1"^^xsd:nonNegativeInteger
1209         ] ,
1210         [ rdf:type owl:Restriction ;
1211             owl:onProperty fhir:AllergyIntolerance.substance ;
1212             owl:allValuesFrom fhir:CodeableConcept
1213         ] ,
1214 Etc..
1215 .
```

1216 The substance Object Property has no valueset type yet only the restriction that it is a CodeableConcept type.

1217 The valueset gets applied through the structural definition or profile binding.

1218

1219 **4.3.6.4 Definitions of Code System, Concept**

1220 This section is needed to ground the definitions of Coding System, and Concept when defined in RDF/OWL.

1221 **4.3.6.4.1 Code System**

1222 *The system ensures that codes can be unambiguously traced back to their original definition, and that logical
1223 comparisons, matching and inferences can be performed consistently by different systems.*

1224 In RDF/OWL a code system is a namespace in which the code is unique. Since a code forms a fragment of a URI,
1225 the code-system forms a prefix to that fragment making it unique. The code system identity and the prefix may
1226 not be the same but are related using a property of the code system.

URI	Source	OID
http://snomed.info/sct	SNOMED CT (IHTSDO)	2.16.840.1.113883.6.96

1227 The prefix for snomed is <http://snomed.info.id/>

1228 However, the URI is a member of the fhir:uri class and an additional class is introduced – fhir:CodeSystemURI as
1229 a subclass of fhir:URI to define the set that are CodeSystem identifiers. The individual code system may then be
1230 declared and referenced:

```
1231    ### http://snomed.info/sct
1232
1233 <http://snomed.info/sct> rdf:type fhir:CodeSystemURI ,
1234                                 owl:NamedIndividual ;
1235
1236                                 fhir:value "http://snomed.info/sct" .
```

1237 A specific CodeSystem may be declared as a class which is a set of all the CodingBase individuals restricted by
1238 the CodingBase.system property.

```
1239    ### http://snomed.info/sct
1240
1241 <http://snomed.info/sct> rdf:type owl:Class ;
1242
1243                                 rdfs:subClassOf fhir:CodingBase_in_Systems .
```

1244 **4.3.6.4.2 Bridging Ontology**

1245 This forms a pun with the individual and it is declared in a bridging ontology which is aware of the constraints of
1246 Concepts in that Code System.

1247 The bridging ontology is aware of FHIR and the external terminology ontologies.

```
1248 [ rdf:type owl:Class ;
1249     rdfs:subClassOf <http://snomed.info/id/282100009> ;
1250     owl:intersectionOf ( <http://snomed.info/sct>
1251                                 [ rdf:type owl:Restriction ;
1252                                 owl:onProperty fhir:CodingBase.code ;
1253                                 owl:someValuesFrom [ rdf:type owl:Restriction ;
1254                                         owl:onProperty fhir:value ;
1255                                         owl:hasValue "282100009"
1256                                         ]
1257                                 )
1258 ] .
```

1261 4.3.6.4.3 Concept
1262 A concept may be a single Class in RDF which may in turn be a union of multiple classes based on subclass
1263 relationships.

1264 4.3.6.4.4 ValueSet
1265 Example is substance-code used in AllergyIntolerance

1266 4.3.6.4.4.1 Summary

Defining URL:	http://hl7.org/fhir/ValueSet/substance-code
Name:	Substance Code
Definition:	This value set contains concept codes for specific substances
OID:	2.16.840.1.113883.4.642.2.57 (for OID based terminology systems)
Copyright:	This value set includes content from SNOMED CT, which is copyright © 2002+ International Health Terminology Standards Development Organisation (IHTSDO), and distributed by agreement between IHTSDO and HL7. Implementer use of SNOMED CT is not covered by this agreement
Source Resource	XML / JSON

1267

1268 4.3.6.4.4.2 Content Logical Definition 

1269 This value set includes codes from the following code systems:

1270• Include codes from <http://snomed.info/sct> where concept is-a 105590001

1271• Include codes from <http://snomed.info/sct> where concept is-a 373873005

1272 4.3.6.4.4.3 RDF Definition

1273 Since these concepts in snomed are hierarchical classes the valueset is by definition a union of concept classes.

1274 However the concept class bound to a system should have a different metatype – e.g. systemconcept.

1275 A concept class is therefore a supertype of the systemconcept classes.

1276 A named Valueset as a class is a union of named systemconcept classes (not a superclass). If an instance of
1277 CodingBase is typed to a Valueset then it probably means that the codeBase is unknown or to be selected.

1278 The FHIR “include” gets stranslated to a union expression:

1279

1280 4.3.6.4.5 Examples

1281 4.3.6.4.5.1 Example from orim

```

1282 #### CONCEPT DOMAIN
1283 #### http://hl7.org/ontology/uv/vocab/cd#ActStatus
1284
1285 cd:ActStatus rdf:type :Class ;
1286     :equivalentClass [ rdf:type :Class ;
1287         :unionOf ( [ rdf:type :Restriction ;
1288             :onProperty hl7:VocabularyConcept.codingRef ;
1289             :someValuesFrom <urn:oid:2.16.840.1.113883.1.11.159331/Recent>
1290         ]
1291         [ rdf:type :Restriction ;
1292             :onProperty dt:ANY.nullFlavor ;
1293             :minCardinality "1"^^xs:nonNegativeInteger
1294         ]
1295     )
1296     ] ;
1297     rdfs:subClassOf hl7:ConceptDomain .
1298
1299 #### CONCEPT
1300 #### http://hl7.org/ontology/uv/vocab/cs/ActStatus/Concept
1301
1302 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/Concept> rdf:type :Class ;
1303     rdfs:subClassOf hl7:VocabularyConcept .
1304
1305 #### http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept
1306
1307 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept> rdf:type :Class ;
1308     rdfs:subClassOf <http://hl7.org/ontology/uv/vocab/cs/ActStatus/Concept> .
1309
1310 #### http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept#active
1311
1312 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept#active> rdf:type :Class ;
1313     :equivalentClass <urn:oid:2.16.840.1.113883.5.14/2011-12-20/Concept#active> ;
1314     rdfs:subClassOf <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept> ,
1315     <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept#normal> .
1316
1317 #### urn:oid:2.16.840.1.113883.5.14/2011-12-20/Concept#active
1318
1319 <urn:oid:2.16.840.1.113883.5.14/2011-12-20/Concept#active> rdf:type :Class ;
1320     :equivalentClass <urn:oid:2.16.840.1.113883.5.14/Recent/Concept#active> ;
1321     rdfs:subClassOf <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept> ,
1322     <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept#normal> .
1323
1324 #### urn:oid:2.16.840.1.113883.5.14/Recent/Concept#active
1325
1326 <urn:oid:2.16.840.1.113883.5.14/Recent/Concept#active> rdf:type :Class ;
1327     rdfs:subClassOf <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept> ,
1328     <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept#normal> .
1329
1330
1331 #### VALUESET
1332 #### http://hl7.org/ontology/uv/vocab/vs/ActStatus
1333
1334 vs:ActStatus rdf:type :Class ;
1335     :equivalentClass <http://hl7.org/ontology/uv/vocab/vs/ActStatus/2011-12-20> ,
1336     <urn:oid:2.16.840.1.113883.1.11.159331> ;
1337     rdfs:subClassOf hl7:ValueSet .
1338
1339 #### http://hl7.org/ontology/uv/vocab/vs/ActStatusActive
1340
1341 vs:ActStatusActive rdf:type :Class ;
1342     :equivalentClass <http://hl7.org/ontology/uv/vocab/vs/ActStatusActive/2011-12-20> ,
1343     <urn:oid:2.16.840.1.113883.1.11.20023> ;
1344     rdfs:subClassOf hl7:ValueSet .
1345

```

```

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### http://hl7.org/ontology/uv/vocab/vs/ActStatus/2011-12-20

<http://hl7.org/ontology/uv/vocab/vs/ActStatus/2011-12-20> rdf:type :Class ;
    :equivalentClass <urn:oid:2.16.840.1.113883.1.11.159331/2011-12-20> ,
        [ rdf:type :Class ;
            :intersectionOf ( [ rdf:type :Restriction ; :onProperty h17:Coding.codeSystemRef ;
                :hasValue <urn:oid:2.16.840.1.113883.5.14>
            ]
            [ rdf:type :Restriction ; :onProperty h17:Coding.codeSystemVersionRef ;
                :hasValue <urn:oid:2.16.840.1.113883.5.14/Recent>
            ]
        )
    ] ;
    rdfs:subClassOf h17:ValueSet .

### http://hl7.org/ontology/uv/vocab/vs/ActStatusActive/2011-12-20

<http://hl7.org/ontology/uv/vocab/vs/ActStatusActive/2011-12-20> rdf:type :Class ;
    :equivalentClass <urn:oid:2.16.840.1.113883.1.11.20023/2011-12-20> ,
        [ rdf:type :Class ; :intersectionOf ( [ rdf:type :Restriction ;:onProperty h17:Coding.conceptRef ;
            :someValuesFrom <urn:oid:2.16.840.1.113883.5.14/2011-12-20/Concept#active>
        ]
        [ rdf:type :Restriction ; :onProperty h17:Coding.codeSystemRef ;
            :hasValue <urn:oid:2.16.840.1.113883.5.14>
        ]
        [ rdf:type :Restriction ; :onProperty h17:Coding.codeSystemVersionRef ;
            :hasValue <urn:oid:2.16.840.1.113883.5.14/Recent>
        ]
    )
]
rdfs:subClassOf h17:ValueSet .

### CODE SYSTEM
### http://hl7.org/ontology/uv/vocab/cs/ActStatus

cs:ActStatus rdf:type h17:CodeSystem ,
    :NamedIndividual ,
    [ rdf:type :Restriction ;
        :onProperty h17:CodeSystem.versionRef ;
        :allValuesFrom [ rdf:type :Restriction ;
            :onProperty h17:CodeSystemVersion.codeSystem ;
            :hasValue "2.16.840.1.113883.5.14"^^xs:string
        ]
    ],
    [ rdf:type :Restriction ;
        :onProperty h17:CodeSystem.versionRef ;
        :allValuesFrom [ rdf:type :Class ;
            :oneOf ( <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20>
                    )
    ]
]
;

h17:CodeSystem.id "2.16.840.1.113883.5.14"^^xs:string ;
:sameAs <urn:oid:2.16.840.1.113883.5.14> .

### http://hl7.org/ontology/uv/vocab/cs/ActStatus/Recent

<http://hl7.org/ontology/uv/vocab/cs/ActStatus/Recent> rdf:type h17:CodeSystemVersion , :NamedIndividual ;
:sameAs <urn:oid:2.16.840.1.113883.5.14/Recent> .

### http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20

<http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20> rdf:type h17:CodeSystemVersion , :NamedIndividual ,
    [ rdf:type :Restriction ; :onProperty h17:CodeSystemVersion.codingRef ;
        :allValuesFrom [ rdf:type :Restriction ;:onProperty h17:Coding.codeSystemVersion ;
            :hasValue "2011-12-20"^^xs:string
        ]
]
```

```

1415
1416 ] ,
1417 [ rdf:type :Restriction ; :onProperty h17:CodeSystemVersion.codingRef ;
1418   :allValuesFrom [ rdf:type :Class ;
1419     :oneOf ( <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#nullified>
1420       <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#normal>
1421       <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#suspended>
1422       <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#new>
1423       <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#obsolete>
1424       <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#aborted>
1425       <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#active>
1426       <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#held>
1427       <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#completed>
1428       <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#cancelled>
1429     )
1430   ]
1431   ],
1432   [ rdf:type :Restriction ; :onProperty h17:CodeSystemVersion.codingRef ;
1433     :allValuesFrom [ rdf:type :Restriction ;:onProperty h17:Coding.codeSystemRef ;
1434       :hasValue cs:ActStatus
1435     ]
1436   ];
1437   h17:CodeSystemVersion.codeSystem "2.16.840.1.113883.5.14"^^xs:string ;
1438   h17:CodeSystemVersion.versionDate "2011-12-20"^^xs:string ;
1439   :sameAs <urn:oid:2.16.840.1.113883.5.14/2011-12-20> .
1440
1441 #### http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#active
1442 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#active> rdf:type h17:Coding ,:NamedIndividual ;
1443   h17:Coding.code "active"^^xs:string .
1444

```

1446 4.3.6.4.5.2 ValueSet schema in FHIR

1447 A ValueSet individual will have define, compose and expansion object properties to applicable objects. The
1448 following RDF samples show a direct translation of the metamodel viewpoint.

```

1449
1450  ### http://hl7.org/fhir/ValueSet
1451  fhir:ValueSet rdf:type owl:Class ;
1452      rdfs:subClassOf fhir:DomainResource ,
1453          [ rdf:type owl:Restriction ;
1454              owl:onProperty fhir:ValueSet.define ;
1455              owl:allValuesFrom fhir:ValueSet.Define
1456          ] ,
1457          [ rdf:type owl:Restriction ;
1458              owl:onProperty fhir:ValueSet.define ;
1459              owl:maxCardinality "1"^^xsd:nonNegativeInteger
1460          ] ,
1461          [ rdf:type owl:Restriction ;
1462              owl:onProperty fhir:ValueSet.compose ;
1463              owl:allValuesFrom fhir:ValueSet.Compose
1464          ] ,
1465          [ rdf:type owl:Restriction ;
1466              owl:onProperty fhir:ValueSet.expansion ;
1467              owl:maxCardinality "1"^^xsd:nonNegativeInteger
1468          ] ,
1469          [ rdf:type owl:Restriction ;
1470              owl:onProperty fhir:ValueSet.expansion ;
1471              owl:allValuesFrom fhir:ValueSet.Expansion
1472          ] ,
1473          [ rdf:type owl:Restriction ;
1474              owl:onProperty fhir:ValueSet.compose ;
1475              owl:maxCardinality "1"^^xsd:nonNegativeInteger
1476          ] .
1477
1478  ### http://hl7.org/fhir/ValueSet.Compose
1479  fhir:ValueSet.Compose rdf:type owl:Class ;
1480      rdfs:subClassOf fhir:BackboneElement .

```

```

1481
1482  ### http://hl7.org/fhir/ValueSet.Concept
1483  fhir:ValueSet.Concept rdf:type owl:Class ;
1484      rdfs:subClassOf fhir:BackboneElement ,
1485          [ rdf:type owl:Restriction ;
1486              owl:onProperty fhir:ValueSet.Concept.display ;
1487              owl:allValuesFrom fhir:string
1488          ] ,
1489          [ rdf:type owl:Restriction ;
1490              owl:onProperty fhir:ValueSet.Concept.code ;
1491              owl:cardinality "1"^^xsd:nonNegativeInteger
1492          ] ,
1493          [ rdf:type owl:Restriction ;
1494              owl:onProperty fhir:ValueSet.Concept.code ;
1495              owl:allValuesFrom fhir:code
1496          ] ,
1497          [ rdf:type owl:Restriction ;
1498              owl:onProperty fhir:ValueSet.Concept.definition ;
1499              owl:maxCardinality "1"^^xsd:nonNegativeInteger
1500          ] ,
1501          [ rdf:type owl:Restriction ;
1502              owl:onProperty fhir:ValueSet.Concept.display ;
1503              owl:maxCardinality "1"^^xsd:nonNegativeInteger
1504          ] ,
1505          [ rdf:type owl:Restriction ;
1506              owl:onProperty fhir:ValueSet.Concept.definition ;
1507              owl:allValuesFrom fhir:string
1508          ] .

```

```
1509
1510  ### http://hl7.org/fhir/ValueSet.Define
1511  fhir:ValueSet.Define rdf:type owl:Class ;
1512      rdfs:subClassOf fhir:BackboneElement ,
1513          [ rdf:type owl:Restriction ;
1514              owl:onProperty fhir:ValueSet.Define.system ;
1515              owl:allValuesFrom fhir:uri
1516          ] ,
1517          [ rdf:type owl:Restriction ;
1518              owl:onProperty fhir:ValueSet.Define.system ;
1519              owl:cardinality "1"^^xsd:nonNegativeInteger
1520          ] ,
1521          [ rdf:type owl:Restriction ;
1522              owl:onProperty fhir:ValueSet.Define.concept ;
1523              owl:allValuesFrom fhir:ValueSet.Concept
1524          ] .
1525
1526  ### http://hl7.org/fhir/ValueSet.Expansion
1527  fhir:ValueSet.Expansion rdf:type owl:Class ;
1528      rdfs:subClassOf fhir:BackboneElement .
```

1529

1530

1531 4.3.6.5 *FHIR internal System and Coding bindings (OWL Schema)*

1532 The system is inclusive of all the terms within it and all the instances of those terms.

```
1533 @prefix allergy-intolerance-status: <http://hl7.org/fhir/allergy-intolerance-status#> .  
1534  
1535 ##### http://hl7.org/fhir/allergy-intolerance-status  
1536  
1537 fhir:allergy-intolerance-status rdf:type owl:Class ;  
1538   rdfs:subClassOf fhir:valueset-system ,  
1539   [ rdf:type owl:Class ;  
1540     owl:unionOf (  
1541       allergy-intolerance-status:confirmed  
1542       allergy-intolerance-status:entered-in-error  
1543       allergy-intolerance-status:refuted  
1544       allergy-intolerance-status:resolved  
1545       allergy-intolerance-status:unconfirmed  
1546     )  
1547   ] ,  
1548   [ rdf:type owl:Restriction ;  
1549     owl:onProperty fhir:CodingBase.system ;  
1550     owl:allValuesFrom [ rdf:type owl:Restriction ;  
1551       owl:onProperty fhir:value ; owl:hasValue "http://hl7.org/fhir/allergy-intolerance-status"  
1552     ]  
1553   ] ;  
1554   fhir:prefix "http://hl7.org/fhir/allergy-intolerance-status#" .  
1555  
1556 ##### http://hl7.org/fhir/allergy-intolerance-status#confirmed  
1557  
1558 allergy-intolerance-status:confirmed rdf:type owl:Class ;  
1559   rdfs:label "Confirmed" ;  
1560   rdfs:subClassOf fhir:allergy-intolerance-status ,  
1561   [ rdf:type owl:Restriction ;  
1562     owl:onProperty fhir:CodingBase.code ;  
1563     owl:allValuesFrom [ rdf:type owl:Restriction ;  
1564       owl:onProperty fhir:value ; owl:hasValue "confirmed"  
1565     ]  
1566   ] ;  
1567   rdfs:comment "A high level of certainty about the propensity for a reaction to the identified Substance, which  
1568 may include clinical evidence by testing or rechallenge." .  
1569  
1570 ##### http://hl7.org/fhir/allergy-intolerance-status#entered-in-error  
1571  
1572 allergy-intolerance-status:entered-in-error rdf:type owl:Class ;  
1573   rdfs:label "Entered In Error" ;  
1574   rdfs:subClassOf fhir:allergy-intolerance-status ,  
1575   [ rdf:type owl:Restriction ;  
1576     owl:onProperty fhir:CodingBase.code ;  
1577     owl:allValuesFrom [ rdf:type owl:Restriction ;  
1578       owl:onProperty fhir:value ; owl:hasValue "entered-in-error"  
1579     ]  
1580   ] ;  
1581   rdfs:comment "The statement was entered in error and is not valid" .
```

1582

1583 The system Class definition shows it is a subclass of the abstract valueset-system and restricts its members to
1584 the CodingBase.system.

1585 There is also an annotation property fhir:prefix which defines the structure of the URI prefix when naming the
1586 members of the system. It causes the @prefix declaration.

1587 Two members are shown “confirmed” and “entered-in-error”. They are subclasses of allergy-intolerance-status
1588 and have the restrictions of that class so they do not have to declare CodingBase.system restrictions.

1589 **4.3.6.6 System and codings external RDF representation**

1590 From the SNOMED RDF:

```
1591 <http://snomed.info/id/138875005> rdf:type owl:Class ;
1592   rdfs:label "SNOMED CT Concept" .
1593
1594 <http://snomed.info/id/105590001> rdf:type owl:Class ;
1595   rdfs:label "Substance (substance)" ;
1596   rdfs:subClassOf <http://snomed.info/id/138875005> .
1597
1598 <http://snomed.info/id/373873005> rdf:type owl:Class ;
1599   rdfs:label "Pharmaceutical / biologic product (product)" ;
1600   rdfs:subClassOf <http://snomed.info/id/138875005> .
1601
1602 <http://snomed.info/id/346325008> rdf:type owl:Class ;
1603   rdfs:label "Antibacterial drugs (product)" ;
1604   rdfs:subClassOf <http://snomed.info/id/373873005> .
1605
1606 <http://snomed.info/id/90614001> rdf:type owl:Class ;
1607   rdfs:label "beta-Lactam antibiotic" ;
1608   rdfs:subClassOf <http://snomed.info/id/346325008> .
```

1609 The system is defined further in the FHIR ontology

```
1610 @prefix sct: <http://snomed.info/id/> .
1611
1612 ### http://snomed.info/sct
1613
1614 <http://snomed.info/sct> rdf:type owl:Class ;
1615   rdfs:subClassOf fhir:valueset-system ;
1616   fhir:prefix "http://snomed.info/id/" .
```

1617

1618

1619 4.3.6.7 *Valueset Definition*

1620 A ValueSet is somewhat similar to a value-set-system in that it applies constraints to the members but they can
1621 be from different systems.

1622 The specific ValueSet is a Class which is a union of Concept classes from one or more coding-systems. It is
1623 expected that this representation can be computed from the FHIR representation.

1624 4.3.6.7.1.1 *Anonymous codings*

1625 Here is the definition of the specific ValueSet as a Class with restrictions on values not types:

```
1626 <http://hl7.org/fhir/vs/allergy-intolerance-status> rdf:type owl:Class ;  
1627   rdfs:label "Allergy Intolerance Status Value Set" ;  
1628   rdfs:subClassOf fhir:valueset ,  
1629     [ rdf:type owl:Class ;  
1630       owl:intersectionOf (  
1631         [ rdf:type owl:Restriction ;  
1632           owl:onProperty fhir:CodingBase.code ;  
1633           owl:someValuesFrom [ rdf:type owl:Class ;  
1634             owl:unionOf (  
1635               [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "confirmed" ]  
1636               [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "entered-in-error" ]  
1637               [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "refuted" ]  
1638               [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "resolved" ]  
1639               [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "unconfirmed" ]  
1640             )  
1641           ]  
1642         ]  
1643         [ rdf:type owl:Restriction ;  
1644           owl:onProperty fhir:CodingBase.system ;  
1645           owl:allValuesFrom [ rdf:type owl:Restriction ; owl:onProperty fhir:value ;  
1646             owl:hasValue "http://fhir/allergy-intolerance-status"  
1647           ]  
1648         ]  
1649       )  
1650     ] .
```

1651 If the valueset needs to identify CodingBase restrictions from other systems then the restriction will have a
1652 slightly different structure. The example here shows the optimization for a single system (Define).

1653 4.3.6.7.2 *Named codings*

1654 If named codings are used then the expression can be greatly simplified since the restrictions are in the named
1655 class.

```
1656 <http://hl7.org/fhir/vs/allergy-intolerance-status> rdf:type owl:Class ;  
1657   rdfs:label "Allergy Intolerance Status Value Set" ;  
1658   rdfs:subClassOf fhir:valueset ,  
1659     [ rdf:type owl:Class ;  
1660       owl:unionOf ( allergy-intolerance-status:confirmed  
1661                     allergy-intolerance-status:entered-in-error  
1662                     allergy-intolerance-status:refuted  
1663                     allergy-intolerance-status:resolved  
1664                     allergy-intolerance-status:unconfirmed  
1665                   )  
1666     ] .
```

1667

1668

1669 ***4.3.6.8 ValueSet schema in the metamodel***

1670 A metamodel is introduced when Classes in the Model are instances of MetaClasses which are subclasses of
1671 owl:Class. In general the Element Definition (1.23.0) is a metamodel.

1672 In the metamodel viewpoint, an instance of ValueSet will have object property assertions to

- 1673 a) instances of ValueSet.Define if all the codes are taken from a single system
- 1674 b) instances of ValueSet.Compose if the codes come from multiple systems and allow inclusion and
1675 exclusion
- 1676 c) instances of ValueSet.Expansion if the valueset is converted into an enumerated list

1677 A ValueSet individual will have define, compose and expansion object properties to applicable objects. However,
1678 these object property semantics are not understood by RDF or OWL. They are translated in the Model to
1679 subclass, intersection and union relationships between classes.

1680

1681 4.3.6.9 *Restriction equivalents to Compose Elements*

1682 The Compose element has subelements – import, include, exclude.

1683 4.3.6.9.1 Import

1684 Import has a value of a ValueSet URI that is to be imported (see earlier Valueset example – 7.2.1)

```
1685 owl:unionOf ( <http://hl7.org/fhir/ValueSet/substance-codeD>
1686     [ rdf:type owl:Restriction ;
1687       Etc. ]
1688 )
```

1689 The import equivalent is the unionOf with the named Class representing the Valueset (here shown as

1690 <<http://hl7.org/fhir/ValueSet/substance-codeD>>.

1691 4.3.6.9.2 CodeSystem – Concepts

1692 The extensional definition of a Code system includes its concepts as subclasses of the top concept. This is
1693 translated into a CodeSystemURI individual with the annotation properties of the CodeSystem and the
1694 associated Concept Classes.

1695 However, there is no direct ontology relationship between the CodeSystemURI and the top concept. Some
1696 thoughts about a pun relationship might be useful.

1697 See - HL7 Internal Concept RDF Example.

1698 4.3.6.9.3 Filter

1699 The Filter element selects concepts by specify a matching criteria based on the properties (including
1700 relationships) defined by the system. If multiple filters are specified, they SHALL all be true.

1701 The Filter Operator value set has an inline code system <http://hl7.org/fhir/filter-operator>, which defines the
1702 following codes:

Code	Display	Definition
=	Equals	The specified property of the code equals the provided value.
is-a	Is A (by subsumption)	Includes all concept ids that have a transitive is-a relationship with the concept Id provided as the value, including the provided concept itself.
is-not-a	Not (Is A) (by subsumption)	The specified property of the code does not have an is-a relationship with the provided value.
regex	Regular Expression	The specified property of the code matches the regex specified in the provided value.
in	In Set	The specified property of the code is in the set of codes or concepts specified in the provided value (comma separated list).
not-in	Not in Set	The specified property of the code is not in the set of codes or concepts

		specified in the provided value (comma separated list).
--	--	---

1703 4.3.6.9.4 Is-a – by subsumption

1704 4.3.6.9.4.1 *XML example*

```

1705 <include>
1706   <system value="http://snomed.info/sct"/>
1707   <filter>
1708     <property value="concept"/>
1709     <op value="is-a"/>
1710     <value value="105590001"/>
1711   </filter>
1712 </include>
1713 <include>
1714   <system value="http://snomed.info/sct"/>
1715   <filter>
1716     <property value="concept"/>
1717     <op value="is-a"/>
1718     <value value="373873005"/>
1719   </filter>
1720 </include>
```

1721

1722 The difficulty with this filter is that while it appears to apply to the concept class which can have is-a
1723 subsumption, the value is the CodingBase.code value which restricts it to the concept class without
1724 subsumption. CodingBase is a single class and the instances are not subsumable.

1725 4.3.6.9.4.2 *Compose Include is-a Concept*

1726 The approach is that the value must be translated into the Concept Class Name which would be
1727 <<http://snomed.info/id/373873005>> and would be used in the restriction.

1728 <<http://snomed.info/sct>> fhir:prefix "<http://snomed.info/id/>"^^xsd:string .

1729 An annotation property on the CodeSystem individual can be used to construct the concept name where a
1730 simple prefix is used with the codeBase value.

1731 This may also be articulated by the ValueSet fragment class which has the system and filter annotation
1732 properties and could be translated into the final RDF form.

1733 The include element in conjunction with filtering on is-a concept is transformed into a union of the named
1734 concept:

```

1735   owl:someValuesFrom [ rdf:type owl:Class ;
1736     owl:unionOf ( <http://snomed.info/id/105590001>
1737       <http://snomed.info/id/373873005>
```

1738 4.3.6.9.5 Exclude

1739 4.3.6.9.5.1 *XML Example*

```

1740 <exclude>
1741   <system value="http://snomed.info/sct"/>
1742   <filter>
1743     <property value="concept"/>
1744     <op value="is-a"/>
1745     <value value="410942007"/>
1746   </filter>
1747 </exclude>
```

1748

1749 4.3.6.9.5.2 Compose Exclude is-a Concept

```
[ rdf:type owl:Class ;
  rdfs:subClassOf <http://hl7.org/fhir/ValueSet/allergyintolerance-substance-code> ;
  owl:unionOf ( <http://hl7.org/fhir/ValueSet/substance-codeD>
    [ rdf:type owl:Restriction ;
      owl:onProperty fhir:CodingBase.concept ;
      owl:someValuesFrom [ rdf:type owl:Class ;
        owl:intersectionOf ( [ rdf:type owl:Class ;
          owl:unionOf ( <http://snomed.info/id/160244002>
            <http://snomed.info/id/409137002>
            <http://snomed.info/id/428607008>
            <http://snomed.info/id/429625007>
          )
        ]
      ]
    )
  ]
] .
```

1771

1772 In this case the concept <http://snomed.info/id/410942007> is in the intersection as a complementOf so as to
1773 be excluded.

1774 4.3.6.9.6 Equals and In

1775 4.3.6.9.6.1 XML Example

```
<description value="All RxNorm codes that have TTY = IN,PIN,MIN,BN, but TTY != OCD."/>
<compose>
  <include>
    <system value="http://www.nlm.nih.gov/research/umls/rxnorm"/>
    <filter>
      <property value="TTY"/>
      <op value="in"/>
      <value value="IN,PIN,MIN,BN"/>
    </filter>
  </include>
  <exclude>
    <system value="http://www.nlm.nih.gov/research/umls/rxnorm"/>
    <filter>
      <property value="TTY"/>
      <op value="="/>
      <value value="OCD"/>
    </filter>
  </exclude>
</compose>
```

1798 These properties are specific to the code systems illustrated and would be expressed in the bridging ontology for
1799 that system.

1800 4.3.6.9.6.2 Filter RDF Expression

1801 Each filter is defined as a class. In the RDF example these will be named to assist testing and visibility.

1802 A filter class will declare the set meeting the filter properties which are annotation properties. The set are
1803 CodingBase individuals and the filter is therefore a fragment of a ValueSet.

```

1804
1805
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1837
1838
1839
1840
1841
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1844
1845
1846
1847
1848
1849
```

```

### http://hl7.org/fhir/SomeBridge/fragmentA

<http://hl7.org/fhir/SomeBridge/fragmentA> rdf:type owl:Class ;
    rdfs:subClassOf fhir:Valuesets ;
    fhir:filter.property "TTY" ;
    fhir:filter.op "in" ;
    fhir:filter.system "http://www.nlm.nih.gov/research/umls/rxnorm" ;
    fhir:filter.value "IN,PIN,MIN,BN" .

### http://hl7.org/fhir/SomeBridge/fragmentB

<http://hl7.org/fhir/SomeBridge/fragmentB> rdf:type owl:Class ;
    rdfs:subClassOf fhir:Valuesets ;
    fhir:filter.property "TTY" ;
    fhir:filter.op "=" ;
    fhir:filter.system "http://www.nlm.nih.gov/research/umls/rxnorm" ;
    fhir:filter.value "OCD" .
```

The definition may not be interpreted by OWL but can be through other mechanisms.

Further exploration needs to be done on SPARQL and SWRL expressions to define the fragment membership of CodingBase individuals thereby the membership of the ValueSet.

4.3.6.9.6.3 *The RDF ValueSet*

The fragments are combined together based on include and exclude elements:

```

### http://hl7.org/fhir/ValueSet/substance-rxnorm

<http://hl7.org/fhir/ValueSet/substance-rxnorm> rdf:type owl:Class ;
    rdfs:label "DAF Substance RxNorm Codes" ;
    rdfs:subClassOf fhir:Valuesets ;
    fhir:telecom.other "http://hl7.org/fhir" ;
    fhir:lastUpdated "2015-10-15T03:44:57.526+00:00" ;
    fhir:publisher "FHIR Project team" ;
    fhir:status "draft" ;
    fhir:concept_definition "All RxNorm codes that have TTY = IN,PIN,MIN,BN, but TTY != OCD." ;
    fhir:valueset-oid "urn:oid:2.16.840.1.113762.1.4.1010.7" .

[ rdf:type owl:Class ;
  rdfs:subClassOf <http://hl7.org/fhir/ValueSet/substance-rxnorm> ;
  owl:intersectionOf ( <http://hl7.org/fhir/SomeBridge/fragmentA>
    [ rdf:type owl:Class ;
      owl:complementOf <http://hl7.org/fhir/SomeBridge/fragmentB>
    ]
  )
]
```

1850 5 Resource References

1851 5.1 Github example

```
1852 :resource a fhir:Observation;
1853   fhir:contained fhir:Observation#23;
1854   fhir:Observation.subject [
1855     fhir:Reference.reference fhir:Observation#23
1856   ].
1857
1858 fhir:Observation#23 a fhir:Patient;
1859   fhir:Patient.name [ fhir:text "John Smith ].
```

1860 This example is partially in line with the resolved example below. Even if it were a URL it will not be understood
1861 by reasoners or SPARQL.

1862 5.2 Subgroup example

1863 5.2.1 FHIR XML

```
1864 <AllergyIntolerance xmlns="http://hl7.org/fhir">
1865   <id value="1"/>
1866   <text>
1867
1868   </text>
1869   <!-- the date that this entry was recorded -->
1870   <recordedDate value="2010-03-01"/>
1871   <!-- the patient that actually has the risk of adverse reaction -->
1872   <patient>
1873     <reference value="http://record/Patient/PeterPatient"/>
1874     <display value="Peter Patient"/>
1875   </patient>
1876 </AllergyIntolerance>
```

1877 5.2.2 RDF Data After processing (acquiring the resource and importing)

```
1878 fhir:AllergyIntolerance.patient [ fhir:Reference.display [ fhir:value "Peter Patient" ] ;
1879   fhir:Reference.reference [ fhir:value "http://record/Patient/PeterPatient" ] ;
1880   fhir:Reference.link <http://record/Patient/PeterPatient>
1881 ] ;
```

1882 Note that Reference object has been supplemented by the URI of the Reference.link.

1883 AllergyIntolerance.patient.link can represent the property chain as shown earlier.

1884 A reverse property of the property chain can get the resources for a particular patient.

```
1885 ### http://hl7.org/fhir/AllergyForPatient
1886 fhir:AllergyForPatient rdf:type owl:ObjectProperty ;
1887   owl:inverseOf fhir:AllergyIntolerance.patient.link .
1888
1889 ### http://hl7.org/fhir/AllergyIntolerance.patient.link
1890
1891 fhir:AllergyIntolerance.patient.link rdf:type owl:ObjectProperty ;
1892   owl:propertyChainAxiom ( fhir:AllergyIntolerance.patient fhir:Reference.link ) .
```

1893
1894 The Reference.link is declared when the resource has been imported and closure has been achieved. This allows
1895 the consumer to determine whether the import has happened or not and can trigger that function. If the
1896 Reference.link is pre-established there will be no indication in the import and the Resource instance will be
1897 empty.

1898 **5.2.3 FHIR OWL Schema**

```
1899 	###  http://hl7.org/fhir/Reference
1900
1901 fhir:Reference rdf:type owl:Class ;
1902
1903 	rdfs:subClassOf fhir:Element ,
1904 	[ rdf:type owl:Restriction ;
1905 	owl:onProperty fhir:Reference.reference ;
1906 	owl:allValuesFrom fhir:string
1907 	] ,
1908 	[ rdf:type owl:Restriction ;
1909 	owl:onProperty fhir:Reference.reference ;
1910 	owl:maxCardinality "1"^^xsd:nonNegativeInteger
1911 	] ,
1912 	[ rdf:type owl:Restriction ;
1913 	owl:onProperty fhir:Reference.display ;
1914 	owl:allValuesFrom fhir:string
1915 	] ,
1916 	[ rdf:type owl:Restriction ;
1917 	owl:onProperty fhir:Reference.display ;
1918 	owl:maxCardinality "1"^^xsd:nonNegativeInteger
1919 	] ,
1920 	[ rdf:type owl:Restriction ;
1921 	owl:onProperty fhir:Reference.link ;
1922 	owl:allValuesFrom fhir:DomainResource
1923 	] ,
1924 	[ rdf:type owl:Restriction ;
1925 	owl:onProperty fhir:Reference.link ;
1926 	owl:maxCardinality "1"^^xsd:nonNegativeInteger
1927 	] .
```

1928

1929

1930 6 Bundle

1931 One common operation performed with resources is to gather a collection of resources into a single instance
1932 with containing context. In FHIR this is referred to as "bundling" the resources together. These resource bundles
1933 are useful for a variety of different reasons, including:

- 1934 • Returning a set of resources that meet some criteria as part of a server operation (see [RESTful](#)
1935 [Search](#))
- 1936 • Returning a set of versions of resources as part of the history operation on a server (see [History](#))
- 1937 • Sending a set of resources as part of a message exchange (see [Messaging](#))
- 1938 • Grouping a self-contained set of resources to act as an exchangeable and persistable collection with
1939 clinical integrity - e.g. a clinical document (see [Documents](#))
- 1940 • Creating/updating/deleting a set of resources on a server as a single operation (including doing so as
1941 a single atomic transaction) (see [Transactions](#))
- 1942 • Storing a collection of resources

1943 6.1 Bundle XML content description

```
1944 <Bundle xmlns="http://hl7.org/fhir">
1945   <!-- from Resource: id, meta, implicitRules, and language -->
1946   <type value="[code]" /><!-- 1..1 document | message | transaction | transaction-response | batch | batch-response
1947   | history | searchset | collection -->
1948   <total value="[unsignedInt]" /><!-- 0..1 If search, the total number of matches -->
1949   <link> <!-- 0..* Links related to this Bundle -->
1950   <relation value="[string]" /><!-- 1..1 http://www.iana.org/assignments/link-relations/link-relations.xhtml -->
1951   <url value="[uri]" /><!-- 1..1 Reference details for the link -->
1952   </link>
1953   <entry> <!-- 0..* Entry in the bundle - will have a resource, or information -->
1954     <link><!-- 0..* Content as for Bundle.link Links related to this entry --></link>
1955     <fullUrl value="[uri]" /><!-- 0..1 Absolute URL for resource (server address, or UUID/OID) -->
1956     <resource><!-- 0..1 Resource A resource in the bundle --></resource>
1957     <search> <!-- 0..1 Search related information -->
1958       <mode value="[code]" /><!-- 0..1 match | include | outcome - why this is in the result set -->
1959       <score value="[decimal]" /><!-- 0..1 Search ranking (between 0 and 1) -->
1960     </search>
1961     <request> <!-- 0..1 Transaction Related Information -->
1962       <method value="[code]" /><!-- 1..1 GET | POST | PUT | DELETE -->
1963       <url value="[uri]" /><!-- 1..1 URL for HTTP equivalent of this entry -->
1964       <ifNoneMatch value="[string]" /><!-- 0..1 For managing cache currency -->
1965       <ifModifiedSince value="[instant]" /><!-- 0..1 For managing update contention -->
1966       <ifMatch value="[string]" /><!-- 0..1 For managing update contention -->
1967       <ifNoneExist value="[string]" /><!-- 0..1 For conditional creates -->
1968     </request>
1969     <response> <!-- 0..1 Transaction Related Information -->
1970       <status value="[string]" /><!-- 1..1 Status return code for entry -->
1971       <location value="[uri]" /><!-- 0..1 The location, if the operation returns a location -->
1972       <etag value="[string]" /><!-- 0..1 The etag for the resource (if relevant) -->
1973       <lastModified value="[instant]" /><!-- 0..1 Server's date time modified -->
1974     </response>
1975   </entry>
1976   <signature><!-- 0..1 Signature Digital Signature --></signature>
1977 </Bundle>
```

1978

1979

6.2 Bundle RDF Content

```

1980 <http://record/medpres1> rdf:type owl:Ontology ; owl:imports <http://hl7.org/fhir> .
1981
1982 #### http://record/medpres1/bundle1
1983
1984 <http://record/medpres1/bundle1> rdf:type fhir:Bundle , owl:NamedIndividual ;
1985   fhir:Bundle.entry [ rdf:type fhir:Bundle.Entry ;
1986     fhir:Bundle.Entry.resource <http://record/MedicationPrescription/1>
1987   ] ;
1988   fhir:Bundle.type [ fhir:value "searchset"];
1989   fhir:Bundle.link [ rdf:type fhir:uri ; fhir:value "self"] ;
1990   fhir:Bundle.total [ rdf:type fhir:unsignedInt ; fhir:value 3 ];
1991   fhir:Resource.meta [ rdf:type fhir:Meta ; fhir:Meta.lastUpdated
1992     [ rdf:type fhir:instant ; fhir:value "2015-08-02T00:00:00"^^xsd:dateTime]
1993   ] .
1994
1995 #### http://record/MedicationPrescription/1
1996
1997 <http://record/MedicationPrescription/1> rdf:type profile:MedicationPrescription , owl:NamedIndividual ;
1998   fhir:MedicationOrder.medicationReference [ rdf:type fhir:Reference ;
1999     fhir:Reference.link <http://record/Medication/1> ;
2000     fhir:Reference.reference [ fhir:value http://record/Medication/1 ] ;
2001     fhir:Reference.display [ fhir:value "Amoxicillin (product)" ]
2002   ] ;
2003   fhir:MedicationOrder.patient [ rdf:type fhir:Reference ;
2004     fhir:Reference.link <http://record/Patient/PeterPatient> ;
2005     fhir:Reference.display [ fhir:value "Peter Patient" ] ;
2006     fhir:Reference.reference [ fhir:value "http://record/Patient/PeterPatient"
2007   ] ]
2008 ] .
2009

```

2010

2011 A Bundle may or may not have an Id (inherited from Resource) therefore it can be referenced as an Ontology
 2012 e.g. record/Bundle/123. It may therefore be a named or anonymous individual.

2013

6.3 Bundle RDF Schema

2014

```
### http://hl7.org/fhir/Bundle

fhir:Bundle rdf:type owl:Class ;
  rdfs:subClassOf fhir:Resource ,
    [ rdf:type owl:Restriction ; owl:onProperty fhir:Bundle.total ;
      owl:onClass fhir:unsignedInt ;
        owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger
    ] ,
    [ rdf:type owl:Restriction ;
      owl:onProperty fhir:Bundle.entry ;
      owl:allValuesFrom fhir:Bundle.Entry
    ] ,
    [ rdf:type owl:Restriction ;
      owl:onProperty fhir:Bundle.signature ;
      owl:onClass fhir:Signature ;
      owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger
    ] ,
    [ rdf:type owl:Restriction ;
      owl:onProperty fhir:Bundle.type ;
      owl:onClass fhir:code ;
      owl:qualifiedCardinality "1"^^xsd:nonNegativeInteger
    ] ,
    [ rdf:type owl:Restriction ;
      owl:onProperty fhir:Bundle.link ;
      owl:allValuesFrom fhir:Bundle.Link
    ] .
```

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```
### http://hl7.org/fhir/Bundle.Entry
```

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2066 **7 Ordering**

2067 **7.1 Github example**

2068 No example

2069 **7.2 RDF individual ordering example**

2070 Simple integer DataProperty fhir:index can be applied to individuals of subclasses of fhir:Element

2071

```
2072     ### http://hl7.org/fhir/index
2073     fhir:index rdf:type owl:DatatypeProperty ;
2074         rdfs:range fhir:index-primitive .
2075
2076     ### http://hl7.org/fhir/index-primitive
2077     fhir:index-primitive rdf:type rdfs:Datatype ;
2078         owl:equivalentClass [ rdf:type rdfs:Datatype ;
2079             owl:onDatatype xsd:integer ;
2080             owl:withRestrictions ( [ xsd:minInclusive 1 ] )
2081         ] .
2082     ### http://hl7.org/fhir/Element
2083     fhir:Element rdf:type owl:Class ;
2084         rdfs:label "Element" ;
2085         rdfs:subClassOf [ rdf:type owl:Restriction ;
2086             owl:onProperty fhir:Element.extension ;
2087             owl:someValuesFrom fhir:Extension
2088             ] ,
2089             [ rdf:type owl:Restriction ;
2090             owl:onProperty fhir:Element.id ;
2091             owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
2092             owl:onDataRange fhir:id-primitive
2093             ] ,
2094             [ rdf:type owl:Restriction ;
2095             owl:onProperty fhir:index ;
2096             owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
2097             owl:onDataRange fhir:index-primitive
2098             ] ;
2099         rdfs:comment "The base element used for all FHIR elements and resources - allows for them to be
2100         extended with extensions" .
2101
```

2102 In general fhir:value and fhir:Element.id are converted to an attribute in XML. fhir:index dictates the sequence
2103 only.

2104 **7.3 RDF Object Property Ordering example**

2105 Where object properties need to be ordered to construct the sequence of properties in XML, the fhir:index is
2106 defined as an annotation property on the Object Property. The example of ordered properties inside CodingBase
2107 is shown:

```
2108     ### http://hl7.org/fhir/index
2109
2110     fhir:index rdf:type owl:AnnotationProperty .
```

2111

```
2112     ### http://hl7.org/fhir/CodingBase.system
2113       fhir:CodingBase.system rdf:type owl:ObjectProperty ;
2114                            fhir:index 1 ;
2115 
2116     ### http://hl7.org/fhir/CodingBase.version
2117       fhir:CodingBase.version rdf:type owl:ObjectProperty ;
2118                            fhir:index 2 .
2119 
2120     ### http://hl7.org/fhir/CodingBase.code
2121       fhir:CodingBase.code rdf:type owl:ObjectProperty ;
2122                            fhir:index 3 .
2123 
2124     ### http://hl7.org/fhir/CodingBase.display
2125       fhir:CodingBase.display rdf:type owl:ObjectProperty ;
2126                            fhir:index 4 ;
2127 
2128     ### http://hl7.org/fhir/CodingBase.primary
2129       fhir:CodingBase.primary rdf:type owl:ObjectProperty ;
2130                            fhir:index 5 ;
```

2131

2132

2133

2134 8 Profiles

2135 The example shows a ‘profile’ ontology restricting the Valueset of Substance:

2136 The AllergyIntolerance Resource is declared again inside the Profile ontology.

```
2137 <http://record/AllergyIntolerance/1> rdf:type <http://PatientSafetyProfile/AllergyIntolerance>,
2138 owl:NamedIndividual ;
```

2140 profile:AllergyIntolerance.substance is defines a restriction to be applied to the valueset for substance

```
2141 @prefix profile: <http://PatientSafetyProfile/> .
2142 ### http://PatientSafetyProfile/AllergyIntolerance
2143
2144 profile:AllergyIntolerance rdf:type owl:Class ;
2145     rdfs:subClassOf fhir:AllergyIntolerance , [ rdf:type owl:Restriction ;
2146         owl:onProperty <http://hl7.org/fhir/AllergyIntolerance/AllergyIntolerance.substance> ;
2147         owl:allValuesFrom profile:substance-type
2148     ] .
```

2149

2150 The valueset definition applies:

```
2151
2152 #### http://PatientSafetyProfile/substance-type
2153 <http://PatientSafetyProfile/substance-type> rdf:type owl:Class ;
2154     rdfs:subClassOf fhir:ValueSets ,
2155     [ rdf:type owl:Class ;
2156         owl:unionOf (
2157             <http://snomed.info/id/105590001>
2158             <http://snomed.info/id/373873005>
2159         )
2160     ] .
```

2162

2163