

FHIR RDF Sample side by side comparisons

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Legend

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

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

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

22 1 Datatypes (section 1.18.0.1)

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

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

26 1.1 Id

27 1.1.1 Id instance

28 1.1.2 Id schema

```
29 fhir:id rdf:type owl:Class ;  
30     rdfs:subClassOf fhir:Element ,  
31         [ rdf:type owl:Restriction ;  
32           owl:onProperty fhir:value ;  
33           owl:allValuesFrom [ rdf:type rdfs:Datatype ;  
34                                 owl:onDatatype xsd:string ;  
35                                 owl:withRestrictions ( [ xsd:pattern "[A-Za-z0-9\\-\\.]{1,64}" ] )  
36                                 ]  
37         ] ,  
38         [ rdf:type owl:Restriction ;  
39           owl:onProperty fhir:value ;  
40           owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;  
41           owl:onDataRange xsd:string  
42         ] ;  
43     rdfs:comment "A whole number in the range 0 to 2^64-1, optionally represented in hex, a uuid, an oid or  
44 any other combination of lower-case letters a-z, numerals, "-" and ".", with a length limit of 36 characters" .
```

45 1.2 Decimal

46 Decimal has an additional DataProperty fhir:fractionaDigits which allows the explicit declaration of scale.

47 1.2.1 Decimal OWL instance

```
48 [ a fhir:decimal ; fhir:value 123.4 ; fhir:fractionalDigits 3 ]
```

49 1.2.2 Decimal OWL Schema

```
50 fhir:decimal rdf:type owl:Class ;  
51     rdfs:subClassOf fhir:Element ,  
52         [ rdf:type owl:Restriction ;  
53           owl:onProperty fhir:fractionDigits ;  
54           owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;  
55           owl:onDataRange xsd:nonNegativeInteger  
56         ] ,  
57         [ rdf:type owl:Restriction ;  
58           owl:onProperty fhir:fractionDigits ;  
59           owl:allValuesFrom xsd:nonNegativeInteger  
60         ] ,  
61         [ rdf:type owl:Restriction ;  
62           owl:onProperty fhir:value ;  
63           owl:allValuesFrom xsd:decimal  
64         ] ,  
65         [ rdf:type owl:Restriction ;  
66           owl:onProperty fhir:value ;  
67           owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;  
68           owl:onDataRange xsd:decimal  
69         ] ;  
70     rdfs:comment "A rational number with implicit precision" .
```

71

72 1.3 FHIR CodeableConcept and Coding Structure Definition

73 1.3.1 FHIR XML

```
74 <code>  
75 <coding>  
76 <system value="http://example.org/local"/>  
77 <code value="admin"/>  
78 <display value="Admin"/>  
79 </coding>  
80 </code>
```

81 CodeableConcept Structural Definition

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

87

88 Coding Structural Definition

```
89 <[name] xmlns="http://hl7.org/fhir">  
90 <!-- from Element: extension -->  
91 <system value="[uri]"/><!-- 0..1 Identity of the terminology system -->  
92 <version value="[string]"/><!-- 0..1 Version of the system - if relevant -->  
93 <code value="[code]"/><!-- 0..1 Symbol in syntax defined by the system -->  
94 <display value="[string]"/><!-- 0..1 Representation defined by the system -->  
95 <primary value="[boolean]"/><!-- 0..1 If this code was chosen directly by the user -->  
96 </[name]>
```

97

98 1.3.2 RDF Data for Coding Instance

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

```
101 xxx.code [ a fhir:CodeableConcept ;  
102   ConceptBase.coding [ rdf:type fhir:CodingBase ;  
103     fhir:CodingBase.system [ a fhir:uri; "fhir:value http://example.org/local" ] ;  
104     fhir:CodingBase.code [ a fhir:codeBase ; fhir:value "admin" ] ;  
105     fhir:CodingBase.display [ a fhir:string; fhir:value "Admin" ] ;  
106   ] ;  
107 ] ;
```

108

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

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

113

1.3.3 FHIR OWL Schema

114

ConceptBase is abstract and has subclasses fhir:CodeableConcept, fhir:Coding and fhir:code.

115

```
#####
```

116

```
# Classes
```

117

```
#####
```

118

119

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

120

121

```
fhir:ConceptBase rdf:type owl:Class ;
```

122

```
  rdfs:subClassOf fhir:Element ,
```

123

```
    [ rdf:type owl:Restriction ;
```

124

```
      owl:onProperty fhir:ConceptBase.coding ;
```

125

```
      owl:allValuesFrom fhir:CodingBase
```

126

```
    ] ,
```

127

```
    [ rdf:type owl:Restriction ;
```

128

```
      owl:onProperty fhir:ConceptBase.text ;
```

129

```
      owl:allValuesFrom fhir:string
```

130

```
    ] ,
```

131

```
    [ rdf:type owl:Restriction ;
```

132

```
      owl:onProperty fhir:ConceptBase.text ;
```

133

```
      owl:maxCardinality "1"^^xsd:nonNegativeInteger
```

134

```
    ] .
```

135

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

136

```
fhir:CodingBase rdf:type owl:Class ;
```

137

```
  rdfs:subClassOf fhir:Element ,
```

138

```
    [ rdf:type owl:Restriction ;
```

139

```
      owl:onProperty fhir:CodingBase.system ;
```

140

```
      owl:allValuesFrom fhir:uri
```

141

```
    ] ,
```

142

```
    [ rdf:type owl:Restriction ;
```

143

```
      owl:onProperty fhir:CodingBase.system ;
```

144

```
      owl:maxCardinality "1"^^xsd:nonNegativeInteger
```

145

```
    ] ,
```

146

```
    [ rdf:type owl:Restriction ;
```

147

```
      owl:onProperty fhir:CodingBase.version ;
```

148

```
      owl:allValuesFrom fhir:string
```

149

```
    ] ,
```

150

```
    [ rdf:type owl:Restriction ;
```

151

```
      owl:onProperty fhir:CodingBase.version ;
```

152

```
      owl:maxCardinality "1"^^xsd:nonNegativeInteger
```

153

```
    ] ,
```

154

```
    [ rdf:type owl:Restriction ;
```

155

```
      owl:onProperty fhir:CodingBase.code ;
```

156

```
      owl:allValuesFrom fhir:codeBase
```

157

```
    ]
```

158

```
    [ rdf:type owl:Restriction ;
```

159

```
      owl:onProperty fhir:CodingBase.code ;
```

160

```
      owl:maxCardinality "1"^^xsd:nonNegativeInteger
```

161

```
    ] ,
```

162

```
    [ rdf:type owl:Restriction ;
```

163

```
      owl:onProperty fhir:CodingBase.display ;
```

164

```
      owl:allValuesFrom fhir:string
```

165

```
    ] ,
```

166

```
    [ rdf:type owl:Restriction ;
```

167

```
      owl:onProperty fhir:CodingBase.display ;
```

168

```
      owl:maxCardinality "1"^^xsd:nonNegativeInteger
```

169

```
    ] ,
```

170

```
    [ rdf:type owl:Restriction ;
```

171

```
      owl:onProperty fhir:CodingBase.primary ;
```

172

```
      owl:maxCardinality "1"^^xsd:nonNegativeInteger
```

173

```
    ] ,
```

174

```
    [ rdf:type owl:Restriction ;
```

175

```
      owl:onProperty fhir:CodingBase.primary ;
```

176

```
      owl:allValuesFrom fhir:boolean
```

177

```
    ] .
```

178

```
179 fhir:codeBase rdf:type owl:Class ;
180
181     rdfs:subClassOf fhir:Element ,
182         [ rdf:type owl:Restriction ;
183           owl:onProperty fhir:value ;
184           owl:allValuesFrom xsd:token
185         ] ,
186         [ rdf:type owl:Restriction ;
187           owl:onProperty fhir:value ;
188           owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
189           owl:onDataRange xsd:token
190         ] .
```

191 The concrete subclasses of ConceptBase apply the additional restrictions:

```
192 ### http://hl7.org/fhir/CodeableConcept
193 fhir:CodeableConcept rdf:type owl:Class ;
194     rdfs:subClassOf fhir:ConceptBase ;
195     rdfs:comment "The set of possible coded values this coding was chosen from or constrained
196 by." .
```

197

```
198 ### http://hl7.org/fhir/Coding
199 fhir:Coding rdf:type owl:Class ;
200     rdfs:subClassOf fhir:ConceptBase ,
201         [ rdf:type owl:Restriction ;
202           owl:onProperty fhir:ConceptBase.text ;
203           owl:maxCardinality "0"^^xsd:nonNegativeInteger
204         ] ,
205         [ rdf:type owl:Restriction ;
206           owl:onProperty fhir:ConceptBase.coding ;
207           owl:cardinality "1"^^xsd:nonNegativeInteger
208         ] .
```

209

```

210 fhir:code rdf:type owl:Class ;
211     rdfs:subClassOf fhir:ConceptBase ,
212         [ rdf:type owl:Restriction ;
213           owl:onProperty fhir:ConceptBase.coding ;
214           owl:cardinality "1"^^xsd:nonNegativeInteger
215         ] ,
216         [ rdf:type owl:Restriction ;
217           owl:onProperty fhir:ConceptBase.coding ;
218           owl:allValuesFrom [ rdf:type owl:Class ;
219                                 owl:intersectionOf ( fhir:CodingBase
220                                                         [ rdf:type owl:Restriction ;
221                                                           owl:onProperty fhir:CodingBase.code ;
222                                                           owl:cardinality "1"^^xsd:nonNegativeInteger
223                                                         ]
224                                                         [ rdf:type owl:Restriction ;
225                                                           owl:onProperty fhir:CodingBase.system ;
226                                                           owl:cardinality "1"^^xsd:nonNegativeInteger
227                                                         ]
228                                                         [ rdf:type owl:Restriction ;
229                                                           owl:onProperty fhir:CodingBase.version ;
230                                                           owl:cardinality "1"^^xsd:nonNegativeInteger
231                                                         ]
232                                                         [ rdf:type owl:Restriction ;
233                                                           owl:onProperty fhir:CodingBase.display ;
234                                                           owl:maxCardinality "0"^^xsd:nonNegativeInteger
235                                                         ]
236                                                         [ rdf:type owl:Restriction ;
237                                                           owl:onProperty fhir:CodingBase.primary ;
238                                                           owl:maxCardinality "0"^^xsd:nonNegativeInteger
239                                                         ]
240                                                         )
241                                 ]
242         ] .

```

243

244 2 Concept Binding external (section 1.17.3.3.5)

245 2.1 Github example

```
246 @prefix loinc: <http://loinc.org/owl#> .  
247 :resource a fhir:Observation;  
248   fhir:Observation.code [  
249     fhir:CodeableConcept.coding [  
250       fhir:Coding.system <http://loinc.org>;  
251       fhir:Coding.code "54411-4";  
252       fhir:Coding.display "Rh immune globulin given Qualitative";  
253       ex:concept loinc:54411-4;  
254     ];  
255     fhir:CodeableConcept.text "Rh immune globulin";  
256   ].
```

257 Extension adds a new object property “concept” which points to an instance “http://loinc.org/owl#54411-4”
258 which has a type - probably http://loinc.org/54411-4 which returns Turtle for the type not the HTML
259 description. Notice that Coding instance is not typed but could be inferred from the range of
260 CodeableConcept.coding.

261 2.2 Subgroup example

262 2.2.1 FHIR XML

263 The following is a Resource instance fragment in FHIR XML showing the equivalent example:

```
264 <Observation xmlns="http://hl7.org/fhir">  
265   <code>  
266     <coding>  
267       <system value="http://Loinc.org"/>  
268       <code value="54411-4"/>  
269       <display value=" Rh immune globulin given Qualitative "/>  
270     </coding>  
271     <text value="Rh immune globulin"/>  
272   </code>  
273   .....
```

274 2.2.2 RDF Data with Terminology blank nodes in RDF

```
275 @prefix loinc: <http://loinc.org/> .  
276 @prefix fhir: <http://hl7.org/fhir/> .  
277 <sourceNamespace/Observation/resource.id> a fhir:Observation, http://loinc.org/54411-4 ;  
278   fhir:Observation.code [ a fhir:CodeableConcept , <http://loinc.org/54411-4> ;  
279     fhir:ConceptBase.coding [ a fhir:CodingBase , <http://loinc.org/54411-4> ;  
280       fhir:CodingBase.system [ a fhir:uri fhir:value "http://loinc.org" ] ;  
281       fhir:CodingBase.code [ a fhir:codeBase fhir:value "54411-4" ] ;  
282       fhir:CodingBase.display [ a fhir:string fhir:value "Rh immune globulin given Qualitative" ] ;  
283     ] ;  
284     fhir:ConceptBase.text [ a fhir:string fhir:value "Rh immune globulin" ]  
285   ] .
```

286 sourceNamespace is the namespace from which the resource instance came. Resource.id is the unique name of
287 the Observation instance within the source namespace and type (Observation).

288 The type on the CodingBase instance is calculated based on the formation of the URL for that terminology. The
289 type in the CodingBase instance is carried up to the CodeableConcept blank node.

290 There is an argument for Object Properties - .code, .type and .category to carry the type all the way to the
291 resource itself since there is no sub state or component identified such as status, confidence etc.

292 2.3 Allergy Intolerance Subgroup Example

293 2.3.1 FHIR XML

```
294 <AllergyIntolerance xmlns=http://hl7.org/fhir >  
295   <id value="1"/>  
296   <text>  
297  
298   </text>  
299   <!-- the date that this entry was recorded -->  
300   <recordedDate value="2010-03-01"/>  
301   <!-- the patient that actually has the risk of adverse reaction -->  
302   <patient>  
303     <reference value="http://record/Patient/PeterPatient"/>  
304     <display value="Peter Patient"/>  
305   </patient>  
306   <!-- substance, coded from SNOMED CT-->  
307   <substance>  
308     <coding>  
309       <system value="http://snomed.info/id"/>  
310       <code value="90614001"/>  
311       <display value="beta-Lactam antibiotic"/>  
312     </coding>  
313   </substance>  
314   <status value="confirmed"/>  
315   <criticality value="high"/>  
316   <category value="medication"/>  
317 </AllergyIntolerance>
```

318

319

320 2.3.2 RDF Instance Example

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

```
322 @prefix : <http://record/AllergyIntolerance/> .
323 @prefix owl: <http://www.w3.org/2002/07/owl#> .
324 @prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
325 @prefix sct: <http://snomed.info/id/> .
326 @prefix xml: <http://www.w3.org/XML/1998/namespace> .
327 @prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
328 @prefix fhir: <http://hl7.org/fhir/> .
329 @prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
330 @prefix profile: <http://PatientSafetyProfile/> .
331 @base <http://record/AllergyIntolerance/1> .
332
333
334 <http://record/AllergyIntolerance/> rdf:type owl:Ontology ;
335 owl:imports <http://PatientSafetyProfile> .
336
337 ### http://record/AllergyIntolerance/1
338
339 <http://record/AllergyIntolerance/1> rdf:type profile:DomainResource , owl:NamedIndividual ,
340 profile:AllergyIntolerance ;
341 fhir:tag "AllergyIntolerance" ;
342 fhir:AllergyIntolerance.status [ rdf:type fhir:code,
343 <http://hl7.org/fhir/allergyIntoleranceStatus#confirmed> ;
344 fhir:ConceptBase.coding [ rdf:type fhir:CodingBase ;
345 fhir:CodingBase.code [ rdf:type fhir:codeBase; fhir:value "confirmed"
346 ]
347 ]
348 ] ;
349 fhir:AllergyIntolerance.patient [ rdf:type fhir:Reference ;
350 fhir:Reference.reference [ fhir:value "http://record/Patient/PeterPatient" ] ;
351 fhir:Reference.display [ fhir:value "Peter Patient" ] ;
352 fhir:Reference.link <http://record/Patient/PeterPatient> ;
353 ] ;
354 fhir:AllergyIntolerance.substance [ rdf:type fhir:CodeableConcept , http://snomed.info/id/90614001 ;
355 rdfs:label "beta-lactam (antibiotic)" ;
356 fhir:ConceptBase.coding [ rdf:type fhir:CodingBase , http://snomed.info/id/90614001 ;
357 fhir:CodingBase.code [ rdf:type fhir:codeBase ; fhir:value "90614001" ] ;
358 fhir:CodingBase.system [ rdf:type fhir:uri ; fhir:value "http://snomed.info/id/90614001" ] ;
359 fhir:CodingBase.display [ rdf:type fhir:string ; fhir:value "beta-lactam (antibiotic)" ]
360 ] ;
361 fhir:ConceptBase.text [ rdf:type fhir:string ; fhir:value "beta-lactam (antibiotic)"
362 ]
363 ] .### Generated by the OWL API (version 3.5.1) http://owlapi.sourceforge.net
364
```

365

366 Note the use of a profile binding through the type “profile:DomainResource”. The fhir:tag causes the inference
367 of the type to be “profile:AllergyIntolerance” which then restricts the types of CodingBasey instances.

368 Creation of import statements is TBD.

369 2.3.3 FHIR OWL Schema

370 The example applies the rdf:type at the Coding instances.

371 This works directly with RDF terminologies such as SNOMED CT and ICD-11.

372 2.3.4 FHIR Allergy Intolerance OWL Schema

373 The schema is abridged to show the concepts of interest:

```
374 ### http://hl7.org/fhir/AllergyIntolerance
375
376 fhir:AllergyIntolerance rdf:type owl:Class ;
377
378     rdfs:subClassOf fhir:DomainResource ,
379                   [ rdf:type owl:Restriction ;
380                     owl:onProperty fhir:AllergyIntolerance.substance ;
381                     owl:maxCardinality "1"^^xsd:nonNegativeInteger
382                   ] ,
383                   [ rdf:type owl:Restriction ;
384                     owl:onProperty fhir:AllergyIntolerance.substance ;
385                     owl:allValuesFrom fhir:CodeableConcept
386                   ] ,
387 Etc..
388 .
```

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

390 The valueset gets applied through the profile binding.

391

392 3 FHIR internal System and Coding Definitions RDF

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

```
394 @prefix allergy-intolerance-status: <http://hl7.org/fhir/allergy-intolerance-status#> .
395
396 ### http://hl7.org/fhir/allergy-intolerance-status
397
398 fhir:allergy-intolerance-status rdf:type owl:Class ;
399   rdfs:subClassOf fhir:valueset-system ,
400   [ rdf:type owl:Class ;
401     owl:unionOf (
402       allergy-intolerance-status:confirmed
403       allergy-intolerance-status:entered-in-error
404       allergy-intolerance-status:refuted
405       allergy-intolerance-status:resolved
406       allergy-intolerance-status:unconfirmed
407     )
408   ] ,
409   [ rdf:type owl:Restriction ;
410     owl:onProperty fhir:CodingBase.system ;
411     owl:allValuesFrom [ rdf:type owl:Restriction ;
412       owl:onProperty fhir:value ; owl:hasValue "http://hl7.org/fhir/allergy-intolerance-status"
413     ]
414   ] ;
415 fhir:prefix "http://hl7.org/fhir/allergy-intolerance-status#" .
416
417 ### http://hl7.org/fhir/allergy-intolerance-status#confirmed
418
419 allergy-intolerance-status:confirmed rdf:type owl:Class ;
420   rdfs:subClassOf fhir:allergy-intolerance-status ,
421   [ rdf:type owl:Restriction ;
422     owl:onProperty fhir:CodingBase.code ;
423     owl:allValuesFrom [ rdf:type owl:Restriction ;
424       owl:onProperty fhir:value ; owl:hasValue "confirmed"
425     ]
426   ] .
427
428 ### http://hl7.org/fhir/allergy-intolerance-status#entered-in-error
429
430 allergy-intolerance-status:entered-in-error rdf:type owl:Class ;
431   rdfs:subClassOf fhir:allergy-intolerance-status ,
432   [ rdf:type owl:Restriction ;
433     owl:onProperty fhir:CodingBase.code ;
434     owl:allValuesFrom [ rdf:type owl:Restriction ;
435       owl:onProperty fhir:value ; owl:hasValue "entered-in-error"
436     ]
437   ] .
```

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

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

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

444 4 System and codings external RDF representation

445 From the SNOMED RDF:

```
446 <http://snomed.info/id/138875005> rdf:type owl:Class ;  
447     rdfs:label "SNOMED CT Concept" .  
448  
449 <http://snomed.info/id/105590001> rdf:type owl:Class ;  
450     rdfs:label "Substance (substance)" ;  
451     rdfs:subClassOf <http://snomed.info/id/138875005> .  
452  
453 <http://snomed.info/id/373873005> rdf:type owl:Class ;  
454     rdfs:label "Pharmaceutical / biologic product (product)" ;  
455     rdfs:subClassOf <http://snomed.info/id/138875005> .  
456  
457 <http://snomed.info/id/346325008> rdf:type owl:Class ;  
458     rdfs:label "Antibacterial drugs (product)" ;  
459     rdfs:subClassOf <http://snomed.info/id/373873005> .  
460  
461 <http://snomed.info/id/105590001> rdf:type owl:Class ;  
462     rdfs:label "beta-Lactam antibiotic" ;  
463     rdfs:subClassOf <http://snomed.info/id/346325008> .
```

464 The system is defined further in the FHIR ontology

```
465 ### http://snomed.info/sct  
466  
467 <http://snomed.info/sct> rdf:type owl:Class ;  
468     rdfs:subClassOf fhir:valueSet-system ;  
469     fhir:prefix "http://snomed.info/id/" .
```

470

471

472 5 Valueset Definition

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

475 The specific ValueSet is a Class which is a union of CodingBase classes from one or more valueset-systems. It is
476 expected that this representation can be computed from the FHIR representation.

477 5.1.1 Anonymous codings

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

```
479 <http://hl7.org/fhir/vs/allergy-intolerance-status> rdf:type owl:Class ;  
480   rdfs:label "Allergy Intolerance Status Value Set" ;  
481   rdfs:subClassOf fhir:valueset ,  
482   [ rdf:type owl:Class ;  
483     owl:intersectionOf (  
484       [ rdf:type owl:Restriction ;  
485         owl:onProperty fhir:CodingBase.code ;  
486         owl:someValuesFrom [ rdf:type owl:Class ;  
487           owl:unionOf (  
488             [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "confirmed" ]  
489             [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "entered-in-error" ]  
490             [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "refuted" ]  
491             [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "resolved" ]  
492             [ rdf:type owl:Restriction ; owl:onProperty fhir:value ; owl:hasValue "unconfirmed" ]  
493           )  
494         ]  
495       ]  
496     [ rdf:type owl:Restriction ;  
497       owl:onProperty fhir:CodingBase.system ;  
498       owl:allValuesFrom [ rdf:type owl:Restriction ; owl:onProperty fhir:value ;  
499         owl:hasValue "http://fhir/allergy-intolerance-status"  
500       ]  
501     ]  
502   )  
503 ] .
```

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

506 5.2 Named codings

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

```
509 <http://hl7.org/fhir/vs/allergy-intolerance-status> rdf:type owl:Class ;  
510   rdfs:label "Allergy Intolerance Status Value Set" ;  
511   rdfs:subClassOf fhir:valueset ,  
512   [ rdf:type owl:Class ;  
513     owl:unionOf ( allergy-intolerance-status:confirmed  
514                   allergy-intolerance-status:entered-in-error  
515                   allergy-intolerance-status:refuted  
516                   allergy-intolerance-status:resolved  
517                   allergy-intolerance-status:unconfirmed  
518     )  
519   ] .
```

520

521

522 **6 ValueSet schema in the metamodel**

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

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

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

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

532 However, these object property semantics are not understood by RDF or OWL. They are translated in the Model
533 to subclass and union relationships between classes.

534

536 7 Resource References

537 7.1 Github example

```
538 :resource a fhir:Observation;  
539   fhir:contained fhir:Observation\#23;  
540   fhir:Observation.subject [  
541     fhir:Reference.reference fhir:Observation\#23  
542   ] .  
543  
544 fhir:Observation\#23 a fhir:Patient;  
545   fhir:Patient.name [ fhir:text "John Smith" ] .
```

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

548 7.2 Subgroup example

549 7.2.1 FHIR XML

```
550 <AllergyIntolerance xmlns="http://hl7.org/fhir">  
551   <id value="1"/>  
552   <text>  
553  
554   </text>  
555   <!-- the date that this entry was recorded -->  
556   <recordedDate value="2010-03-01"/>  
557   <!-- the patient that actually has the risk of adverse reaction -->  
558   <patient>  
559     <reference value="http://record/Patient/PeterPatient"/>  
560     <display value="Peter Patient"/>  
561   </patient>  
562 </AllergyIntolerance>
```

563 7.2.2 RDF Data After processing (acquiring the resource and importing)

```
564 fhir:AllergyIntolerance.patient [ fhir:Reference.display [ fhir:value "Peter Patient" ] ;  
565   fhir:Reference.reference [ fhir:value "http://record/Patient/PeterPatient" ] ;  
566   fhir:Reference.link <http://record/Patient/PeterPatient>  
567 ] ;
```

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

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

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

```
571 ### http://hl7.org/fhir/AllergyForPatient  
572 fhir:AllergyForPatient rdf:type owl:ObjectProperty ;  
573   owl:inverseOf fhir:AllergyIntolerance.patient.link .  
574  
575 ### http://hl7.org/fhir/AllergyIntolerance.patient.link  
576  
577 fhir:AllergyIntolerance.patient.link rdf:type owl:ObjectProperty ;  
578   owl:propertyChainAxiom ( fhir:AllergyIntolerance.patient fhir:Reference.link ) .
```

579

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

584

7.2.3 FHIR OWL Schema

585

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

586

```
fhir:Reference rdf:type owl:Class ;
```

587

588

```
    rdfs:subClassOf fhir:Element ,
```

589

```
    [ rdf:type owl:Restriction ;
```

590

```
      owl:onProperty fhir:Reference.reference ;
```

591

```
      owl:allValuesFrom fhir:string
```

592

```
    ] ,
```

593

```
    [ rdf:type owl:Restriction ;
```

594

```
      owl:onProperty fhir:Reference.reference ;
```

595

```
      owl:maxCardinality "1"^^xsd:nonNegativeInteger
```

596

```
    ] ,
```

597

```
    [ rdf:type owl:Restriction ;
```

598

```
      owl:onProperty fhir:Reference.display ;
```

599

```
      owl:allValuesFrom fhir:string
```

600

```
    ] ,
```

601

```
    [ rdf:type owl:Restriction ;
```

602

```
      owl:onProperty fhir:Reference.display ;
```

603

```
      owl:maxCardinality "1"^^xsd:nonNegativeInteger
```

604

```
    ] ,
```

605

```
    [ rdf:type owl:Restriction ;
```

606

```
      owl:onProperty fhir:Reference.link ;
```

607

```
      owl:allValuesFrom fhir:DomainResource
```

608

```
    ] ,
```

609

```
    [ rdf:type owl:Restriction ;
```

610

```
      owl:onProperty fhir:Reference.link ;
```

611

```
      owl:maxCardinality "1"^^xsd:nonNegativeInteger
```

612

```
    ] .
```

613

614

615

616 **8 Bundle**

617 Some preliminary notes:

618 A Bundle instance has no special namespace semantics and therefore it can be referenced as an Ontology
619 record/Bundle/123.

620 The contents of the Bundle.Entry have URIs and would be imported into the Bundle Ontology.

621 The Bundle.Link will be treated as a Reference and Bundle.Link.link will be created when the referenced
622 resource has been resolved.

623 **9 URI Naming**

624 **9.1 Github example**

625 No example

626 **9.2 Subgroup example**

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

- 629 1. the Resource namespace precedes the assigned identifier for the contained instance
630 2. the root resource object has an URI identifier identical to the resource class instance URI

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

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

634 `<http://record/AllergyIntolerance/> rdf:type owl:Ontology ;`
635

636

637 10 Ordering

638 10.1 Github example

639 No example

640 10.2 RDF individual ordering example

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

642

```
643 ### http://hl7.org/fhir/index
644 fhir:index rdf:type owl:DatatypeProperty ;
645           rdfs:range fhir:index-primitive .
646
647 ### http://hl7.org/fhir/index-primitive
648 fhir:index-primitive rdf:type rdfs:Datatype ;
649                    owl:equivalentClass [ rdf:type rdfs:Datatype ;
650                                         owl:onDatatype xsd:integer ;
651                                         owl:withRestrictions ( [ xsd:minInclusive 1 ] )
652                                         ] .
653 ### http://hl7.org/fhir/Element
654 fhir:Element rdf:type owl:Class ;
655            rdfs:label "Element" ;
656            rdfs:subClassOf [ rdf:type owl:Restriction ;
657                             owl:onProperty fhir:Element.extension ;
658                             owl:someValuesFrom fhir:Extension
659                             ] ,
660                             [ rdf:type owl:Restriction ;
661                             owl:onProperty fhir:Element.id ;
662                             owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
663                             owl:onDataRange fhir:id-primitive
664                             ] ,
665                             [ rdf:type owl:Restriction ;
666                             owl:onProperty fhir:index ;
667                             owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
668                             owl:onDataRange fhir:index-primitive
669                             ] ;
670            rdfs:comment "The base element used for all FHIR elements and resources - allows for them to be
671 extended with extensions" .
672 .
```

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

675 10.3 RDF Object Property Ordering example

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

678 CodingBasey is shown:

```
679   ### http://hl7.org/fhir/CodingBasey.system
680   fhir:CodingBase.system rdf:type owl:ObjectProperty ;
681       fhir:index 1 ;
682
683   ### http://hl7.org/fhir/CodingBasey.version
684   fhir:CodingBase.version rdf:type owl:ObjectProperty ;
685       fhir:index 2 .
686
687   ### http://hl7.org/fhir/CodingBasey.code
688   fhir:CodingBase.code rdf:type owl:ObjectProperty ;
689       fhir:index 3 .
690
691   ### http://hl7.org/fhir/CodingBasey.display
692   fhir:CodingBase.display rdf:type owl:ObjectProperty ;
693       fhir:index 4 ;
694
695   ### http://hl7.org/fhir/CodingBasey.primary
696   fhir:CodingBase.primary rdf:type owl:ObjectProperty ;
697       fhir:index 5 ;
```

698
699

700

701 11 Profiles

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

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

```
705 allergy:AllergyIntolerance.substance.coding rdf:type owl:ObjectProperty ;  
706     owl:inverseOf fhir:Coding.Resource ;  
707     owl:propertyChainAxiom ( allergy:AllergyIntolerance.substance fhir:ConceptBase.coding ).
```

708

```
709 ### http://PatientSafetyProfile/AllergyIntolerance  
710  
711 profile:AllergyIntolerance rdf:type owl:Class ;  
712     owl:equivalentClass [ rdf:type owl:Class ;  
713         owl:intersectionOf ( profile:DomainResource  
714             [ rdf:type owl:Restriction ;  
715                 owl:onProperty fhir:tag ;  
716                 owl:hasValue "AllergyIntolerance"  
717             ]  
718         )  
719     ] ;  
720     rdfs:subClassOf fhir:AllergyIntolerance ,  
721     [ rdf:type owl:Restriction ;  
722         owl:onProperty <http://hl7.org/fhir/AllergyIntolerance/AllergyIntolerance.substance> ;  
723         owl:allValuesFrom <http://PatientSafetyProfile/substance-type>  
724     ] .  
725  
726 ### http://PatientSafetyProfile/DomainResource  
727  
728 profile:DomainResource rdf:type owl:Class ;  
729     rdfs:subClassOf fhir:DomainResource .  
730  
731 ### http://PatientSafetyProfile/substance-type  
732 <http://PatientSafetyProfile/substance-type> rdf:type owl:Class ;  
733     rdfs:subClassOf fhir:ValueSet ,  
734     [ rdf:type owl:Class ;  
735         owl:unionOf (  
736             <http://snomed.info/id/105590001>  
737             <http://snomed.info/id/373873005>  
738         )  
739     ] .  
740
```

741

742