FHIR RDF Extension Model

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FHIR RDF Specification Requirement

- “Round-trippability” — Data must be able to be converted to and from the RDF representation without loss (or gain)
  - ***This includes any potential extensions***

FHIR Extensions

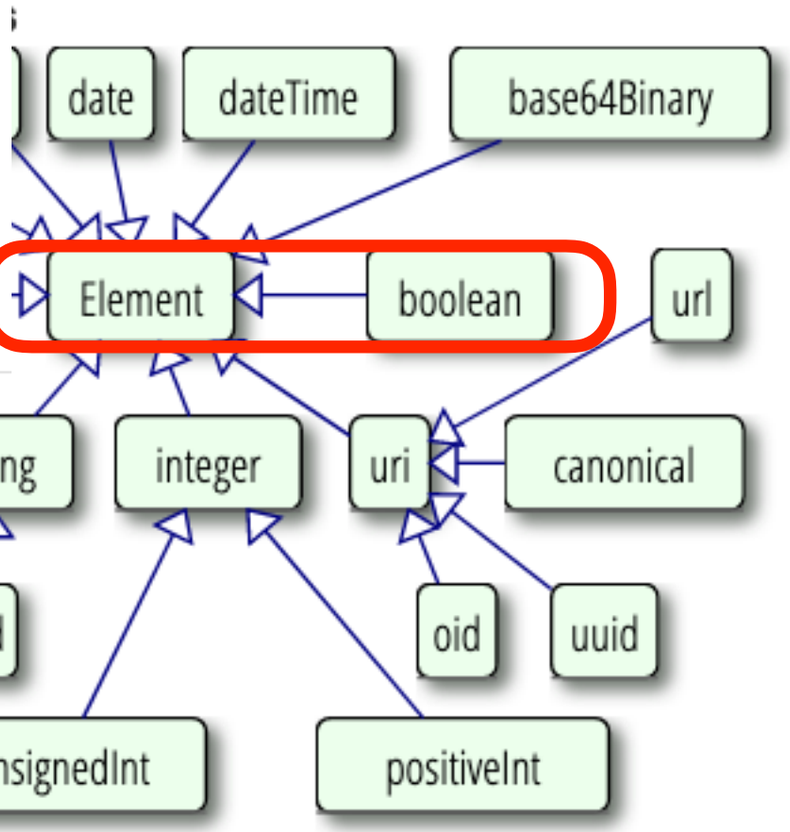
2.28.0.1 Content

Structure | UML | XML | JSON | All

Structure

Name	Flags	Card.	Type	Description & Constraints
Element	I		n/a	Base for all elements *All FHIR elements must have a @value or children*
id		0..1	string	Unique id for inter-element referencing
extension		0..*	Extension	Additional content defined by implementations

Documentation for this format



(Almost) everything in FHIR is extensible - even the boolean data type!

Structure | UML | XML | JSON | Turtle | R3 Diff | All

Structure

Name	Flags	Card.	Type	Description & Constraints
Extension	I N		Element	Optional Extensions Element *+ Rule: Must have either extensions or value[x], not both* Elements defined in Ancestors: id, extension
url		1..1	uri	identifies the meaning of the extension
value[x]		0..1	*	Value of extension

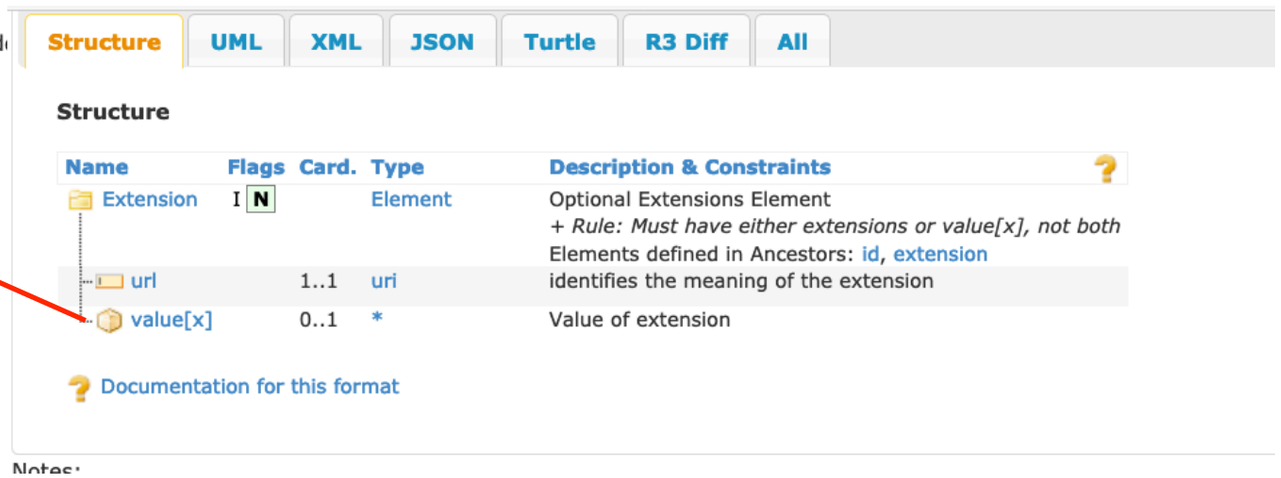
Documentation for this format

An extension is a tag (URI) / value tuple or another extension

Extensions are actually another FHIR modeling language…
… and it is currently not possible for something to be *both* an extension
… and a first-class FHIR StructureDefinition element

FHIR Extensions

- The *value[x]* element has an actual name of "value" and then the TitleCased name of one of these defined t
  - valueBase64Binary: base64Binary
  - valueBoolean: boolean
  - valueCanonical: canonical
  - valueCode: code (only if the extension definition provides a fixed binding to a suitable set of cod
  - valueDate: date
  - valueDateTime: dateTime
  - valueDecimal: decimal
  - valueId: id
  - valueInstant: instant
  - valueInteger: integer
  - valueMarkdown: markdown
  - valueOid: oid
  - valuePositiveInt: positiveInt
  - valueString: string
  - valueTime: time
  - valueUnsignedInt: unsignedInt
  - valueUri: uri
  - valueUrl: url
  - valueUuid: uuid
  - valueAddress: Address
  - valueAge: Age
  - valueAnnotation: Annotation
  - valueAttachment: Attachment
  - valueCodeableConcept: CodeableConcept
  - valueCoding: Coding
  - valueContactPoint: ContactPoint
  - valueCount: Count
  - valueDistance: Distance
  - valueDuration: Duration
  - valueHumanName: HumanName
  - valueIdentifier: Identifier
  - valueMoney: Money
  - valuePeriod: Period
  - valueQuantity: Quantity
  - valueRange: Range
  - valueRatio: Ratio
  - valueReference: Reference - a reference to another resource
  - valueSampledData: SampledData
  - valueSignature: Signature
  - valueTiming: Timing
  - valueContactDetail: ContactDetail
  - valueContributor: Contributor
  - valueDataRequirement: DataRequirement
  - valueExpression: Expression
  - valueParameterDefinition: ParameterDefinition
  - valueRelatedArtifact: RelatedArtifact
  - valueTriggerDefinition: TriggerDefinition
  - valueUsageContext: UsageContext
  - valueDosage: Dosage
  - valueMeta: Meta



- **Extension value can be *any* FHIR “DataType”**
- **Actual type is determined lexically (valueType)**

Extending FHIR Boolean Example

8.1.3 Resource Content

Structure | UML | XML | JSON | Turtle | R3 Diff | All

Structure

Name	Flags	Card.	Type	Description & Constraints
Patient	N		DomainResource	Information about an individual or animal receiving health care serv
				Elements defined in Ancestors: id, meta, implicitRules, language, te
identifier	Σ	0..*	Identifier	An identifier for this patient
active	?! Σ	0..1	boolean	Whether this patient's record is in active use
name	Σ	0..*	HumanName	A name associated with the patient
telecom	Σ	0..*	ContactPoint	A contact detail for the individual
gender	Σ	0..1	code	male | female | other | unknown AdministrativeGender (Required)
birthDate	Σ	0..1	date	The date of birth for the individual
deceased[x]	?! Σ	0..1		Indicates if the individual is deceased or not
deceasedBoolean			boolean	
deceasedDateTime			dateTime	
address	Σ	0..*	Address	An address for the individual

Extending FHIR Boolean XML

```xml
<?xml version="1.0" encoding="UTF-8"?>

<Patient xmlns="http://hl7.org/fhir">
  <id value="pat4"/>
  <text>
    <status value="generated"/>
    <div xmlns="http://www.w3.org/1999/xhtml">
      <p> Patient Sandy Notsowell @ Acme Healthcare, Inc. MR = 123458, DECEASED</p>
    </div>
  </text>
  <identifier>
    <use value="usual"/>
    <type>
      <coding>
        <system value="http://terminology.hl7.org/CodeSystem/v2-0203"/>
        <code value="MR"/>
      </coding>
    </type>
    <system value="urn:oid:0.1.2.3.4.5.6.7"/>
    <value value="123458"/>
  </identifier>
  <active value="true"/>
  <name>
    <use value="official"/>
    <family value="Notsowell"/>
    <given value="Sandy"/>
  </name>
  <gender value="female"/>
  <birthDate value="1982-08-02"/>
  <deceasedBoolean value="true"/>
  <managingOrganization>
    <reference value="Organization/1"/>
    <display value="ACME Healthcare, Inc"/>
  </managingOrganization>
</Patient>
```

```xml
</identifier>
<active value="true">
    <extension url="http://example.org/Profile/booleanUncertainty">
        <valueDecimal value="0.9"/>
    </extension>
</active>
<name>
```

Extending Boolean JSON


```
{
  "resourceType": "Patient",
  "id": "pat4",
  "text": {
    "status": "generated",
    "div": "<div xmlns=\"http://www.w3.org/1999/xhtml\">\n\t\t\t<p>Patient Sandy Notsowell @ Acm
e Healthcare, Inc. MR = 123458, DECEASED</p>\n\t\t</div>"
  },
  "identifier": [
    {
      "use": "usual",
      "type": {
        "coding": [
          {
            "system": "http://terminology.hl7.org/CodeSystem/v2-0203",
            "code": "MR"
          }
        ]
      },
      "system": "urn:oid:0.1.2.3.4.5.6.7",
      "value": "123458"
    }
  ],
  "active": true,
  "name": [
    {
      "use": "official",
      "family": "Notsowell",
      "given": [
        "Sandy"
      ]
    }
  ],
  "gender": "female",
  "birthDate": "1982-08-02",
  "deceasedBoolean": true,
  "managingOrganization": {
    "reference": "Organization/1",
    "display": "ACME Healthcare, Inc"
  }
}
```



```
"active": true,
"_active": {
    "extension": [
      {
        "url": "http://example.org/Profile/booleanUncertainty",
        "valueDecimal": 0.9
      }
    ]
},
```

Extending Boolean RDF (v1.0)

```
@prefix fhir: <http://hl7.org/fhir/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

# - resource -----------------------------------------------------------------

<http://hl7.org/fhir/Patient/pat4> a fhir:Patient;
  fhir:nodeRole fhir:treeRoot;
  fhir:Resource.id [ fhir:value "pat4"];
  fhir:DomainResource.text [
     fhir:Narrative.status [ fhir:value "generated" ];
     fhir:Narrative.div "<div xmlns=\"http://www.w3.org/1999/xhtml\">\n                <p>Patie
nt Sandy Notsowell @ Acme Healthcare, Inc. MR = 123458, DECEASED</p>\n         </div>"
  ];
  fhir:Patient.identifier [
     fhir:index 0;
     fhir:Identifier.use [ fhir:value "usual" ];
     fhir:Identifier.type [
       fhir:CodeableConcept.coding [
         fhir:index 0;
         fhir:Coding.system [ fhir:value "http://terminology.hl7.org
         fhir:Coding.code [ fhir:value "MR" ]
       ]
     ];
     fhir:Identifier.system [ fhir:value "urn:oid:0.1.2.3.4.5.6.7" ]
     fhir:Identifier.value [ fhir:value "123458" ]
  ];
  fhir:Patient.active [ fhir:value "true"^^xsd:boolean];
  fhir:Patient.name [
     fhir:index 0;
     fhir:HumanName.use [ fhir:value "official" ];
     fhir:HumanName.family [ fhir:value "Notsowell" ];
     fhir:HumanName.given [
       fhir:value "Sandy";
       fhir:index 0
     ]
  ];
  fhir:Patient.gender [ fhir:value "female"];
  fhir:Patient.birthDate [ fhir:value "1982-08-02"^^xsd:date];
  fhir:Patient.deceasedBoolean [ fhir:value "true"^^xsd:boolean];
  fhir:Patient.managingOrganization [
     fhir:link <http://hl7.org/fhir/Organization/1>;
     fhir:Reference.reference [ fhir:value "Organization/1" ];
     fhir:Reference.display [ fhir:value "ACME Healthcare, Inc" ]
  ] .

<http://hl7.org/fhir/Organization/1> a fhir:Organization .

# - ontology header ----------------------------------------------------------

<http://hl7.org/fhir/Patient/pat4.ttl> a owl:Ontology;
  owl:imports fhir:fhir.ttl;
  owl:versionIRI <http://build.fhir.org/Patient/pat4.ttl> .

# -------------------------------------------------------------------------------------
```

```
fhir:Patient.active [
  fhir:value "true"^^xsd:boolean;
  fhir:Element.extension [
      fhir:index 0;
      fhir:Extension.url [ fhir:value "http://example.org/Profile/booleanUncertainty" ];
      fhir:Extension.valueDecimal [ fhir:value "0.9"^^xsd:decimal]
  ]
];
```

XML code more or less makes sense

XML Code

```
record.active.value = true

if record.active.value then { … }

if record.active.extension and record.active.extension[0].url == “….” then {}
```

JSON Code

```
record.active = true

if record.active then { …}

if record._active.extension and record._active.extension[0].url == “…” then
```

RDF as Specified Today

```
fhir:Patient.active [
  fhir:value "true"^^xsd:boolean;
  fhir:Element.extension [
      fhir:index 0;
      fhir:Extension.url [ fhir:value "http://example.org/Profile/booleanUncertainty" ];
      fhir:Extension.valueDecimal [ fhir:value "0.9"^^xsd:decimal]
   ]
];
```

```
<http://hl7.org/fhir/Patient/pat4.ttl> <http://www.w3.org/2002/07/owl#versionIRI> <http://build.fhir.org/Patient/pat4.ttl> .
_:ub1bL9C20 <http://hl7.org/fhir/value> "pat4" .
<http://hl7.org/fhir/Patient/pat4> <http://hl7.org/fhir/Patient.name> _:ub2bL34C21 .
_:ub1bL10C28 <http://hl7.org/fhir/Narrative.status> _:ub1bL11C28 .
_:ub2bL11C28 <http://hl7.org/fhir/value> "generated" .
_:ub2bL48C31 <http://hl7.org/fhir/value> "Organization/1" .
_:ub2bL17C36 <http://hl7.org/fhir/Coding.code> _:ub2bL20C27 .
<http://hl7.org/fhir/Patient/pat4> <http://hl7.org/fhir/Patient.active> _:ub2bL26C23 .
_:ub2bL26C23 <http://hl7.org/fhir/value> "true"^^<http://www.w3.org/2001/XMLSchema#boolean> .
_:ub2bL26C23 <http://hl7.org/fhir/Element.extension> _:ub2bL28C28 .
_:ub2bL28C28 <http://hl7.org/fhir/Extension.url> _:ub2bL30C28 .
_:ub2bL30C28 <http://hl7.org/fhir/value> "http://example.org/Profile/booleanUncertainty" .
_:ub2bL28C28 <http://hl7.org/fhir/Extension.valueDecimal> _:ub2bL31C37 .
_:ub2bL31C37 <http://hl7.org/fhir/value> "0.9"^^<http://www.w3.org/2001/XMLSchema#decimal> .
_:ub2bL28C28 <http://hl7.org/fhir/index> "0"^^<http://www.w3.org/2001/XMLSchema#integer> .
```

Accessing RDF

RDF Code (SPARQL)

```
SELECT ?active

WHERE

{   <http://hl7.org/fhir/Patient/pat4> fhir:active ?n .

    ?n fhir:value ?active .

}
```

RDF Code (RDFLIB)

```python
from rdflib import Graph, URIRef, BNode, Namespace, Literal
FHIR = Namespace("http://hl7.org/fhir/")
g = Graph()

pat = URIRef("http://hl7.org/fhir/Patient/pat4")
# Read active
g.value(g.value(pat, FHIR.Patient.active), FHIR.value)
```

Setting RDF

```
# Set active
v = BNode()
g.add((pat, FHIR.Patient.active, v))
g.add((v, FHIR.value, Literal(True)))
```

Note: The intermediate BNode makes our fhir.schema.org use case virtually impossible — RDFa transformations from a simple “true” to this structure require a lot of plumbing

Searching RDF

```
<http://hl7.org/fhir/Patient/pat4> <http://hl7.org/fhir/Patient.identifier> _:ub2bL13C27 .
_:ub2bL13C27 <http://hl7.org/fhir/Identifier.use> _:ub2bL15C26 .
_:ub2bL13C27 <http://hl7.org/fhir/Identifier.system> _:ub2bL23C29 .
_:ub2bL13C27 <http://hl7.org/fhir/index> "0"^^<http://www.w3.org/2001/XMLSchema#integer> .
_:ub2bL13C27 <http://hl7.org/fhir/Identifier.type> _:ub2bL16C27 .
_:ub2bL13C27 <http://hl7.org/fhir/Identifier.value> _:ub2bL24C28 .
_:ub2bL24C28 <http://hl7.org/fhir/value> "123458" .
```

```python
# Look up a patient in a triple store
for pat, id_bnode in g.subject_objects(FHIR.identifier):
    idtype_bnode = g.value(id_bnode, FHIR.CodeableConcept.coding)
    idcode_bnode = g.value(idtype_bnode, FHIR.Coding.code)
    identifiertype = g.value(idcode_bnode, FHIR.value)
    if identifiertype == Literal("MR"):
        identifier_value_bnode = g.value(id_bnode, FHIR.Identifier.value)
        identifier = g.value(identifier_value_bnode, FHIR.value)
        if identifier == Literal("12345"):
            # Found the patient
```

What Happened?

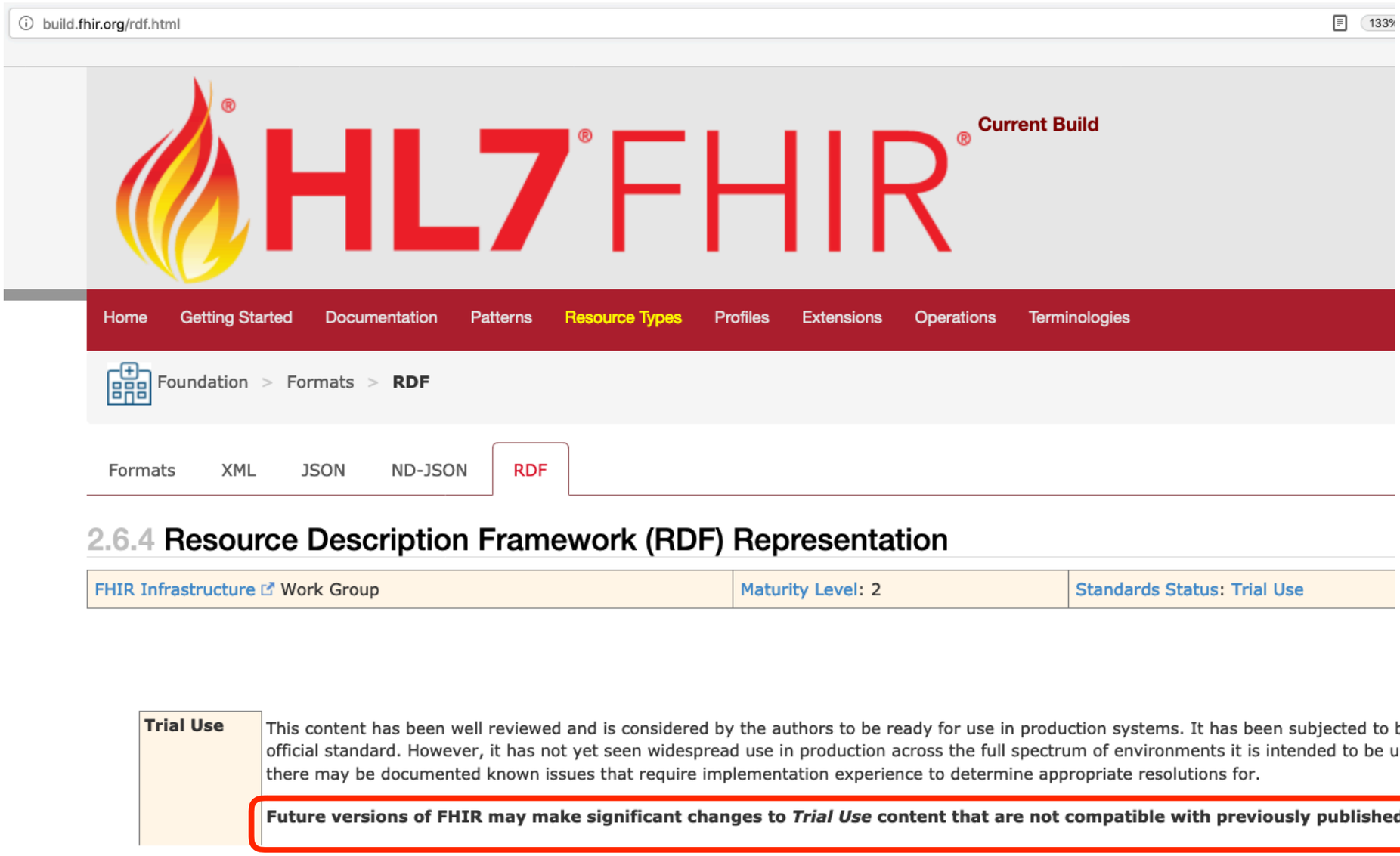
Target design philosophy:

- Make the routine easy
- Make the possible possible

What we've done in RDF 1.0:

- Made the possible easy
- Made the routine possible

Good news


build.fhir.org/rdf.html
133%
HL7 FHIR
Current Build
Home
Getting Started
Documentation
Patterns
Resource Types
Profiles
Extensions
Operations
Terminologies
Foundation > Formats > RDF
Formats
XML
JSON
ND-JSON
RDF
2.6.4 Resource Description Framework (RDF) Representation
FHIR Infrastructure Work Group
Maturity Level: 2
Standards Status: Trial Use
Trial Use
This content has been well reviewed and is considered by the authors to be ready for use in production systems. It has been subjected to ballot and approved as an official standard. However, it has not yet seen widespread use in production across the full spectrum of environments it is intended to be used in. In some cases, there may be documented known issues that require implementation experience to determine appropriate resolutions for.
Future versions of FHIR may make significant changes to Trial Use content that are not compatible with previously published content.

Proposal

1. Revisit the FHIR extension language with the goal of eliminating the tag/value speed bump in the RDF implementation

2. Make regular values as expected. Make extensions possible

```
..
fhir:Patient.active "true"^^xsd:boolean,
fhir:Patient.active.extension [
  <http://example.org/Profile/booleanUncertainty> "0.9"^^xsd:decimal
]
```