

# FHIR RDF Sample side by side comparisons

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## Contents

1	1	Default Mapping.....	2
2	1.1	Instance mapping .....	2
3	1.2	Type mapping .....	2
4	2	Datatypes (section 1.18.0.1).....	4
5	2.1	Id.....	4
6	2.2	Decimal.....	4
7	2.3	FHIR CodeableConcept and Coding Structure Definition.....	5
8	3	Terminology.....	9
9	3.1	Code system .....	9
10	3.2	Concept.....	10
11	3.3	ValueSets .....	14
12	4	Resource References .....	43
13	4.1	Github example .....	43
14	4.2	Subgroup example.....	43
15	5	Bundle.....	45
16	5.1	Bundle XML content description .....	45
17	5.2	Bundle RDF Content .....	46
18	5.3	Bundle RDF Schema.....	47
19	6	URI Naming.....	48
20	6.1	Github example .....	48
21	6.2	Subgroup example.....	48
22	7	Ordering.....	49
23	7.1	Github example .....	49
24	7.2	RDF individual ordering example .....	49
25	7.3	RDF Object Property Ordering example .....	49
26	8	Profiles .....	51

## 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**.

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 Root tag**

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

51 Many renderings of RDF including Turtle do not have a root element.

52 <<http://record/medpres1>> rdf:type owl:Ontology ;

53 Shows the record as an ontology. So the identity of the record is

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

56 <<http://record/MedicationPrescription/1>> rdf:type profile:MedicationPrescription , owl:NamedIndividual ;

57 In simple resources the identity of the message is the same as the identity of the root element. However they  
58 may have different styles.

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

60 **1.1.4 XML Attribute**

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

63 fhir:CodingBase.display [ a fhir:string; fhir:value "Admin"^^xsd:string] ;

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

65 **1.2 Type mapping**

66 **1.2.1 Complex type to Class**

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

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

70    **1.2.2 Nested elements**  
71    An XML tag is unique within the namespace that it is declared in. FHIR does not use global namespaces. The XML  
72    tag is mapped to an Object Property where the name is prefixed with the Class name in which it was declared. A  
73    tag “bar” declared in a complex type “Foo” would become an Object Property “Foo.bar”. This is aligned with the  
74    structural definition mechanism in FHIR.

75    **1.2.3 Datatypes**  
76    In RDF the value attribute of a datatype is a Data Property named “value” with undefined range. Each FHIR data  
77    type has a restriction on the range of the Data Property (see section on Datatypes).

## 78    2 Datatypes (section 1.18.0.1)

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

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

### 82    2.1 Id

#### 83    2.1.1 Id instance

#### 84    2.1.2 Id schema

```
85 fhir:id rdf:type owl:Class ;
86   rdfs:subClassOf fhir:Element ,
87     [ rdf:type owl:Restriction ;
88       owl:onProperty fhir:value ;
89       owl:allValuesFrom [ rdf:type rdfs:Datatype ;
90         owl:onDatatype xsd:string ;
91         owl:withRestrictions ( [ xsd:pattern "[A-Za-z0-9\\-\\.]{1,64}" ] )
92       ]
93     ] ,
94     [ rdf:type owl:Restriction ;
95       owl:onProperty fhir:value ;
96       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
97       owl:onDataRange xsd:string
98     ] ;
99   rdfs:comment "A whole number in the range 0 to 2^64-1, optionally represented in hex, a uuid, an oid or
100 any other combination of lower-case letters a-z, numerals, “-” and “.”, with a length limit of 36 characters" .
```

### 101    2.2 Decimal

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

#### 103    2.2.1 Decimal OWL instance

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

#### 105    2.2.2 Decimal OWL Schema

```
106 fhir:decimal rdf:type owl:Class ;
107   rdfs:subClassOf fhir:Element ,
108     [ rdf:type owl:Restriction ;
109       owl:onProperty fhir:fractionDigits ;
110       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
111       owl:onDataRange xsd:nonNegativeInteger
112     ] ,
113     [ rdf:type owl:Restriction ;
114       owl:onProperty fhir:fractionDigits ;
115       owl:allValuesFrom xsd:nonNegativeInteger
116     ] ,
117     [ rdf:type owl:Restriction ;
118       owl:onProperty fhir:value ;
119       owl:allValuesFrom xsd:decimal
120     ] ,
121     [ rdf:type owl:Restriction ;
122       owl:onProperty fhir:value ;
123       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
124       owl:onDataRange xsd:decimal
125     ] ;
126   rdfs:comment "A rational number with implicit precision" .
```

128    **2.3 FHIR CodeableConcept and Coding Structure Definition**

129    **2.3.1 FHIR XML**

```
130 <code>
131   <coding>
132     <system value="http://example.org/local"/>
133     <code value="admin"/>
134     <display value="Admin"/>
135   </coding>
136 </code>
```

137    CodeableConcept Structural Definition

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

143

144    Coding Structural Definition

```
145 <[name] xmlns="http://hl7.org/fhir">
146   <!-- from Element: extension -->
147   <system value="[uri]" /><!-- 0..1 Identity of the terminology system -->
148   <version value="[string]" /><!-- 0..1 Version of the system - if relevant -->
149   <code value="[code]" /><!-- 0..1 Symbol in syntax defined by the system -->
150   <display value="[string]" /><!-- 0..1 Representation defined by the system -->
151   <primary value="[boolean]" /><!-- 0..1 If this code was chosen directly by the user -->
152 </[name]>
```

153

154    **2.3.2 RDF Data for Coding Instance**

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

```
157 xxx.code [ a fhir:CodeableConcept ;
158   ConceptBase.coding [ rdf:type fhir:CodingBase ;
159     fhir:CodingBase.system [ a fhir:uri; "fhir:value http://example.org/local" ] ;
160     fhir:CodingBase.code [ a fhir:codeBase ; fhir:value "admin" ] ;
161     fhir:CodingBase.display [ a fhir:string; fhir:value "Admin" ] ;
162   ] ;
163 ] ;
```

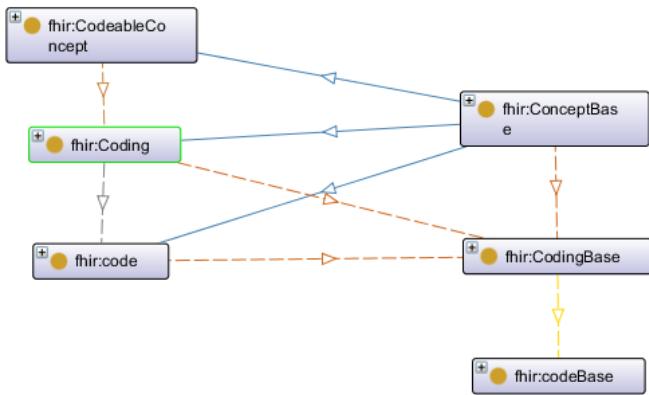
164

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

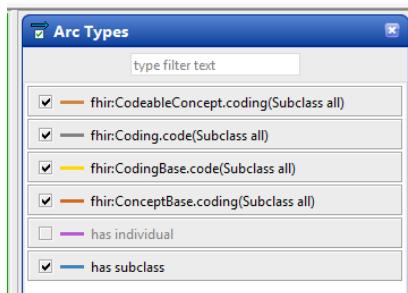
167    This approach will be implemented by creating ConceptBase, CodingBase and codeBase individuals as blank  
168    nodes.

169    2.3.3    FHIR OWL Schema

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



171



172

```
[ rdf:type owl:AllDisjointClasses ;
  owl:members ( fhir:CodingBase
                 fhir:ConceptBase
                 fhir:codeBase
               )
]
```

179

```
#####
#  Classes
#####

###  http://hl7.org/fhir/ConceptBase

fhir:ConceptBase rdf:type owl:Class ;
  rdfs:subClassOf fhir:Datatype ,
    [ rdf:type owl:Restriction ;
      owl:onProperty fhir:ConceptBase.coding ;
      owl:allValuesFrom fhir:CodingBase
    ] ,
    [ rdf:type owl:Restriction ;
      owl:onProperty fhir:ConceptBase.text ;
      owl:maxCardinality "1"^^xsd:nonNegativeInteger
    ] ,
    [ rdf:type owl:Restriction ;
      owl:onProperty fhir:ConceptBase.text ;
      owl:allValuesFrom fhir:string
    ]
.
```

```
202     ### http://hl7.org/fhir/CodingBase
203     fhir:CodingBase rdf:type owl:Class ;
204         rdfs:subClassOf fhir:Element ,
205             [ rdf:type owl:Restriction ;
206                 owl:onProperty fhir:CodingBase.system ;
207                 owl:allValuesFrom fhir:uri
208             ] ,
209             [ rdf:type owl:Restriction ;
210                 owl:onProperty fhir:CodingBase.system ;
211                 owl:maxCardinality "1"^^xsd:nonNegativeInteger
212             ] ,
213             [ rdf:type owl:Restriction ;
214                 owl:onProperty fhir:CodingBase.version ;
215                 owl:allValuesFrom fhir:string
216             ] ,
217             [ rdf:type owl:Restriction ;
218                 owl:onProperty fhir:CodingBase.version ;
219                 owl:maxCardinality "1"^^xsd:nonNegativeInteger
220             ] ,
221             [ rdf:type owl:Restriction ;
222                 owl:onProperty fhir:CodingBase.code ;
223                 owl:allValuesFrom fhir:codeBase
224             ] ,
225             [ rdf:type owl:Restriction ;
226                 owl:onProperty fhir:CodingBase.code ;
227                 owl:maxCardinality "1"^^xsd:nonNegativeInteger
228             ] ,
229             [ rdf:type owl:Restriction ;
230                 owl:onProperty fhir:CodingBase.display ;
231                 owl:allValuesFrom fhir:string
232             ] ,
233             [ rdf:type owl:Restriction ;
234                 owl:onProperty fhir:CodingBase.display ;
235                 owl:maxCardinality "1"^^xsd:nonNegativeInteger
236             ] ,
237             [ rdf:type owl:Restriction ;
238                 owl:onProperty fhir:CodingBase.primary ;
239                 owl:maxCardinality "1"^^xsd:nonNegativeInteger
240             ] ,
241             [ rdf:type owl:Restriction ;
242                 owl:onProperty fhir:CodingBase.primary ;
243                 owl:allValuesFrom fhir:boolean
244             ] .
245
```

```
246     fhir:codeBase rdf:type owl:Class ;
247         rdfs:subClassOf fhir:Element ,
248             [ rdf:type owl:Restriction ;
249                 owl:onProperty fhir:value ;
250                 owl:allValuesFrom xsd:token
251             ] ,
252             [ rdf:type owl:Restriction ;
253                 owl:onProperty fhir:value ;
254                 owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
255                 owl:onDataRange xsd:token
256             ] .
257
```

258 The concrete subclasses of ConceptBase apply the additional restrictions:

```
259     ### http://hl7.org/fhir/CodeableConcept
260     fhir:CodeableConcept rdf:type owl:Class ;
261         rdfs:subClassOf fhir:ConceptBase ;
262         rdfs:comment "The set of possible coded values this coding was chosen from or constrained by." .
263
```

```
264     ### http://hl7.org/fhir/Coding
265     fhir:Coding rdf:type owl:Class ;
266         rdfs:subClassOf fhir:ConceptBase ,
267                 [ rdf:type owl:Restriction ;
268                 owl:onProperty fhir:ConceptBase.text ;
269                 owl:maxCardinality "0"^^xsd:nonNegativeInteger
270             ] ,
271                 [ rdf:type owl:Restriction ;
272                 owl:onProperty fhir:ConceptBase.coding ;
273                 owl:cardinality "1"^^xsd:nonNegativeInteger
274             ] .
275
```

```
276     fhir:code rdf:type owl:Class ;
277         rdfs:subClassOf fhir:ConceptBase , [ rdf:type owl:Restriction ;
278                 owl:onProperty fhir:ConceptBase.coding ;
279                 owl:allValuesFrom [ rdf:type owl:Class ;
280                 owl:intersectionOf ( fhir:CodingBase
281                         [ rdf:type owl:Restriction ;
282                         owl:onProperty fhir:CodingBase.code ;
283                         owl:cardinality "1"^^xsd:nonNegativeInteger
284                 ] ,
285                         [ rdf:type owl:Restriction ;
286                         owl:onProperty fhir:CodingBase.display ;
287                         owl:maxCardinality "0"^^xsd:nonNegativeInteger
288                 ] ,
289                         [ rdf:type owl:Restriction ;
290                         owl:onProperty fhir:CodingBase.primary ;
291                         owl:maxCardinality "0"^^xsd:nonNegativeInteger
292                 ] ,
293                         [ rdf:type owl:Restriction ;
294                         owl:onProperty fhir:CodingBase.system ;
295                         owl:maxCardinality "1"^^xsd:nonNegativeInteger
296                 ] ,
297                         [ rdf:type owl:Restriction ;
298                         owl:onProperty fhir:CodingBase.version ;
299                         owl:maxCardinality "1"^^xsd:nonNegativeInteger
300                 ]
301             )
302         ]
303         ,
304         [ rdf:type owl:Restriction ;
305                 owl:onProperty fhir:ConceptBase.coding ;
306                 owl:cardinality "1"^^xsd:nonNegativeInteger
307         ] .
```

308

309 **3 Terminology**

310 **3.1 Code system**

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

314 **3.1.1 HL7 FHIR Internal Code System XML example**

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

```
316 <codeSystem>
317   <extension url="http://hl7.org/fhir/StructureDefinition/valueset-oid">
318     <valueUri value="urn:oid:2.16.840.1.113883.4.642.1.50"/>
319   </extension>
320   <system value="http://hl7.org/fhir/allergy-intolerance-status"/>
321   <version value="1.0.0"/>
322   <caseSensitive value="true"/>
323   <concept>
324     <code value="active"/>
325     <display value="Active"/>
326     <definition value="An active record of a reaction to the identified Substance."/>
327     <concept>
328       <code value="confirmed"/>
329       <display value="Confirmed"/>
330       <definition value="A high level of certainty about the propensity for a reaction to the identified Substance,
331         which may include clinical evidence by testing or rechallenge."/>
332     </concept>
333   </concept>
334 </codeSystem>
```

335

336 **3.1.2 RDF CodeSystemURI declaration**

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

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

342 **3.1.2.1 HL7 Internal Code system URI example**

```
343 ### http://hl7.org/fhir/cs/allergy-intolerance-status
344
345 fhircs:allergy-intolerance-status rdf:type fhir:CodeSystemURI , owl:NamedIndividual ;
346   fhir:caseSensitive "true"^^xsd:boolean ;
347   fhir:valueset-oid "urn:oid:2.16.840.1.113883.4.642.1.50" ;
348   fhir:value "http://hl7.org/fhir/cs/allergy-intolerance-status" ;
349   fhir:prefix "http://hl7.org/fhir/allergy-intolerance-status#" ;
350   fhir:version "1.0.2" .
```

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

353    **3.1.2.2 SNOMED Code System URI example**

```
354    ##### http://snomed.info/sct
355
356 <http://snomed.info/sct> rdf:type fhir:CodeSystemURI , owl:NamedIndividual ;
357   fhir:value "http://snomed.info/sct"^^xsd:anyURI .
358   fhir:caseSensitive "false"^^xsd:boolean ;
359   fhir:prefix "http://snomed.info/id/"^^xsd:string ;
360   fhir:valueset-oid "2.16.840.1.113883.6.96" ;
361   fhir:version "US1000124_20140301" .
```

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

364    **3.1.2.3 Code System Version**

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

366    **3.2 Concept**

367    **3.2.1 HL7 FHIR Concept XML**

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

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

371    ValueSet.codeSystem.concept have code, abstract, display, definition, designation and nested  
372    Valueset.Concepts.

```
373 <codeSystem>
374   <extension url="http://hl7.org/fhir/StructureDefinition/valueset-oid">
375     <valueUri value="urn:oid:2.16.840.1.113883.4.642.1.50"/>
376   </extension>
377   <system value="http://hl7.org/fhir/allergy-intolerance-status"/>
378   <version value="1.0.0"/>
379   <caseSensitive value="true"/>
380   <concept>
381     <code value="active"/>
382     <display value="Active"/>
383     <definition value="An active record of a reaction to the identified Substance."/>
384     <concept>
385       <code value="confirmed"/>
386       <display value="Confirmed"/>
387       <definition value="A high level of certainty about the propensity for a reaction to the identified Substance,
388         which may include clinical evidence by testing or rechallenge."/>
389     </concept>
390   </concept>
391 </codeSystem>
392 </ValueSet>
```

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

395    **3.2.2 RDF Concept Definition**

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

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

403    ***3.2.2.1 FHIR internal XML Concept mapping***

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

- 406    • System maps to the restriction on CodingBase.system
- 407    • Code maps to the restriction on CodingBase.code
- 408    • Display maps to rdfs:label
- 409    • Definition maps to fhir:concept\_definition annotation
- 410    • Nesting maps to subclass assertions (as a default)
- 411    • An abstract Concept (ValueSetConcept.abstract = “true”) has no restriction on CodingBase.code just a  
412    position in the class hierarchy.
- 413    • Designation will probably transform into annotation language (e.g. @en) or type.

414

### 3.2.2.2 HL7 Internal Concept RDF Example

```

415  #### http://hl7.org/fhir/allergy-intolerance-status#Concept
416
417  allergy-intolerance-status:Concept rdf:type owl:Class ;
418    rdfs:label "Allergy Intolerance Status Concept" ;
419    rdfs:subClassOf fhir:Concepts ;
420    fhir:concept_definition "Assertion about certainty associated with a propensity, or potential risk, of a reaction to the
421 identified Substance." .
422
423  #### http://hl7.org/fhir/allergy-intolerance-status#active
424
425  allergy-intolerance-status:active rdf:type owl:Class ;
426    rdfs:label "Active" ;
427    rdfs:subClassOf allergy-intolerance-status:Concept ;
428    fhir:concept_definition "An active record of a reaction to the identified Substance" .
429
430  [ rdf:type owl:Restriction ;
431    rdfs:subClassOf allergy-intolerance-status:active ; owl:onProperty fhir:ConceptBase.coding ;
432    owl:someValuesFrom [ rdf:type owl:Class ;
433      owl:intersectionOf ( [ rdf:type owl:Restriction ;
434        owl:onProperty fhir:CodingBase.code ;
435        owl:allValuesFrom [ rdf:type owl:Restriction ;
436          owl:onProperty fhir:value ;
437          owl:hasValue "active"
438        ]
439      ]
440      [ rdf:type owl:Restriction ;
441        owl:onProperty fhir:CodingBase.system ;
442        owl:hasValue fhircs:allergy-intolerance-status
443      ]
444    )
445  ]
446
447  #### http://hl7.org/fhir/allergy-intolerance-status#confirmed
448
449  allergy-intolerance-status:confirmed rdf:type owl:Class ;
450    rdfs:label "Confirmed@en" ;
451    rdfs:subClassOf allergy-intolerance-status:active ;
452    fhir:concept_definition "A high level of certainty about the propensity for a reaction to the identified Substance, which may
453 include clinical evidence by testing or rechallenge." .
454
455  [ rdf:type owl:Restriction ;
456    rdfs:subClassOf allergy-intolerance-status:confirmed ; owl:onProperty fhir:ConceptBase.coding ;
457    owl:someValuesFrom [ rdf:type owl:Class ;
458      owl:intersectionOf ( [ rdf:type owl:Restriction ;
459        owl:onProperty fhir:CodingBase.code ;
460        owl:allValuesFrom [ rdf:type owl:Restriction ;
461          owl:onProperty fhir:value ;
462          owl:hasValue "confirmed"
463        ]
464      ]
465      [ rdf:type owl:Restriction ;
466        owl:onProperty fhir:CodingBase.system ;
467        owl:hasValue fhircs:allergy-intolerance-status
468      ]
469    )
470  ]
471
472  ] .
473
474

```

475 3.2.2.3 External Concept RDF Example

476 An external terminology is treated differently in that it is assumed that the ontology provided by the external  
477 organization cannot be changed. A bridging ontology is therefore provided which allows the expressions to be  
478 added to bind to the FHIR CodingBase instances.

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

482 3.2.2.3.1 External SNOMED Ontology

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

```
485    ###  http://snomed.info/id/105590001
486
487    <http://snomed.info/id/105590001> rdf:type owl:Class ;
488                                rdfs:label "Substance (substance)" ;
489                                rdfs:subClassOf <http://snomed.info/id/138875005> .
490
491    ###  http://snomed.info/id/373873005
492
493    <http://snomed.info/id/373873005> rdf:type owl:Class ;
494                                rdfs:label "Pharmaceutical / biologic product (product)" ;
495                                rdfs:subClassOf <http://snomed.info/id/138875005> .
```

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

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

```
499     ###  http://snomed.info/id/160244002
500
501      <http://snomed.info/id/160244002> rdf:type owl:Class ;
502          rdfs:label "No Known Allergies" ;
503          rdfs:subClassOf <http://snomed.info/id/138875005> .
504
505     ###  http://snomed.info/id/409137002
506
507      <http://snomed.info/id/409137002> rdf:type owl:Class ;
508          rdfs:label "No Known Drug Allergies" ;
509          rdfs:subClassOf <http://snomed.info/id/138875005> .
510
511     ###  http://snomed.info/id/428607008
512
513      <http://snomed.info/id/428607008> rdf:type owl:Class ;
514          rdfs:label "No Known Environmental Allergy" ;
515          rdfs:subClassOf <http://snomed.info/id/138875005> .
516
517     ###  http://snomed.info/id/429625007
518
519      <http://snomed.info/id/429625007> rdf:type owl:Class ;
520          rdfs:label "No Known Food Allergies" ;
521          rdfs:subClassOf <http://snomed.info/id/138875005> .
```

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

### 523 3.2.2.3.2 Bridging Ontology

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

525 <<http://hl7.org/fhirSCTBridge>> rdf:type owl:Ontology ;  
526 owl:imports <<http://hl7.org/fhir>> ,  
527 <<http://snomed.info/id>> .

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

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

```
[ 531   rdf:type owl:Restriction ;
 532   rdfs:subClassOf <http://snomed.info/id/90614001> ;
 533   owl:onProperty fhir:ConceptBase.coding ;
 534   owl:someValuesFrom [ rdf:type owl:Class ;
 535     owl:intersectionOf ( [ rdf:type owl:Restriction ;
 536       owl:onProperty fhir:CodingBase.code ;
 537       owl:allValuesFrom [ rdf:type owl:Restriction ;
 538         owl:onProperty fhir:value ;
 539         owl:hasValue "90614001"
 540       ]
 541     ]
 542     [ rdf:type owl:Restriction ;
 543       owl:onProperty fhir:CodingBase.system ;
 544       owl:hasValue <http://snomed.info/sct>
 545     ]
 546   )
 547 ]
 548 ] .
```

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

### 552 **3.2.3 Relationship of Concept to Code SystemURI**

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

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

## 556 **3.3 ValueSets**

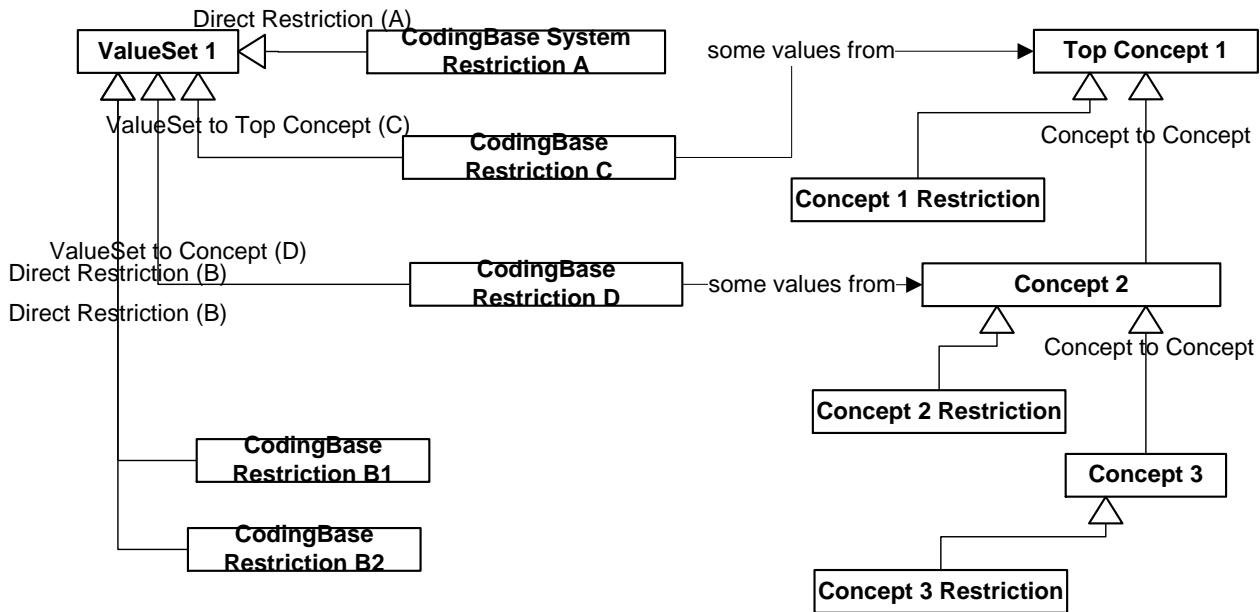
557 A ValueSet in RDF is a specific Class which defines the CodingBase individuals which are members of it.

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

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

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

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



564

A

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

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

- 567     A. Aligned ValueSet with Code system (all codes from).  
568     B. Unaligned ValueSet direct restriction on CodingBase  
569     C. Aligned ValueSet with Top Concept (all concepts from)  
570     D. Unaligned ValueSet restriction on Concepts

571    3.3.1 FHIR Schema definition

572    3.3.1.1 Allergy Intolerance Status Structural Definition

```
573 <element>
574   <path value="AllergyIntolerance.status"/>
575   <short value="active | unconfirmed | confirmed | inactive | resolved | refuted | entered-in-error"/>
576   <definition value="Assertion about certainty associated with the propensity, or potential risk, of a reaction
577     to the identified Substance."/>
578   <comments value="Decision support would typically raise alerts for 'Unconfirmed', 'Confirmed', and 'Resolved'
579     and ignore a 'Refuted' reaction. In particular, 'Refuted' may be useful for reconciliation of the Adverse Reaction
580     List. Some implementations may choose to make this field mandatory."/>
581   <alias value="State"/>
582   <min value="0"/>
583   <max value="1"/>
584   <type>
585     <code value="code"/>
586   </type>
587   <isModifier value="true"/>
588   <isSummary value="true"/>
589   <binding>
590     <strength value="required"/>
591     <description value="Assertion about certainty associated with a propensity, or potential risk, of a reaction
592       to the identified Substance."/>
593   <valueSetReference>
594     <reference value="http://hl7.org/fhir/ValueSet/allergy-intolerance-status"/>
595   </valueSetReference>
596 </binding>
597   <mapping>
598     <identity value="v2"/>
599     <map value="IAM-17"/>
600   </mapping>
601   <mapping>
602     <identity value="w5"/>
603     <map value="status"/>
604   </mapping>
605 </element>
```

606    3.3.1.2 AllergyIntolerance.substance Structural Definition

```
607 <element>
608   <path value="AllergyIntolerance.substance"/>
609   <short value="Substance, (or class) considered to be responsible for risk"/>
610   <definition value="Identification of a substance, or a class of substances, that is considered to be responsible
611     for the adverse reaction risk."/>
612   <comments value="It is strongly recommended that the substance be coded with a terminology, where possible.
613     For example, some terminologies used include RxNorm, SNOMED CT, DM+D, NDFRT, ICD-9, IDC-10,
614     UNI, ATC and CPT. Plain text should only be used if there is no appropriate terminology
615     available. Additional details about a substance can be specified in the text."/>
616   <alias value="Agent"/>
617   <min value="1"/>
618   <max value="1"/>
619   <type>
620     <code value="CodeableConcept"/>
621   </type>
622   <isSummary value="true"/>
623   <binding>
624     <strength value="example"/>
625     <description value="Type of the substance and Negation codes for reporting no known allergies."/>
626     <valueSetReference>
627       <reference value="http://hl7.org/fhir/ValueSet/allergyintolerance-substance-code"/>
628     </valueSetReference>
629   </binding>
630   <mapping>
631     <identity value="v2"/>
632     <map value="AL1-3 / IAM-3"/>
633   </mapping>
634   <mapping>
635     <identity value="w5"/>
636     <map value="what"/>
637   </mapping>
638 </element>
```

639    3.3.2 OWL Schema Definition

640    **3.3.2.1 Allergy Intolerance Class**

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

```
642    ##### http://hl7.org/fhir/AllergyIntolerance
643
644    fhir>AllergyIntolerance rdf:type owl:Class ;
645
646                 rdfs:subClassOf fhir:DomainResource ,
647                         [ rdf:type owl:Restriction ;
648                         owl:onProperty fhir>AllergyIntolerance.status ;
649                         owl:allValuesFrom fhirvs:allergy-intolerance-statusA
650                         ] ,
651                         [ rdf:type owl:Restriction ;
652                         owl:onProperty fhir>AllergyIntolerance.status ;
653                         owl:maxCardinality "1"^^xsd:nonNegativeInteger
654                         ] ,
655                         [ rdf:type owl:Restriction ;
656                         owl:onProperty fhir>AllergyIntolerance.patient ;
657                         owl:allValuesFrom fhir:Reference
658                         ] ,
659                         [ rdf:type owl:Restriction ;
660                         owl:onProperty fhir>AllergyIntolerance.patient ;
661                         owl:maxCardinality "1"^^xsd:nonNegativeInteger
662                         ] ,
663                         [ rdf:type owl:Restriction ;
664                         owl:onProperty fhir>AllergyIntolerance.substance ;
665                         owl:allValuesFrom fhir:CodeableConcept
666                         ] ,
667                         [ rdf:type owl:Restriction ;
668                         owl:onProperty fhir>AllergyIntolerance.substance ;
669                         owl:maxCardinality "1"^^xsd:nonNegativeInteger
670                         ] ,
671                         .....
672
673
```

674    It shows that:

- 675    • AllergyIntolerance.status is restricted to the set defined by fhirvs:allergy-intolerance-statusA.
- 676    • AllergyIntolerance.substance is not restricted to the set defined by  
677         fhirvs:allergyintolerance-substance-code but purely to the CodeableConcept since the binding is  
678         “example”.

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

680

### 3.3.2.2 AllergyIntolerance.status Object Property definition

```

681  #### http://hl7.org/fhir/AllergyIntolerance.status
682
683 fhir:AllergyIntolerance.status rdf:type owl:ObjectProperty ;
684   fhir:binding.valueSetReference "http://hl7.org/fhir/ValueSet/allergy-intolerance-status"^^xsd:anyURI ;
685   fhir:isModifier "true"^^xsd:boolean ;
686   fhir:isSummary "true"^^xsd:boolean ;
687   rdfs:comment "Decision support would typically raise alerts for 'Unconfirmed', 'Confirmed', and 'Resolved' and ignore a
688   'Refuted' reaction. In particular, 'Refuted' may be useful for reconciliation of the Adverse Reaction List. Some implementations
689   may choose to make this field mandatory." ;
690   fhir:short "active | unconfirmed | confirmed | inactive | resolved | refuted | entered-in-error" ;
691   fhir:binding.description "Assertion about certainty associated with a propensity, or potential risk, of a reaction to the
692   identified Substance." ;
693   fhir:concept_definition "Assertion about certainty associated with the propensity, or potential risk, of a reaction to the
694   identified Substance." ;
695   fhir:binding.strength "required" ;
696   rdfs:domain fhir:AllergyIntolerance ;
697   rdfs:range fhir:code ;
698   rdfs:subPropertyOf fhir:objectProperty .

```

699

### 3.3.2.3 AllergyIntolerance.substance Object Property

```

700  #### http://hl7.org/fhir/AllergyIntolerance.substance
701
702 fhir:AllergyIntolerance.substance rdf:type owl:ObjectProperty ;
703   fhir:isSummary "true"^^xsd:boolean ;
704   fhir:binding.valueSetReference "http://hl7.org/fhir/ValueSet/allergyintolerance-substance-code" ;
705   fhir:short "Substance, (or class) considered to be responsible for risk" ;
706   fhir:concept_definition "Identification of a substance, or a class of substances, that is considered to be responsible for the
707   adverse reaction risk." ;
708   fhir:binding.strength "example" ;
709   rdfs:comment "It is strongly recommended that the substance be coded with a terminology, where possible. For example, some
710   terminologies used include RxNorm, SNOMED CT, DM+D, NDFRT, ICD-9, IDC-10, UNI, ATC and CPT. Plain text should only be used if
711   there is no appropriate terminology available. Additional details about a substance can be specified in the text." ;
712   fhir:binding.description "Type of the substance and Negation codes for reporting no known allergies." ;
713   rdfs:domain fhir:AllergyIntolerance ;
714   rdfs:range fhir:CodeableConcept ;
715   rdfs:subPropertyOf fhir:objectProperty .

```

716

### 3.3.3 Approach to Conformance

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

Almost all of the elements that have a coded data type are bound to a value set. The bindings are associated 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

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

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

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

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

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

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

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

### 3.3.4 HL7 Internal Concept RDF Example

#### 3.3.4.1 CodeSystem and Concept XML

```

738 <ValueSet xmlns="http://hl7.org/fhir">
739   <id value="allergy-intolerance-status"/>
740   <meta>
741     <lastUpdated value="2015-10-27T02:58:28.599+00:00"/>
742     <profile value="http://hl7.org/fhir/StructureDefinition/valueset-shareable-definition"/>
743   </meta>
744   <text>
745
746   </text>
747   <extension url="http://hl7.org/fhir/StructureDefinition/valueset-oid">
748     <valueUri value="urn:oid:2.16.840.1.113883.4.642.2.50"/>
749   </extension>
750   <url value="http://hl7.org/fhir/ValueSet/allergy-intolerance-status"/>
751   <version value="1.0.2"/>
752   <name value="AllergyIntoleranceStatus"/>
753   <status value="draft"/>
754   <experimental value="false"/>
755   <publisher value="HL7 (FHIR Project)"/>
756   <contact>
757     <telecom>
758       <system value="other"/>
759       <value value="http://hl7.org/fhir"/>
760     </telecom>
761     <telecom>
762       <system value="email"/>
763       <value value="fhir@lists.hl7.org"/>
764     </telecom>
765   </contact>
766   <date value="2015-10-27T02:58:28+00:00"/>
767   <description value="Assertion about certainty associated with a propensity, or potential risk, of a reaction
768     to the identified Substance."/>
769   <codeSystem>
770     <extension url="http://hl7.org/fhir/StructureDefinition/valueset-oid">
771       <valueUri value="urn:oid:2.16.840.1.113883.4.642.1.50"/>
772     </extension>
773     <system value="http://hl7.org/fhir/allergy-intolerance-status"/>
774     <version value="1.0.2"/>
775     <caseSensitive value="true"/>
776     <concept>
777       <code value="active"/>
778       <display value="Active"/>
779       <definition value="An active record of a reaction to the identified Substance."/>
780       <concept>
781         <code value="unconfirmed"/>
782         <display value="Unconfirmed"/>
783         <definition value="A low level of certainty about the propensity for a reaction to the identified Substance."/>
784       </concept>
785     <concept>
786       <code value="confirmed"/>
787       <display value="Confirmed"/>
788       <definition value="A high level of certainty about the propensity for a reaction to the identified Substance,
789         which may include clinical evidence by testing or rechallenge."/>
790     </concept>
791   </concept>
792   <concept>
793     <code value="inactive"/>
794     <display value="Inactive"/>
795     <definition value="An inactive record of a reaction to the identified Substance."/>
796     <concept>
797       <code value="resolved"/>
798       <display value="Resolved"/>
799       <definition value="A reaction to the identified Substance has been clinically reassessed by testing or rechallenge
800         and considered to be resolved."/>
801     </concept>
802   <concept>
803     <code value="refuted"/>
804     <display value="Refuted"/>
805     <definition value="A propensity for a reaction to the identified Substance has been disproven with a high
806       level of clinical certainty, which may include testing or rechallenge, and is refuted."/>
807   </concept>
808   <concept>
809     <code value="entered-in-error"/>
810     <display value="Entered In Error"/>
811     <definition value="The statement was entered in error and is not valid."/>
```

```
812 </concept>
813 </concept>
814 </codeSystem>
815 </ValueSet>
```

### 3.3.4.2 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

```
821 ### http://hl7.org/fhir/ValueSet/allergy-intolerance-statusA
822
823 fhirvs:allergy-intolerance-statusA rdf:type owl:Class ;
824   rdfs:subClassOf fhir:Valuesets .
825
826 [ rdf:type owl:Restriction ;
827   rdfs:subClassOf fhirvs:allergy-intolerance-statusA ;
828   owl:onProperty fhir:CodingBase.system ;
829   owl:hasValue fhircs:allergy-intolerance-status
830 ]
831 ] .
```

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).

### 3.3.4.3 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.

```
839 ### http://hl7.org/fhir/ValueSet/allergy-intolerance-statusB
840
841 fhirvs:allergy-intolerance-statusB rdf:type owl:Class ;
842   rdfs:subClassOf fhir:CodingBase_in_Valuesets .
843
844 [ rdf:type owl:Class ;
845   rdfs:subClassOf fhirvs:allergy-intolerance-statusB ;
846   owl:intersectionOf ( [ rdf:type owl:Restriction ; owl:onProperty fhir:CodingBase.code ;
847     owl:someValuesFrom [ rdf:type owl:Class ;
848       owl:unionOf ( [ rdf:type owl:Restriction ; owl:onProperty fhir:value ;
849         owl:hasValue "confirmed"
850         ]
851         [ rdf:type owl:Restriction ; owl:onProperty fhir:value ;
852           owl:hasValue "unconfirmed"
853         ]
854       )
855     ]
856     [ rdf:type owl:Restriction ; owl:onProperty fhir:CodingBase.system ;
857       owl:hasValue fhircs:allergy-intolerance-status
858     ]
859   )
860 ]
861 ] .
```

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.

867    **3.3.4.4 RDF Aligned ValueSet of CodingBase individuals within Top Concept (C)**

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

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

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

```
874    ### http://hl7.org/fhir/ValueSet/allergy-intolerance-statusC
875
876    fhirvs:allergy-intolerance-statusC rdf:type owl:Class ;
877       rdfs:label "Allergy Int Status C" ;
878       rdfs:subClassOf fhir:Valuesets .
879
880    [ rdf:type owl:Restriction ;
881       rdfs:subClassOf fhirvs:allergy-intolerance-statusC ;
882       owl:onProperty fhir:CodingBase.concept ;
883       owl:someValuesFrom allergy-intolerance-status:Concept
884 ] .
```

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

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

```
887    ### http://hl7.org/fhir/CodingBase.concept
888
889    fhir:CodingBase.concept rdf:type owl:ObjectProperty ;
890       owl:inverseOf fhir:ConceptBase.coding ;
891       rdfs:subPropertyOf fhir:objectProperty .
```

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

894    **3.3.4.5 RDF CodingBase individuals of specific Concepts (D)**

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

```
896    ### http://hl7.org/fhir/ValueSet/allergy-intolerance-statusD
897
898    fhirvs:allergy-intolerance-statusD rdf:type owl:Class ;
899       rdfs:subClassOf fhir:CodingBase_in_Valuesets .
900
901    [ rdf:type owl:Restriction ;
902       rdfs:subClassOf fhirvs:allergy-intolerance-statusD ;
903       owl:onProperty fhir:CodingBase.concept ;
904       owl:someValuesFrom [ rdf:type owl:Class ;
905                 owl:unionOf ( allergy-intolerance-status:confirmed
906                                 allergy-intolerance-status:unconfirmed
907                                 )
908                 ]
909 ] .
```

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

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

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

915    3.3.5 External terminology ValueSets

916    3.3.5.1 All codes from

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

919    3.3.5.2 ValueSet Resource example in XML

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

```
922 <ValueSet xmlns="http://hl7.org/fhir">
923   <id value="substance-code"/>
924
925   <description value="This value set contains concept codes for specific substances"/>
926   <copyright value="This value set includes content from SNOMED CT, which is copyright © 2002+ International
927     Health Terminology Standards Development Organisation (IHTSDO), and distributed by agreement
928     between IHTSDO and HL7. Implementer use of SNOMED CT is not covered by this agreement"/>
929   <compose>
930     <include>
931       <system value="http://snomed.info/sct"/>
932       <filter>
933         <property value="concept"/>
934         <op value="is-a"/>
935         <value value="105590001"/>
936       </filter>
937     </include>
938     <include>
939       <system value="http://snomed.info/sct"/>
940       <filter>
941         <property value="concept"/>
942         <op value="is-a"/>
943         <value value="373873005"/>
944       </filter>
945     </include>
946   </compose>
947 </ValueSet>
```

948

```
949 <ValueSet xmlns="http://hl7.org/fhir">
950   <id value="allergyintolerance-substance-code"/>
951
952   <description value="This value set includes concept codes for specific substances and negation codes to specify
953     the absence of specific types of allergies." />
954   <copyright value="This value set includes content from SNOMED CT, which is copyright © 2002+ International
955     Health Terminology Standards Development Organisation (IHTSDO), and distributed by agreement
956     between IHTSDO and HL7. Implementer use of SNOMED CT is not covered by this agreement"/>
957   <compose>
958     <import value="http://hl7.org/fhir/ValueSet/substance-code"/>
959     <include>
960       <system value="http://snomed.info/sct"/>
961       <concept>
962         <code value="160244002"/>
963         <display value="No Known Allergies"/>
964       </concept>
965       <concept>
966         <code value="429625007"/>
967         <display value="No Known Food Allergies"/>
968       </concept>
969       <concept>
970         <code value="409137002"/>
971         <display value="No Known Drug Allergies"/>
972       </concept>
973       <concept>
974         <code value="428607008"/>
975         <display value="No Known Environmental Allergy"/>
976       </concept>
977     </include>
978   </compose>
979 </ValueSet>
```

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

982    **3.3.5.3 RDF CodingBase Direct Restriction Unaligned with a Code System (B)**

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

```
984    ##### http://hl7.org/fhir/ValueSet/substance-codeB  
985    fhirvs:substance-codeB rdf:type owl:Class ;  
986      rdfs:label "Substance Code" ;  
987      rdfs:subClassOf fhir:Valuesets.  
988  
989
```

990

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

```
993    [ rdf:type owl:Class ;  
994      rdfs:subClassOf <http://hl7.org/fhir/ValueSet/substance-codeB> ;  
995      owl:intersectionOf ( [ rdf:type owl:Restriction ; owl:onProperty fhir:CodingBase.code ;  
996        owl:allValuesFrom [ rdf:type owl:Class ;  
997          owl:unionOf ( [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "105590001" ]  
998            [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "373873005" ]  
999            )  
1000        )  
1001        ]  
1002        [ rdf:type owl:Restriction ; owl:onProperty fhir:CodingBase.system ;  
1003          owl:hasValue <http://snomed.info/sct>  
1004        ]  
1005        )  
1006     )  
1007 ].
```

1008    This will only define the ValueSet as the top code and **does not** include all the subconcepts as codes. In order to  
1009    do this an expansion must be made with a filter. See <http://hl7-fhir.github.io/valueset-allergyintolerance-substance-code.html>

1011    The operation <filter><op> declares “is-a” to mean transitive subclassing. However this is not understood by  
1012    RDF/OWL. What is understood is the subclassing of the SNOMED Concept ontology itself.

1013    The only solution is to extract all the codes in the hierarchy and explicitly declare them in the Bridging Ontology.  
1014    The treatment of allergyintolerance-substance-code is to add the concepts to the enumerated list.

1015    ***3.3.5.4 RDF ValueSet binding to Concepts(D)***

1016    The valueset substance-codeD is declared in FHIR as before:

```
1017    ### http://hl7.org/fhir/ValueSet/substance-codeD  
1018    fhirvs:substance-codeB rdf:type owl:Class ;  
1019         rdfs:label "Substance Codes D" ;  
1020         rdfs:subClassOf fhir:Valuesets .  
1021
```

1022

1023    The allergyintolerance-substance-code valueset is also declared in FHIR

```
1024    ### http://hl7.org/fhir/ValueSet/allergyintolerance-substance-code  
1025    <http://hl7.org/fhir//ValueSet/allergyintolerance-substance-code> rdf:type owl:Class ;  
1026         rdfs:label "AllergyIntolerance Substance and Negation Codes" ;  
1027         rdfs:subClassOf fhir:CodingBase_in_Valuesets .  
1028
```

1029

1030    The bridging ontology declares a general Class axiom which shows the mapping to the Concepts:

```
1031    [ rdf:type owl:Restriction ;  
1032         rdfs:subClassOf <http://hl7.org/fhir/ValueSet/substance-codeD> ;  
1033         owl:onProperty fhir:CodingBase.concept ; owl:someValuesFrom [ rdf:type owl:Class ;  
1034                 owl:unionOf ( <http://snomed.info/id/105590001>  
1035                         <http://snomed.info/id/373873005>  
1036                         )  
1037                 ]  
1038         ].
```

1039

```
1040    [ rdf:type owl:Class ;  
1041         rdfs:subClassOf <http://hl7.org/fhir/ValueSet/allergyintolerance-substance-code> ;  
1042         owl:unionOf ( <http://hl7.org/fhir/ValueSet/substance-codeD>  
1043                 [ rdf:type owl:Restriction ;  
1044                         owl:onProperty fhir:CodingBase.concept ; owl:someValuesFrom [ rdf:type owl:Class ;  
1045                                 owl:unionOf ( <http://snomed.info/id/160244002>  
1046                                         <http://snomed.info/id/409137002>  
1047                                         <http://snomed.info/id/428607008>  
1048                                         <http://snomed.info/id/429625007>  
1049                                 )  
1050                 ]  
1051                 )  
1052         ].  
1053
```

1054    CodingBase.concept defines the restriction on concepts for the Codingbase.

1055    The display values are redundant and since closure is achieved with these classes, their display as rdfs:label can  
1056    be shown at any time in an OWL tool.

1057    3.3.6 Coding Binding to external terminology (section 1.17.3.3.5)

1058    3.3.6.1 FHIR XML

```
1059 <AllergyIntolerance xmlns="http://hl7.org/fhir" >
1060   <id value="1"/>
1061   <text>
1062     </text>
1063   <!-- the date that this entry was recorded -->
1064   <recordedDate value="2010-03-01"/>
1065   <!-- the patient that actually has the risk of adverse reaction -->
1066   <patient>
1067     <reference value="http://record/Patient/PeterPatient"/>
1068     <display value="Peter Patient"/>
1069   </patient>
1070   <!-- substance, coded from SNOMED CT-->
1071   <substance>
1072     <coding>
1073       <system value="http://snomed.info/id"/>
1074       <code value="90614001"/>
1075       <display value="beta-Lactam antibiotic"/>
1076     </coding>
1077   </substance>
1078   <status value="confirmed"/>
1079   <criticality value="high"/>
1080   <category value="medication"/>
1081 </AllergyIntolerance>
```

1082    3.3.6.2 RDF Instance Example

1083    This is the raw instance before processing and after in green for inference and red for specific processing

```
1084 @prefix : <http://record/AllergyIntolerance/> .
1085 @prefix owl: <http://www.w3.org/2002/07/owl#> .
1086 @prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
1087 @prefix sct: <http://snomed.info/id/> .
1088 @prefix xml: <http://www.w3.org/XML/1998/namespace> .
1089 @prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
1090 @prefix fhir: <http://hl7.org/fhir/> .
1091 @prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
1092 @prefix profile: <http://PatientSafetyProfile/> .
1093 @base <http://record/AllergyIntolerance/1> .
1094
1095 <http://record/AllergyIntolerance/> rdf:type owl:Ontology ;
1096   owl:imports <http://PatientSafetyProfile> .
1097
1098 ### http://record/AllergyIntolerance/1
1099
1100 <http://record/AllergyIntolerance/1> rdf:type profile:DomainResource, owl:NamedIndividual ;
1101   fhir:Resource.id [ rdf:type fhir:id ; fhir:value "1" ] ;
1102   fhir:AllergyIntolerance.status [ rdf:type fhir:code , <http://hl7.org/fhir/allergyIntoleranceStatus#confirmed> ;
1103     fhir:ConceptBase.coding [ fhir:CodingBase.code [ fhir:value "confirmed" ] ]
1104   ] ;
1105   fhir:AllergyIntolerance.patient [ rdf:type fhir:Reference ;
1106     fhir:Reference.reference [ fhir:value "http://record/Patient/PeterPatient" ] ;
1107     fhir:Reference.display [ fhir:value "Peter Patient" ] ;
1108     fhir:Reference.link <http://record/Patient/PeterPatient> ;
1109   ] ;
1110   fhir:AllergyIntolerance.substance [ rdf:type fhir:CodeableConcept , <http://snomed.info/id/90614001> ;
1111     rdfs:label "beta-lactam (antibiotic)" ;
1112     fhir:ConceptBase.coding [ rdf:type fhir:CodingBase ;
1113       fhir:CodingBase.code [ rdf:type fhir:codeBase ; fhir:value "90614001" ] ;
1114       fhir:CodingBase.system [ rdf:type fhir:string ; fhir:value "http://snomed.info/sct" ] ;
1115       fhir:CodingBase.display [ rdf:type fhir:string ; fhir:value "beta-lactam (antibiotic)" ]
1116     ] ;
1117     fhir:ConceptBase.text [ rdf:type fhir:string ; fhir:value "beta-lactam (antibiotic)" ]
1118   ] .
```

1119

1120 Note the use of a profile binding through the type “profile:AllergyIntolerance” which then restricts the types of  
1121 CodingBase instances.

1122 **3.3.6.3 FHIR Allergy Intolerance OWL Schema**

1123 The schema is abridged to show the topics of interest:

```
1124 ### http://hl7.org/fhir/AllergyIntolerance
1125
1126 fhir:AllergyIntolerance rdf:type owl:Class ;
1127
1128     rdfs:subClassOf fhir:DomainResource ,
1129         [ rdf:type owl:Restriction ;
1130             owl:onProperty fhir:AllergyIntolerance.substance ;
1131             owl:maxCardinality "1"^^xsd:nonNegativeInteger
1132         ] ,
1133         [ rdf:type owl:Restriction ;
1134             owl:onProperty fhir:AllergyIntolerance.substance ;
1135             owl:allValuesFrom fhir:CodeableConcept
1136         ] ,
1137 Etc..
1138 .
```

1139 The substance Object Property has no valueset type yet only the restriction that it is a CodeableConcept type.

1140 The valueset gets applied through the structural definition or profile binding.

1141

1142 **3.3.6.4 Definitions of Code System, Concept**

1143 This section is needed to ground the definitions of Coding System, and Concept when defined in RDF/OWL.

1144 **3.3.6.4.1 Code System**

1145 *The system ensures that codes can be unambiguously traced back to their original definition, and that logical  
1146 comparisons, matching and inferences can be performed consistently by different systems.*

1147 In RDF/OWL a code system is a namespace in which the code is unique. Since a code forms a fragment of a URI,  
1148 the code-system forms a prefix to that fragment making it unique. The code system identity and the prefix may  
1149 not be the same but are related using a property of the code system.

URI	Source	OID
http://snomed.info/sct	SNOMED CT ( <a href="#">IHTSDO</a> )	2.16.840.1.113883.6.96

1150 The prefix for snomed is <http://snomed.info.id/>

1151 However, the URI is a member of the fhir:uri class and an additional class is introduced – fhir:CodeSystemURI as  
1152 a subclass of fhir:URI to define the set that are CodeSystem identifiers. The individual code system may then be  
1153 declared and referenced:

```
1154 ### http://snomed.info/sct
1155 <http://snomed.info/sct> rdf:type fhir:CodeSystemURI ,
1156           owl:NamedIndividual ;
1157
1158         fhir:value "http://snomed.info/sct" .
```

1160 A specific CodeSystem may be declared as a class which is a set of all the CodingBase individuals restricted by  
1161 the CodingBase.system property.

```
1162 ### http://snomed.info/sct
1163 <http://snomed.info/sct> rdf:type owl:Class ;
1164
1165         rdfs:subClassOf fhir:CodingBase_in_Systems .
```

1167 **3.3.6.4.2 Bridging Ontology**

1168 This forms a pun with the individual and it is declared in a bridging ontology which is aware of the constraints of  
1169 Concepts in that Code System.

1170 The bridging ontology is aware of FHIR and the external terminology ontologies.

```
1171 [ rdf:type owl:Class ;
1172   rdfs:subClassOf <http://snomed.info/id/282100009> ;
1173   owl:intersectionOf ( <http://snomed.info/sct>
1174     [ rdf:type owl:Restriction ;
1175       owl:onProperty fhir:CodingBase.code ;
1176       owl:someValuesFrom [ rdf:type owl:Restriction ;
1177         owl:onProperty fhir:value ;
1178         owl:hasValue "282100009"
1179       ]
1180     )
1181   ] .
```

1183

1184 3.3.6.4.3 Concept  
1185 A concept may be a single Class in RDF which may in turn be a union of multiple classes based on subclass  
1186 relationships.

1187 3.3.6.4.4 ValueSet  
1188 Example is substance-code used in AllergyIntolerance

1189 3.3.6.4.4.1 Summary

Defining URL:	<a href="http://hl7.org/fhir/ValueSet/substance-code">http://hl7.org/fhir/ValueSet/substance-code</a>
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	<a href="#">XML</a> / <a href="#">JSON</a>

1190

1191 3.3.6.4.4.2 Content Logical Definition 

1192 This value set includes codes from the following code systems:

1193• Include codes from <http://snomed.info/sct> where concept is-a 105590001

1194• Include codes from <http://snomed.info/sct> where concept is-a 373873005

1195 3.3.6.4.4.3 RDF Definition

1196 Since these concepts in snomed are hierarchical classes the valueset is by definition a union of concept classes.

1197 However the concept class bound to a system should have a different metatype – e.g. systemconcept.

1198 A concept class is therefore a supertype of the systemconcept classes.

1199 A named Valueset as a class is a union of named systemconcept classes (not a superclass). If an instance of  
1200 CodingBase is typed to a Valueset then it probably means that the codeBase is unknown or to be selected.

1201 The FHIR “include” gets stranslated to a union expression:

1202

## 1203 3.3.6.4.5 Examples

## 1204 3.3.6.4.5.1 Example from orim

```

1205  #### CONCEPT DOMAIN
1206  #### http://hl7.org/ontology/uv/vocab/cd#ActStatus
1207
1208 cd:ActStatus rdf:type :Class ;
1209     :equivalentClass [ rdf:type :Class ;
1210         :unionOf ( [ rdf:type :Restriction ;
1211             :onProperty hl7:VocabularyConcept.codingRef ;
1212             :someValuesFrom <urn:oid:2.16.840.1.113883.1.11.159331/Recent>
1213         ]
1214         [ rdf:type :Restriction ;
1215             :onProperty dt:ANY.nullFlavor ;
1216             :minCardinality "1"^^xs:nonNegativeInteger
1217         ]
1218     )
1219     ] ;
1220 rdfs:subClassOf hl7:ConceptDomain .
1221
1222 #### CONCEPT
1223 #### http://hl7.org/ontology/uv/vocab/cs/ActStatus/Concept
1224
1225 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/Concept> rdf:type :Class ;
1226     rdfs:subClassOf hl7:VocabularyConcept .
1227
1228 #### http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept
1229
1230 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept> rdf:type :Class ;
1231     rdfs:subClassOf <http://hl7.org/ontology/uv/vocab/cs/ActStatus/Concept> .
1232
1233 #### http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept#active
1234
1235 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept#active> rdf:type :Class ;
1236     :equivalentClass <urn:oid:2.16.840.1.113883.5.14/2011-12-20/Concept#active> ;
1237     rdfs:subClassOf <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept> ,
1238     <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept#normal> .
1239
1240 #### urn:oid:2.16.840.1.113883.5.14/2011-12-20/Concept#active
1241
1242 <urn:oid:2.16.840.1.113883.5.14/2011-12-20/Concept#active> rdf:type :Class ;
1243     :equivalentClass <urn:oid:2.16.840.1.113883.5.14/Recent/Concept#active> ;
1244     rdfs:subClassOf <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept> ,
1245     <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept#normal> .
1246
1247 #### urn:oid:2.16.840.1.113883.5.14/Recent/Concept#active
1248
1249 <urn:oid:2.16.840.1.113883.5.14/Recent/Concept#active> rdf:type :Class ;
1250     rdfs:subClassOf <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept> ,
1251     <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20/Concept#normal> .
1252
1253
1254 #### VALUESET
1255 #### http://hl7.org/ontology/uv/vocab/vs/ActStatus
1256
1257 vs:ActStatus rdf:type :Class ;
1258     :equivalentClass <http://hl7.org/ontology/uv/vocab/vs/ActStatus/2011-12-20> ,
1259     <urn:oid:2.16.840.1.113883.1.11.159331> ;
1260     rdfs:subClassOf hl7:ValueSet .
1261
1262 #### http://hl7.org/ontology/uv/vocab/vs/ActStatusActive
1263
1264 vs:ActStatusActive rdf:type :Class ;
1265     :equivalentClass <http://hl7.org/ontology/uv/vocab/vs/ActStatusActive/2011-12-20> ,
1266     <urn:oid:2.16.840.1.113883.1.11.20023> ;
1267     rdfs:subClassOf hl7:ValueSet .
1268

```

```

1269
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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
        ]
    ]

```

```

1338           ] ,
1339           [ rdf:type :Restriction ; :onProperty h17:CodeSystemVersion.codingRef ;
1340             :allValuesFrom [ rdf:type :Class ;
1341               :oneOf ( <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#nullified>
1342                 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#normal>
1343                 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#suspended>
1344                 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#new>
1345                 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#obsolete>
1346                 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#aborted>
1347                 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#active>
1348                 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#held>
1349                 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#completed>
1350                 <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#cancelled>
1351               )
1352             ]
1353           ] ,
1354           [ rdf:type :Restriction ; :onProperty h17:CodeSystemVersion.codingRef ;
1355             :allValuesFrom [ rdf:type :Restriction ;:onProperty h17:Coding.codeSystemRef ;
1356               :hasValue cs:ActStatus
1357             ]
1358           ] ;
1359           h17:CodeSystemVersion.codeSystem "2.16.840.1.113883.5.14"^^xs:string ;
1360           h17:CodeSystemVersion.versionDate "2011-12-20"^^xs:string ;
1361           :sameAs <urn:oid:2.16.840.1.113883.5.14/2011-12-20> .
1362
1363   ###  http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#active
1364
1365   <http://hl7.org/ontology/uv/vocab/cs/ActStatus/2011-12-20#active> rdf:type h17:Coding ,:NamedIndividual ;
1366     h17:Coding.code "active"^^xs:string .
1367

```

### 3.3.6.4.5.2 ValueSet schema in FHIR

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

```

1372
1373  ### http://hl7.org/fhir/ValueSet
1374  fhir:ValueSet rdf:type owl:Class ;
1375      rdfs:subClassOf fhir:DomainResource ,
1376          [ rdf:type owl:Restriction ;
1377              owl:onProperty fhir:ValueSet.define ;
1378              owl:allValuesFrom fhir:ValueSet.Define
1379          ] ,
1380          [ rdf:type owl:Restriction ;
1381              owl:onProperty fhir:ValueSet.define ;
1382              owl:maxCardinality "1"^^xsd:nonNegativeInteger
1383          ] ,
1384          [ rdf:type owl:Restriction ;
1385              owl:onProperty fhir:ValueSet.compose ;
1386              owl:allValuesFrom fhir:ValueSet.Compose
1387          ] ,
1388          [ rdf:type owl:Restriction ;
1389              owl:onProperty fhir:ValueSet.expansion ;
1390              owl:maxCardinality "1"^^xsd:nonNegativeInteger
1391          ] ,
1392          [ rdf:type owl:Restriction ;
1393              owl:onProperty fhir:ValueSet.expansion ;
1394              owl:allValuesFrom fhir:ValueSet.Expansion
1395          ] ,
1396          [ rdf:type owl:Restriction ;
1397              owl:onProperty fhir:ValueSet.compose ;
1398              owl:maxCardinality "1"^^xsd:nonNegativeInteger
1399          ] .
1400
1401  ### http://hl7.org/fhir/ValueSet.Compose
1402  fhir:ValueSet.Compose rdf:type owl:Class ;
1403      rdfs:subClassOf fhir:BackboneElement .

```

1403

```

1404
1405  ### http://hl7.org/fhir/ValueSet.Concept
1406  fhir:ValueSet.Concept rdf:type owl:Class ;
1407      rdfs:subClassOf fhir:BackboneElement ,
1408          [ rdf:type owl:Restriction ;
1409              owl:onProperty fhir:ValueSet.Concept.display ;
1410              owl:allValuesFrom fhir:string
1411          ] ,
1412          [ rdf:type owl:Restriction ;
1413              owl:onProperty fhir:ValueSet.Concept.code ;
1414              owl:cardinality "1"^^xsd:nonNegativeInteger
1415          ] ,
1416          [ rdf:type owl:Restriction ;
1417              owl:onProperty fhir:ValueSet.Concept.code ;
1418              owl:allValuesFrom fhir:code
1419          ] ,
1420          [ rdf:type owl:Restriction ;
1421              owl:onProperty fhir:ValueSet.Concept.definition ;
1422              owl:maxCardinality "1"^^xsd:nonNegativeInteger
1423          ] ,
1424          [ rdf:type owl:Restriction ;
1425              owl:onProperty fhir:ValueSet.Concept.display ;
1426              owl:maxCardinality "1"^^xsd:nonNegativeInteger
1427          ] ,
1428          [ rdf:type owl:Restriction ;
1429              owl:onProperty fhir:ValueSet.Concept.definition ;
1430              owl:allValuesFrom fhir:string
1431          ] .

```

1431

```
1432
1433  ### http://hl7.org/fhir/ValueSet.Define
1434  fhir:ValueSet.Define rdf:type owl:Class ;
1435      rdfs:subClassOf fhir:BackboneElement ,
1436          [ rdf:type owl:Restriction ;
1437              owl:onProperty fhir:ValueSet.Define.system ;
1438              owl:allValuesFrom fhir:uri
1439          ] ,
1440          [ rdf:type owl:Restriction ;
1441              owl:onProperty fhir:ValueSet.Define.system ;
1442              owl:cardinality "1"^^xsd:nonNegativeInteger
1443          ] ,
1444          [ rdf:type owl:Restriction ;
1445              owl:onProperty fhir:ValueSet.Define.concept ;
1446              owl:allValuesFrom fhir:ValueSet.Concept
1447          ] .
1448
1449  ### http://hl7.org/fhir/ValueSet.Expansion
1450  fhir:ValueSet.Expansion rdf:type owl:Class ;
1451      rdfs:subClassOf fhir:BackboneElement .
```

1451

1452

1453

1454    3.3.6.5 *FHIR internal System and Coding bindings (OWL Schema)*

1455    The system is inclusive of all the terms within it and all the instances of those terms.

```
1456 @prefix allergy-intolerance-status: <http://hl7.org/fhir/allergy-intolerance-status#> .  
1457  
1458    ### http://hl7.org/fhir/allergy-intolerance-status  
1459  
1460    fhir:allergy-intolerance-status rdf:type owl:Class ;  
1461    rdfs:subClassOf fhir:valueset-system ,  
1462    [ rdf:type owl:Class ;  
1463    owl:unionOf (  
1464       allergy-intolerance-status:confirmed  
1465       allergy-intolerance-status:entered-in-error  
1466       allergy-intolerance-status:refuted  
1467       allergy-intolerance-status:resolved  
1468       allergy-intolerance-status:unconfirmed  
1469     )  
1470    ] ,  
1471    [ rdf:type owl:Restriction ;  
1472     owl:onProperty fhir:CodingBase.system ;  
1473     owl:allValuesFrom [ rdf:type owl:Restriction ;  
1474       owl:onProperty fhir:value ; owl:hasValue "http://hl7.org/fhir/allergy-intolerance-status"  
1475     ]  
1476    ] ;  
1477    fhir:prefix "http://hl7.org/fhir/allergy-intolerance-status#" .  
1478  
1479    ### http://hl7.org/fhir/allergy-intolerance-status#confirmed  
1480  
1481    allergy-intolerance-status:confirmed rdf:type owl:Class ;  
1482    rdfs:label "Confirmed" ;  
1483    rdfs:subClassOf fhir:allergy-intolerance-status ,  
1484    [ rdf:type owl:Restriction ;  
1485     owl:onProperty fhir:CodingBase.code ;  
1486     owl:allValuesFrom [ rdf:type owl:Restriction ;  
1487       owl:onProperty fhir:value ; owl:hasValue "confirmed"  
1488     ]  
1489    ] ;  
1490    rdfs:comment "A high level of certainty about the propensity for a reaction to the identified Substance, which  
1491 may include clinical evidence by testing or rechallenge." .  
1492  
1493    ### http://hl7.org/fhir/allergy-intolerance-status#entered-in-error  
1494  
1495    allergy-intolerance-status:entered-in-error rdf:type owl:Class ;  
1496    rdfs:label "Entered In Error" ;  
1497    rdfs:subClassOf fhir:allergy-intolerance-status ,  
1498    [ rdf:type owl:Restriction ;  
1499     owl:onProperty fhir:CodingBase.code ;  
1500     owl:allValuesFrom [ rdf:type owl:Restriction ;  
1501       owl:onProperty fhir:value ; owl:hasValue "entered-in-error"  
1502     ]  
1503    ] ;  
1504    rdfs:comment "The statement was entered in error and is not valid" .
```

1505

1506    The system Class definition shows it is a subclass of the abstract valueset-system and restricts its members to  
1507 the CodingBase.system.

1508    There is also an annotation property fhir:prefix which defines the structure of the URI prefix when naming the  
1509 members of the system. It causes the @prefix declaration.

1510    Two members are shown “confirmed” and “entered-in-error”. They are subclasses of allergy-intolerance-status  
1511 and have the restrictions of that class so they do not have to declare CodingBase.system restrictions.

1512    ***3.3.6.6 System and codings external RDF representation***

1513    From the SNOMED RDF:

```
1514 <http://snomed.info/id/138875005> rdf:type owl:Class ;
1515   rdfs:label "SNOMED CT Concept" .
1516
1517 <http://snomed.info/id/105590001> rdf:type owl:Class ;
1518   rdfs:label "Substance (substance)" ;
1519   rdfs:subClassOf <http://snomed.info/id/138875005> .
1520
1521 <http://snomed.info/id/373873005> rdf:type owl:Class ;
1522   rdfs:label "Pharmaceutical / biologic product (product)" ;
1523   rdfs:subClassOf <http://snomed.info/id/138875005> .
1524
1525 <http://snomed.info/id/346325008> rdf:type owl:Class ;
1526   rdfs:label "Antibacterial drugs (product)" ;
1527   rdfs:subClassOf <http://snomed.info/id/373873005> .
1528
1529 <http://snomed.info/id/90614001> rdf:type owl:Class ;
1530   rdfs:label "beta-Lactam antibiotic" ;
1531   rdfs:subClassOf <http://snomed.info/id/346325008> .
```

1532    The system is defined further in the FHIR ontology

```
1533 @prefix sct: <http://snomed.info/id/> .
1534
1535 ### http://snomed.info/sct
1536
1537 <http://snomed.info/sct> rdf:type owl:Class ;
1538   rdfs:subClassOf fhir:valueset-system ;
1539   fhir:prefix "http://snomed.info/id/" .
```

1540

1541

1542     3.3.6.7 *Valueset Definition*

1543     A ValueSet is somewhat similar to a value-set-system in that it applies constraints to the members but they can  
1544     be from different systems.

1545     The specific ValueSet is a Class which is a union of Concept classes from one or more coding-systems. It is  
1546     expected that this representation can be computed from the FHIR representation.

1547       3.3.6.7.1.1 *Anonymous codings*

1548       Here is the definition of the specific ValueSet as a Class with restrictions on values not types:

```
1549 <http://hl7.org/fhir/vs/allergy-intolerance-status> rdf:type owl:Class ;  
1550   rdfs:label "Allergy Intolerance Status Value Set" ;  
1551   rdfs:subClassOf fhir:valueset ,  
1552     [ rdf:type owl:Class ;  
1553       owl:intersectionOf (  
1554         [ rdf:type owl:Restriction ;  
1555           owl:onProperty fhir:CodingBase.code ;  
1556           owl:someValuesFrom [ rdf:type owl:Class ;  
1557             owl:unionOf (  
1558               [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "confirmed" ]  
1559               [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "entered-in-error" ]  
1560               [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "refuted" ]  
1561               [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "resolved" ]  
1562               [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "unconfirmed" ]  
1563             )  
1564           ]  
1565         ]  
1566         [ rdf:type owl:Restriction ;  
1567           owl:onProperty fhir:CodingBase.system ;  
1568           owl:allValuesFrom [ rdf:type owl:Restriction ; owl:onProperty fhir:value ;  
1569             owl:hasValue "http://fhir/allergy-intolerance-status"  
1570           ]  
1571         ]  
1572       )  
1573     ] .
```

1574       If the valueset needs to identify CodingBase restrictions from other systems then the restriction will have a  
1575       slightly different structure. The example here shows the optimization for a single system (Define).

1576       3.3.6.7.2 *Named codings*

1577       If named codings are used then the expression can be greatly simplified since the restrictions are in the named  
1578       class.

```
1579 <http://hl7.org/fhir/vs/allergy-intolerance-status> rdf:type owl:Class ;  
1580   rdfs:label "Allergy Intolerance Status Value Set" ;  
1581   rdfs:subClassOf fhir:valueset ,  
1582     [ rdf:type owl:Class ;  
1583       owl:unionOf ( allergy-intolerance-status:confirmed  
1584         allergy-intolerance-status:entered-in-error  
1585         allergy-intolerance-status:refuted  
1586         allergy-intolerance-status:resolved  
1587         allergy-intolerance-status:unconfirmed  
1588       )  
1589     ] .
```

1590

1591

1592    ***3.3.6.8 ValueSet schema in the metamodel***

1593    A metamodel is introduced when Classes in the Model are instances of MetaClasses which are subclasses of  
1594    owl:Class. In general the Element Definition (1.23.0) is a metamodel.

1595    In the metamodel viewpoint, an instance of ValueSet will have object property assertions to

- 1596        a) instances of ValueSet.Define if all the codes are taken from a single system
- 1597        b) instances of ValueSet.Compose if the codes come from multiple systems and allow inclusion and  
1598              exclusion
- 1599        c) instances of ValueSet.Expansion if the valueset is converted into an enumerated list

1600    A ValueSet individual will have define, compose and expansion object properties to applicable objects. However,  
1601    these object property semantics are not understood by RDF or OWL. They are translated in the Model to  
1602    subclass, intersection and union relationships between classes.

1603

1604    **3.3.6.9    Restriction equivalents to Compose Elements**

1605    The Compose element has subelements – import, include, exclude.

1606    **3.3.6.9.1    Import**

1607    Import has a value of a ValueSet URI that is to be imported (see earlier Valueset example – 7.2.1)

```
1608       owl:unionOf ( <http://hl7.org/fhir/ValueSet/substance-codeD>
1609                 [ rdf:type owl:Restriction ;
1610                 Etc. ]
1611         )
```

1612    The import equivalent is the unionOf with the named Class representing the Valueset (here shown as  
1613    <<http://hl7.org/fhir/ValueSet/substance-codeD>>).

1614    **3.3.6.9.2    CodeSystem – Concepts**

1615    The extensional definition of a Code system includes its concepts as subclasses of the top concept. This is  
1616    translated into a CodeSystemURI individual with the annotation properties of the CodeSystem and the  
1617    associated Concept Classes.

1618    However, there is no direct ontology relationship between the CodeSystemURI and the top concept. Some  
1619    thoughts about a pun relationship might be useful.

1620    See - HL7 Internal Concept RDF Example.

1621    **3.3.6.9.3    Filter**

1622    The Filter element selects concepts by specify a matching criteria based on the properties (including  
1623    relationships) defined by the system. If multiple filters are specified, they SHALL all be true.

1624    The Filter Operator value set has an inline code system <http://hl7.org/fhir/filter-operator>, which defines the  
1625    following codes:

<b>Code</b>	<b>Display</b>	<b>Definition</b>
=	Equals	The specified property of the <b>code</b> equals the provided value.
is-a	Is A (by subsumption)	Includes all <b>concept</b> 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 <b>code</b> does not have an is-a relationship with the provided value.
regex	Regular Expression	The specified property of the <b>code</b> matches the regex specified in the provided value.
in	In Set	The specified property of the <b>code</b> 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 <b>code</b> is not in the set of codes or concepts

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

1626    3.3.6.9.4 Is-a – by subsumption

1627    3.3.6.9.4.1 *XML example*

```

1628 <include>
1629   <system value="http://snomed.info/sct"/>
1630   <filter>
1631     <property value="concept"/>
1632     <op value="is-a"/>
1633     <value value="105590001"/>
1634   </filter>
1635 </include>
1636 <include>
1637   <system value="http://snomed.info/sct"/>
1638   <filter>
1639     <property value="concept"/>
1640     <op value="is-a"/>
1641     <value value="373873005"/>
1642   </filter>
1643 </include>
```

1644

1645    The difficulty with this filter is that while it appears to apply to the concept class which can have is-a  
1646    subsumption, the value is the CodingBase.code value which restricts it to the concept class without  
1647    subsumption. CodingBase is a single class and the instances are not subsumable.

1648    3.3.6.9.4.2 *Compose Include is-a Concept*

1649    The approach is that the value must be translated into the Concept Class Name which would be  
1650    <<http://snomed.info/id/373873005>> and would be used in the restriction.

1651    <<http://snomed.info/sct>> fhir:prefix "<http://snomed.info/id/>"^^xsd:string .

1652    An annotation property on the CodeSystem individual can be used to construct the concept name where a  
1653    simple prefix is used with the codeBase value.

1654    This may also be articulated by the ValueSet fragment class which has the system and filter annotation  
1655    properties and could be translated into the final RDF form.

1656    The include element in conjunction with filtering on is-a concept is transformed into a union of the named  
1657    concept:

```

1658 owl:someValuesFrom [ rdf:type owl:Class ;
1659   owl:unionOf ( <http://snomed.info/id/105590001>
1660     <http://snomed.info/id/373873005>
```

1661    3.3.6.9.5 Exclude

1662    3.3.6.9.5.1 *XML Example*

```

1663 <exclude>
1664   <system value="http://snomed.info/sct"/>
1665   <filter>
1666     <property value="concept"/>
1667     <op value="is-a"/>
1668     <value value="410942007"/>
1669   </filter>
1670 </exclude>
```

1671

1672     3.3.6.9.5.2   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>
          )
        ]
      ]
    )
  )
] .
```

1694

1695   In this case the concept <http://snomed.info/id/410942007> is in the intersection as a complementOf so as to  
1696   be excluded.

1697     3.3.6.9.6   Equals and In

1698       3.3.6.9.6.1   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>
```

1721   These properties are specific to the code systems illustrated and would be expressed in the bridging ontology for  
1722   that system.

1723       3.3.6.9.6.2   Filter RDF Expression

1724   Each filter is defined as a class. In the RDF example these will be named to assist testing and visibility.

1725   A filter class will declare the set meeting the filter properties which are annotation properties. The set are  
1726   CodingBase individuals and the filter is therefore a fragment of a ValueSet.

```
###  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.

### **3.3.6.9.6.3 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>
    ]
  )
] .
```

## 1773 4 Resource References

### 1774 4.1 Github example

```
1775 :resource a fhir:Observation;
1776   fhir:contained fhir:Observation#23;
1777   fhir:Observation.subject [
1778     fhir:Reference.reference fhir:Observation#23
1779   ].
1780
1781 fhir:Observation#23 a fhir:Patient;
1782   fhir:Patient.name [ fhir:text "John Smith ].
```

1783 This example is partially in line with the resolved example below. Even if it were a URL it will not be understood  
1784 by reasoners or SPARQL.

### 1785 4.2 Subgroup example

#### 1786 4.2.1 FHIR XML

```
1787 <AllergyIntolerance xmlns="http://hl7.org/fhir">
1788   <id value="1"/>
1789   <text>
1790
1791   </text>
1792   <!-- the date that this entry was recorded -->
1793   <recordedDate value="2010-03-01"/>
1794   <!-- the patient that actually has the risk of adverse reaction -->
1795   <patient>
1796     <reference value="http://record/Patient/PeterPatient"/>
1797     <display value="Peter Patient"/>
1798   </patient>
1799 </AllergyIntolerance>
```

#### 1800 4.2.2 RDF Data After processing (acquiring the resource and importing)

```
1801 fhir:AllergyIntolerance.patient [ fhir:Reference.display [ fhir:value "Peter Patient" ] ;
1802   fhir:Reference.reference [ fhir:value "http://record/Patient/PeterPatient" ] ;
1803   fhir:Reference.link <http://record/Patient/PeterPatient>
1804 ] ;
```

1805 Note that Reference object has been supplemented by the URI of the Reference.link.

1806 AllergyIntolerance.patient.link can represent the property chain as shown earlier.

1807 A reverse property of the property chain can get the resources for a particular patient.

```
1808 ### http://hl7.org/fhir/AllergyForPatient
1809 fhir:AllergyForPatient rdf:type owl:ObjectProperty ;
1810   owl:inverseOf fhir:AllergyIntolerance.patient.link .
1811
1812 ### http://hl7.org/fhir/AllergyIntolerance.patient.link
1813
1814 fhir:AllergyIntolerance.patient.link rdf:type owl:ObjectProperty ;
1815   owl:propertyChainAxiom ( fhir:AllergyIntolerance.patient fhir:Reference.link ) .
```

1816  
1817 The Reference.link is declared when the resource has been imported and closure has been achieved. This allows  
1818 the consumer to determine whether the import has happened or not and can trigger that function. If the  
1819 Reference.link is pre-established there will be no indication in the import and the Resource instance will be  
1820 empty.

## 1821 4.2.3 FHIR OWL Schema

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

fhir:Reference rdf:type owl:Class ;

        rdfs:subClassOf fhir:Element ,
            [ rdf:type owl:Restriction ;
                owl:onProperty fhir:Reference.reference ;
                owl:allValuesFrom fhir:string
            ] ,
            [ rdf:type owl:Restriction ;
                owl:onProperty fhir:Reference.reference ;
                owl:maxCardinality "1"^^xsd:nonNegativeInteger
            ] ,
            [ rdf:type owl:Restriction ;
                owl:onProperty fhir:Reference.display ;
                owl:allValuesFrom fhir:string
            ] ,
            [ rdf:type owl:Restriction ;
                owl:onProperty fhir:Reference.display ;
                owl:maxCardinality "1"^^xsd:nonNegativeInteger
            ] ,
            [ rdf:type owl:Restriction ;
                owl:onProperty fhir:Reference.link ;
                owl:allValuesFrom fhir:DomainResource
            ] ,
            [ rdf:type owl:Restriction ;
                owl:onProperty fhir:Reference.link ;
                owl:maxCardinality "1"^^xsd:nonNegativeInteger
            ] .
```

1851

1852

## 1853 5 Bundle

1854 One common operation performed with resources is to gather a collection of resources into a single instance  
1855 with containing context. In FHIR this is referred to as "bundling" the resources together. These resource bundles  
1856 are useful for a variety of different reasons, including:

- 1857 • Returning a set of resources that meet some criteria as part of a server operation (see [RESTful](#)  
1858 [Search](#))
- 1859 • Returning a set of versions of resources as part of the history operation on a server (see [History](#))
- 1860 • Sending a set of resources as part of a message exchange (see [Messaging](#))
- 1861 • Grouping a self-contained set of resources to act as an exchangeable and persistable collection with  
1862 clinical integrity - e.g. a clinical document (see [Documents](#))
- 1863 • Creating/updating/deleting a set of resources on a server as a single operation (including doing so as  
1864 a single atomic transaction) (see [Transactions](#))
- 1865 • Storing a collection of resources

### 1866 5.1 Bundle XML content description

```
1867 <Bundle xmlns="http://hl7.org/fhir">
1868   <!-- from Resource: id, meta, implicitRules, and language -->
1869   <type value="[code]" /><!-- 1..1 document | message | transaction | transaction-response | batch | batch-response
| history | searchset | collection -->
1870   <total value="[unsignedInt]" /><!-- 0..1 If search, the total number of matches -->
1871   <link> <!-- 0..* Links related to this Bundle -->
1872     <relation value="[string]" /><!-- 1..1 http://www.iana.org/assignments/link-relations/link-relations.xhtml -->
1873     <url value="[uri]" /><!-- 1..1 Reference details for the link -->
1874   </link>
1875   <entry> <!-- 0..* Entry in the bundle - will have a resource, or information -->
1876     <link><!-- 0..* Content as for Bundle.link Links related to this entry --></link>
1877     <fullUrl value="[uri]" /><!-- 0..1 Absolute URL for resource (server address, or UUID/OID) -->
1878     <resource><!-- 0..1 Resource A resource in the bundle --></resource>
1879     <search> <!-- 0..1 Search related information -->
1880       <mode value="[code]" /><!-- 0..1 match | include | outcome - why this is in the result set -->
1881       <score value="[decimal]" /><!-- 0..1 Search ranking (between 0 and 1) -->
1882     </search>
1883     <request> <!-- 0..1 Transaction Related Information -->
1884       <method value="[code]" /><!-- 1..1 GET | POST | PUT | DELETE -->
1885       <url value="[uri]" /><!-- 1..1 URL for HTTP equivalent of this entry -->
1886       <ifNoneMatch value="[string]" /><!-- 0..1 For managing cache currency -->
1887       <ifModifiedSince value="[instant]" /><!-- 0..1 For managing update contention -->
1888       <ifMatch value="[string]" /><!-- 0..1 For managing update contention -->
1889       <ifNoneExist value="[string]" /><!-- 0..1 For conditional creates -->
1890     </request>
1891     <response> <!-- 0..1 Transaction Related Information -->
1892       <status value="[string]" /><!-- 1..1 Status return code for entry -->
1893       <location value="[uri]" /><!-- 0..1 The location, if the operation returns a location -->
1894       <etag value="[string]" /><!-- 0..1 The etag for the resource (if relevant) -->
1895       <lastModified value="[instant]" /><!-- 0..1 Server's date time modified -->
1896     </response>
1897   </entry>
1898   <signature><!-- 0..1 Signature Digital Signature --></signature>
1899 </Bundle>
1900
```

1901

1902

## 5.2 Bundle RDF Content

```
1903 <http://record/medpres1> rdf:type owl:Ontology ; owl:imports <http://hl7.org/fhir> .  
1904  
1905 ##### http://record/medpres1/bundle1  
1906  
1907 <http://record/medpres1/bundle1> rdf:type fhir:Bundle , owl:NamedIndividual ;  
1908   fhir:Bundle.entry [ rdf:type fhir:Bundle.Entry ;  
1909     fhir:Bundle.Entry.resource <http://record/MedicationPrescription/1>  
1910   ] ;  
1911   fhir:Bundle.type [ fhir:value "searchset"];  
1912   fhir:Bundle.link [ rdf:type fhir:uri ; fhir:value "self"] ;  
1913   fhir:Bundle.total [ rdf:type fhir:unsignedInt ; fhir:value 3 ];  
1914   fhir:Resource.meta [ rdf:type fhir:Meta ; fhir:Meta.lastUpdated  
1915     [ rdf:type fhir:instant ; fhir:value "2015-08-02T00:00:00"^^xsd:dateTime]  
1916   ] .  
1917  
1918 ##### http://record/MedicationPrescription/1  
1919  
1920 <http://record/MedicationPrescription/1> rdf:type profile:MedicationPrescription , owl:NamedIndividual ;  
1921   fhir:MedicationOrder.medicationReference [ rdf:type fhir:Reference ;  
1922     fhir:Reference.link <http://record/Medication/1> ;  
1923     fhir:Reference.reference [ fhir:value http://record/Medication/1 ] ;  
1924     fhir:Reference.display [ fhir:value "Amoxicillin (product)" ]  
1925   ] ;  
1926   fhir:MedicationOrder.patient [ rdf:type fhir:Reference ;  
1927     fhir:Reference.link <http://record/Patient/PeterPatient> ;  
1928     fhir:Reference.display [ fhir:value "Peter Patient" ] ;  
1929     fhir:Reference.reference [ fhir:value "http://record/Patient/PeterPatient"  
1930   ]  
1931 ] .  
1932
```

1933

1934 A Bundle may or may not have an Id (inherited from Resource) therefore it can be referenced as an Ontology  
1935 e.g. record/Bundle/123. It may therefore be a named or anonymous individual.

1936

### 5.3 Bundle RDF Schema

```

1937  ### http://hl7.org/fhir/Bundle
1938
1939 fhir:Bundle rdf:type owl:Class ;
1940   rdfs:subClassOf fhir:Resource ,
1941     [ rdf:type owl:Restriction ; owl:onProperty fhir:Bundle.total ;
1942       owl:onClass fhir:unsignedInt ;
1943         owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger
1944       ] ,
1945     [ rdf:type owl:Restriction ;
1946       owl:onProperty fhir:Bundle.entry ;
1947       owl:allValuesFrom fhir:Bundle.Entry
1948     ] ,
1949     [ rdf:type owl:Restriction ;
1950       owl:onProperty fhir:Bundle.signature ;
1951       owl:onClass fhir:Signature ;
1952       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger
1953     ] ,
1954     [ rdf:type owl:Restriction ;
1955       owl:onProperty fhir:Bundle.type ;
1956       owl:onClass fhir:code ;
1957       owl:qualifiedCardinality "1"^^xsd:nonNegativeInteger
1958     ] ,
1959     [ rdf:type owl:Restriction ;
1960       owl:onProperty fhir:Bundle.link ;
1961       owl:allValuesFrom fhir:Bundle.Link
1962     ] .
1963

1964  ### http://hl7.org/fhir/Bundle.Entry
1965
1966 fhir:Bundle.Entry rdf:type owl:Class ;
1967   rdfs:subClassOf fhir:BackboneElement ,
1968     [ rdf:type owl:Restriction ;
1969       owl:onProperty fhir:Bundle.Entry.search ;
1970       owl:onClass fhir:Bundle.Search ;
1971       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger
1972     ] ,
1973     [ rdf:type owl:Restriction ;
1974       owl:onProperty fhir:Bundle.Entry.link ;
1975       owl:onClass fhir:Bundle.Link ;
1976       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger
1977     ] ,
1978     [ rdf:type owl:Restriction ;
1979       owl:onProperty fhir:Bundle.Entry.resource ;
1980       owl:onClass fhir:Resource ;
1981       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger
1982     ] ,
1983     [ rdf:type owl:Restriction ;
1984       owl:onProperty fhir:Bundle.Entry.fullURI ;
1985       owl:onClass fhir:uri ;
1986       owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger
1987     ] .
1988

```

1989 **6 URI Naming**

1990 **6.1 Github example**

1991 No example

1992 **6.2 Subgroup example**

1993 Detailed rules for URI construction must be made for internally referenced resource class instances. The  
1994 example has proposed URI constructs where

1995 1. the Resource namespace precedes the assigned identifier for the contained instance

1996 2. the root resource object has an URI identifier identical to the resource class instance URI

1997 Thus <http://record/AllergyIntolerance/1> has “record/AllergyIntolerance” as the resource namespace with “1”  
1998 as the contained instance identifier.

1999 It is also intended that the resource namespace should also be the ontology IRI. This is to be tested.

2000 <http://record/AllergyIntolerance/> rdf:type owl:Ontology ;

2001

2002

2003 **7 Ordering**

2004 **7.1 Github example**

2005 No example

2006 **7.2 RDF individual ordering example**

2007 Simple integer DataProperty fhir:index can be applied to individuals of subclasses of fhir:Element

2008

```
2009 ##### http://hl7.org/fhir/index
2010 fhir:index rdf:type owl:DatatypeProperty ;
2011     rdfs:range fhir:index-primitive .
2012
2013 ##### http://hl7.org/fhir/index-primitive
2014 fhir:index-primitive rdf:type rdfs:Datatype ;
2015     owl:equivalentClass [ rdf:type rdfs:Datatype ;
2016         owl:onDatatype xsd:integer ;
2017         owl:withRestrictions ( [ xsd:minInclusive 1 ] )
2018     ] .
2019 ##### http://hl7.org/fhir/Element
2020 fhir:Element rdf:type owl:Class ;
2021     rdfs:label "Element" ;
2022     rdfs:subClassOf [ rdf:type owl:Restriction ;
2023         owl:onProperty fhir:Element.extension ;
2024         owl:someValuesFrom fhir:Extension
2025     ] ,
2026     [ rdf:type owl:Restriction ;
2027         owl:onProperty fhir:Element.id ;
2028         owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
2029         owl:onDataRange fhir:id-primitive
2030     ] ,
2031     [ rdf:type owl:Restriction ;
2032         owl:onProperty fhir:index ;
2033         owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
2034         owl:onDataRange fhir:index-primitive
2035     ] ;
2036     rdfs:comment "The base element used for all FHIR elements and resources - allows for them to be
2037     extended with extensions" .
2038 .
```

2039 In general fhir:value and fhir:Element.id are converted to an attribute in XML. fhir:index dictates the sequence
2040 only.

2041 **7.3 RDF Object Property Ordering example**

2042 Where object properties need to be ordered to construct the sequence of properties in XML, the fhir:index is
2043 defined as an annotation property on the Object Property. The example of ordered properties inside CodingBase
2044 is shown:

```
2045 ##### http://hl7.org/fhir/index
2046
2047 fhir:index rdf:type owl:AnnotationProperty .
```

2048

```
2049
2050    ### http://hl7.org/fhir/CodingBase.system
2051    fhir:CodingBase.system rdf:type owl:ObjectProperty ;
2052        fhir:index 1 ;
2053
2054    ### http://hl7.org/fhir/CodingBase.version
2055    fhir:CodingBase.version rdf:type owl:ObjectProperty ;
2056        fhir:index 2 .
2057
2058    ### http://hl7.org/fhir/CodingBase.code
2059    fhir:CodingBase.code rdf:type owl:ObjectProperty ;
2060        fhir:index 3 .
2061
2062    ### http://hl7.org/fhir/CodingBase.display
2063    fhir:CodingBase.display rdf:type owl:ObjectProperty ;
2064        fhir:index 4 ;
2065
2066    ### http://hl7.org/fhir/CodingBase.primary
2067    fhir:CodingBase.primary rdf:type owl:ObjectProperty ;
        fhir:index 5 ;
```

2068  
2069

2070

## 2071    8 Profiles

2072    The example shows “profile” ontology restricting the Valueset of Substance:

2073    The AllergyIntolerance Resource is declared again inside the Profile ontology.

```
2074 <http://record/AllergyIntolerance/1> rdf:type profile:AllergyIntolerance , owl:NamedIndividual ;
```

2075  
2076    This prefix on the rdf:type profile:AllergyIntolerance binds to the Profile and causes typing to the  
2077    profile:AllergyIntolerance where further restrictions (and extensions) are added.

2078    AllergyIntolerance.substance.coding is defines as a property chain and allows constraints to be applied to the  
2079    codings for substance

```
2080 allergy:AllergyIntolerance.substance.coding rdf:type owl:ObjectProperty ;  
2081       owl:inverseOf fhir:Coding.Resource ;  
2082       owl:propertyChainAxiom ( allergy:AllergyIntolerance.substance fhir:ConceptBase.coding ).
```

2083

2084    Here is a sample of the Profile Turtle.

```
2085   ### http://PatientSafetyProfile/AllergyIntolerance  
2086  
2087 profile:AllergyIntolerance rdf:type owl:Class ;  
2088       owl:equivalentClass [ rdf:type owl:Class ;  
2089           owl:intersectionOf ( profile:DomainResource  
2090              [ rdf:type owl:Restriction ;  
2091               owl:onProperty fhir:tag ;  
2092               owl:hasValue "AllergyIntolerance"  
2093              ]  
2094           )  
2095       ] ;  
2096       rdfs:subClassOf fhir:AllergyIntolerance ,  
2097           [ rdf:type owl:Restriction ;  
2098               owl:onProperty <http://hl7.org/fhir/AllergyIntolerance/AllergyIntolerance.substance> ;  
2099               owl:allValuesFrom <http://PatientSafetyProfile/substance-type>  
2100       ] .  
2101  
2102   ### http://PatientSafetyProfile/DomainResource  
2103  
2104 profile:DomainResource rdf:type owl:Class ;  
2105       rdfs:subClassOf fhir:DomainResource .  
2106  
2107   ### http://PatientSafetyProfile/substance-type  
2108 <http://PatientSafetyProfile/substance-type> rdf:type owl:Class ;  
2109       rdfs:subClassOf fhir:ValueSet ,  
2110           [ rdf:type owl:Class ;  
2111               owl:unionOf (  
2112               <http://snomed.info/id/105590001>  
2113               <http://snomed.info/id/373873005>  
2114              )  
2115       ] .  
2116
```

2117

2118