



# Introduction to FHIR

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*August 21, 2014*

*(Heavily based on presentation of same name by Grahame Grieve on July 10, 2014)*



# Grahame's presentation



- Can be downloaded here:

- [http://gforge.hl7.org/svn/fhir/trunk/presentations/2014-07 Regenstrief/Introduction to FHIR.pptx](http://gforge.hl7.org/svn/fhir/trunk/presentations/2014-07_Regenstrief/Introduction%20to%20FHIR.pptx)

- Use “anonymous” and email address to logon

- Is licensed for use under the Creative Commons, specifically:

- [Creative Commons Attribution 3.0 Unported License](https://creativecommons.org/licenses/by/3.0/)



- (Do with it as you wish, so long as you give credit)



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# WHAT IS FHIR?

# Answer: An instigator of bad puns



- FHIR is the hottest thing since . . .
- This spec is spreading like . . .
- Committee X is really on FHIR
- Feel free to come up with your own
  - (but please, not here 😊)



# The acronym



- 
- F – Fast (to design & to implement)
    - Relative – No technology can make integration as fast as we'd like
  - H – Health
    - That's why we're here
  - I – Interoperable
    - Ditto
  - R – Resources
    - Building blocks – more on these to follow

# Genesis of FHIR



- Has been a need to share healthcare information electronically for a long time
  - HL7 v2 is over 25 years old
- Increasing pressure to broaden scope of sharing
  - Across organizations, disciplines, even borders
  - Mobile & cloud-based applications
  - Faster – integration in days or weeks, not months or years

# Genesis of FHIR



- Q: So what did HL7 have to offer in this space?
- A: Not much
  - V2 Old, and limited by it's own rules
  - V3 too slow and too hard
  - CDA has success, but both limited and too hard
  - Different contexts of interoperability → different representations that aren't compatible
  - Nothing suitable for light-weight integration, or for Health 2.0

# Genesis of FHIR



- HL7 undertook a “Fresh look”
  - What would healthcare exchange look like if we started from scratch using modern approaches?
- Web search for success markers led to RESTful based APIs
  - Exemplar: Highrise  
(<https://github.com/37signals/highrise-api>)
- Drafted a healthcare exchange API based on this approach

# FHIR Development Progress



- 
- July 2011 – Conception
  - Aug/Sept 2012 – First Draft Ballot
  - Sept 2012 – First Connectathon
  - Aug/Sept 2013 (now) – First DSTU ballot  
DSTU = Draft Standard For Trial Use
  - January 2014 – DSTU finalised
  - ~Mar 2015 – 2<sup>nd</sup> DSTU
  - Mid 2016? – Normative Version

# FHIR Development



## ■ Where are we now?

- Getting ready to update the DSTU (Draft Standard for Trial Use) from 1 to 2 in early next year.
- DSTUs have committed organizations using the DSTU to determine successes, errors—foundational and/or substantive to editorial / cosmetic.
- Within HL7 sponsors include the FHIR Management Group (FMG) and the HL7 Modeling and Methodology Work Group (M & M).

# Current DSTU Project Scope



- This project will update the existing HL7 international FHIR DSTU specification to reflect implementer feedback and enhanced quality guidelines.
- It will also introduce additional infrastructure and clinical content, including profiles developed by HL7 work groups.
- The project will also manage coordination of resolution of ballot issues amongst the work groups responsible for content.

# Current DSTU Sponsors



## ■ Formal Sponsors

- Health Intersections, Grahame Grieve (Australia)
- Furore, Ewout Kramer (The Netherlands)
- Orion Health, Richard Schneider (New Zealand)
- Oridashi, Brett Esler
- University Health Network, James Agnew
- CDA eHealth Solutions, Brian Postlethwaite

## ■ In addition, the following (and more) have been heavily active in development and connectathon testing (at one time or another including:

- Epic, Cerner, GE, Mayo Foundation, IHE

# FHIR DSTU?



- The FHIR specification is "draft". It has been subject to significant review through ballot and other HL7 processes and many aspects of it have been implemented and subjected to interoperability testing through Connectathons and early adoption. However, the degree of testing has varied. Some resources have been well tested in a variety of environments. Others have received relatively little real-world exercise. In general, the infrastructure should be considered to be more stable than the resources themselves. In some cases, there are issues on which input is specifically requested during the DSTU period (see the [Outstanding Issue List](#), and known issues will arise after publication (refer to the [FHIR Change Request](#) tracker for details.) Guidance from early implementation will help address these areas.

# Connectathon Participants

## 5/14 WG Mtg. Phoenix, AZ



- Health Intersections / Grahame Grieve.
- Furore / Ewout Kramer.
- Gordon Point Informatics / Lloyd McKenzie.
- Kaiser Permanente / Brian Pech
- SMART Platforms / Josh Mandel
- Orion Health / David Hay.
- Richard J. Ettema (AEGIS.net)
- GE Healthcare / Scott Bolte.
- Edidin Group, Inc / Howard S. Edidin
- NIST/ Bill Majurski
- Oridashi / Brett Esler
- University Health Network / James Agnew
- Lantana Consulting Group / Dale Nelson, Rick Geimer, Sean McIlvenna
- Roche Diagnostics International Ltd / Stefan Heesch
- Systems Made Simple, Inc. / Jeff Ting, Matt Jenks, Bill de Beaubien, Jeff Hoherz , Cosmo DiFazio
- Health Samurai/Choice Hospital Systems/Pavel Smirnov
- RelayHealth / Peter Bernhardt and Todd Pitchall
- Brian Postlethwaite (DCA eHealth Solutions)
- NProgram / Rik Smithies

# What would ONC like to do?



- 
- User FHIR for OSI Level 1-6 (physical through presentation) layers
    - While FHIR might be ok for DSTU testing / vendor testing the year before the general implementation of MU Stage N,
    - And there is considerable desire within the ONC HIT Standards Committee
    - IMHO, FHIR is at least a year away from being implemented

# What is Needed



- Testing and Confidence in all elements of FHIR necessary for MU Stage 3. This includes:
  - C-CDA (Consolidated CDA Implementation Specification)
  - Lob interactions (LOI, LRI and eDOS)
  - Previous MU requirements
    - CCR / CCD
    - CDC Immunization registry message implementation guide



# Additional Information

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# FHIR PRINCIPLES



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## FHIR Videos

Right-click and then “open hyperlink” or just click on above text in “slide show” mode.

# FHIR Manifesto



- 
- Focus on **Implementers**
  - Target support for **common scenarios**
  - Leverage cross-industry **web technologies**
  - Require **human readability** as base level of interoperability
  - Make content **freely available**
  - Support multiple **paradigms & architectures**
  - Demonstrate best practice **governance**

# Implementer Focus



- Specification is written for one target audience: implementers
  - Rationale, modeling approaches, etc. kept elsewhere
- Multiple reference implementations from day 1
- Publicly available test servers
- Starter APIs published with spec
  - C#, Java, Pascal, ObjectiveC – more to come
- Connectathons to verify specification approaches
- Instances you can read and understand 😊
- Lots of examples (and they're valid too)

```
using HL7.Fhir.Instance.Model;  
using HL7.Fhir.Instance.Parsers;  
using HL7.Fhir.Instance.Support;  
  
XmlReader xr = XmlReader.Create(  
    new StreamRead  
    IFhirReader r = new XmlFhirReader  
  
    // JsonTextReader jr = new JsonTe  
    // new StreamRead  
    // IFhirReader r = new JsonFhirRe  
  
    ErrorList errors = new ErrorList(  
    LabReport rep = (LabReport)Resour  
    Assert.IsTrue(errors.Count() == 0
```

# Support “Common” Scenarios



- Focus on scenarios implementers ask for
- Inclusion of content in core specification is based on core content rule
  - “We only include data elements if we are confident that most normal implementations using that resource will make use of the element”
  - Other content in extensions (more on this later)
  - Easy to say, governance challenge to achieve
- Resources are simple and easy to understand and use

# Web technologies

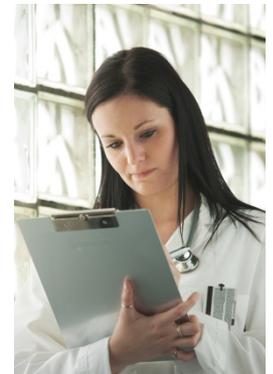


- Instances shared using XML & JSON
- Collections represented using ATOM
  - Same technology that gives you your daily news summary
  - Out-of-the-box publish/subscribe
- Web calls work the same way they do for Facebook & Twitter
- Rely on HTTPS, OAuth, etc. for security functions

# Human Readable



- Clinical Documents has both narrative and data
- The data / narrative dynamic exists throughout the process
- In FHIR, **every** resource is required to have a human-readable expression
  - Can be direct rendering or human entered



# Freely available



- Unencumbered – free for use, no membership required
- <http://hl7.org/fhir>



## FHIR License

1.0.3

FHIR plain English license:

- FHIR is © HL7. The right to maintain FHIR remains vested in HL7
- You can redistribute FHIR
- You can create derivative specifications or implementation-related products and services
- Derivative Specifications cannot redefine what conformance to FHIR means
- You can't claim that HL7 or any of its members endorses your derived [thing] because it uses content from this specification
- Neither HL7 nor any of the contributors to this specification accept any liability for your use of FHIR

# FHIR & Cost of Integration

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- These factors will drive down the cost of integration and interoperability
  - Easier to Develop
  - Easier to Troubleshoot
  - Easier to Leverage in production
  - More people to do the work (less expensive consultants)
- Competing approaches will have to match the cost, or disappear – effect is already being felt

# Future impact of FHIR



- Impact of FHIR on the market:
  - Drive interoperability prices down
  - Higher Expectations
  - Increased spend on integration (N x 2)!
- Overall Market focus
  - PHR on the web
  - Healthcare repositories
  - Device Data management
  - Retooling existing connections



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# ABOUT REST AND RESOURCES

# REST



- 
- “Representational state transfer” – an architecture for how to connect systems
  
  - Outcomes
    - Simple stable interfaces
    - High Performance / Scalability
    - Visible Process (e.g. can debug)
    - Portability
    - Reliability (resistance to failure)

# REST in practice



- “Resources” with an explicit and stable URI (uniform resource indicator)
  - The name for what gets exchanged in REST (representational state transfer)
  - Defined behaviour and meaning
  - Known identity / location
  - Quite an abstract idea
- Formats: XML (extensible mark-up language) / JSON (JavaScript Object Notation) / RDF (resource description framework)
- Exchange using HTTP (hypertext transfer protocol)
- Security: SSL (secure sockets layer) / OAuth (open standard for authorization)
- “REST” followed loosely, hence “RESTful”

# REST Operations



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## CRUD(E):

- Create – create a new instance of data
- Read – get the content (state) of an instance of data
- Update – change the content of an instance of data
- Delete – remove the instance of data
- Execute – get the instance of data (?) to do something for you

# RPC vs REST



## ■ RPC (Remote Procedure Call):

- Ask a server to perform some operation
- Hand it a set of parameters
- Server performs some operations
- Returns a set of parameters

## ■ REST:

- Define a URI that represents the state of something
- Tell the server what the state should be
- Server makes the state change happen

# RPC vs REST example



- Example:
  - A device that monitors a patient %O<sub>2</sub> Sat (mixed venous oxygen saturation)
  - Raises an alarm on EHR if it's too low
  - EHR can turn the alarm off
- RPC:
  - POST <http://acme.org/devices/turnOffAlarm>
  - Parameters: device id, alarm id
- REST:
  - POST [http://acme.org/devices/\[deviceid\]/\[alarmid\]](http://acme.org/devices/[deviceid]/[alarmid])
  - Content: data to say “Alarm is off”

# RPC vs REST

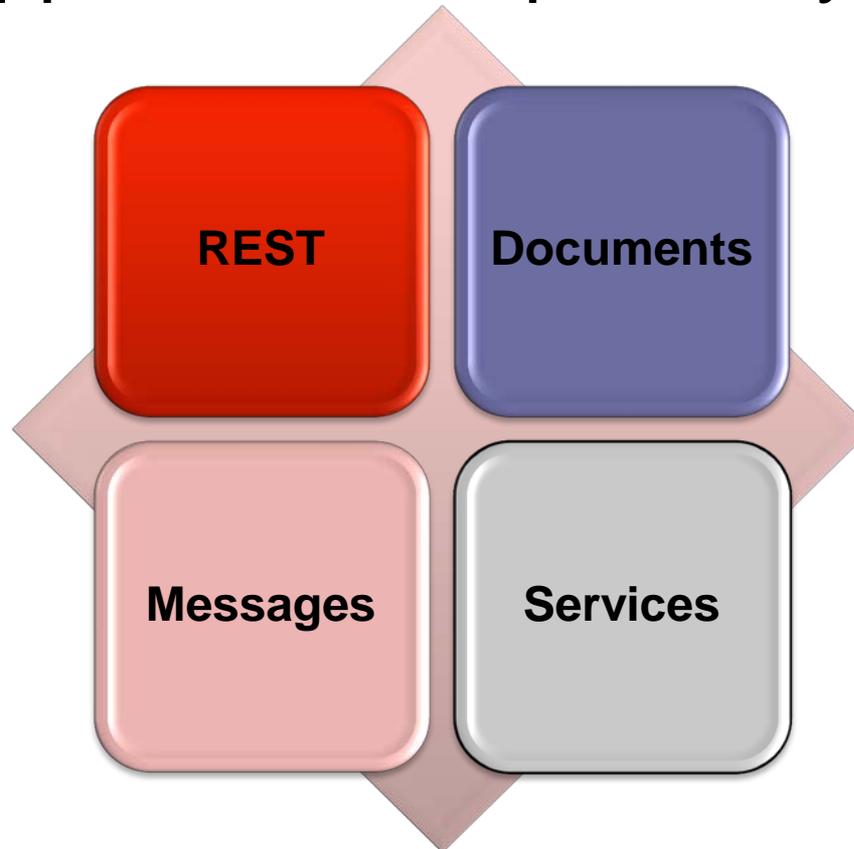


- Difference is subtle, and depends on perspective
- Outcome is large difference
- REST is increasingly preferred in practice
- Most systems mix and match
  - “mini-operations”
- General issue: REST doesn't deal well if server needs context from the client
  - Needed for poorly trusted clients

# Paradigms



- FHIR supports 4 interoperability paradigms



# Documents



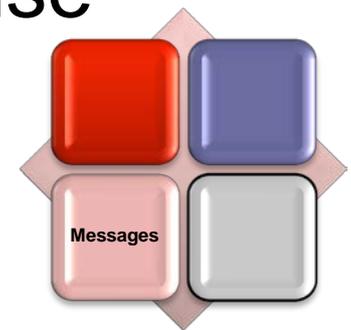
- Similar to CDA
- Collection of resources bound together
  - Root is a “Composition” resource
  - Just like CDA header
- Sent as an ATOM feed
- One context
- Can be signed, authenticated, etc.



# Messages



- Similar to v2 and v3 messaging
- Also a collection of resources as an ATOM feed
- Allows request/response behavior with bundles for both request and response
- Event-driven
  - E.g. Send lab order, get back result
- Can be asynchronous

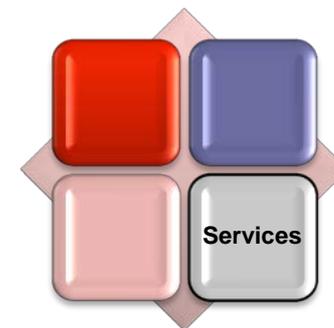


# Service Oriented Architecture (SOA)



## ■ Do whatever you like

- (based on SOA principles)
- Ultra complex workflows
- Ultra simple workflows
- Individual resources or collections (in Atom or other formats)
- Use HTTP or use something else
- Only constraint is that you're passing around FHIR resources in some shape or manner



# Paradigms



- Regardless of paradigm **the content is the same**
- This means it's straight-forward to share content across paradigms
  - E.g. Receive a lab result in a message. Package it in a discharge summary document
- It also means constraints can be shared across paradigms
  - E.g. Define a profile for Blood Pressure and use it on resources in messages, documents, REST and services



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# FHIR RESOURCES

# Resources



## ■ “Resources” are:

- Small logically discrete units of exchange
- Defined behaviour and meaning
- Known identity / location
- Smallest unit of transaction
- “of interest” to healthcare
  
- V2: Sort of like Segments
- V3: Sort of like CMETs



# What's a Resource?



## Examples

- Administrative
  - Patient, Practitioner, Organization, Location, Coverage, Invoice
- Clinical Concepts
  - Allergy, Condition, Family History, Care Plan
- Infrastructure
  - Document, Message, Profile, Conformance

## Non-examples

- Gender
  - Too small
- Electronic Health Record
  - Too big
- Blood Pressure
  - Too specific
- Intervention
  - Too broad

**100-150 total**

## Clinical

### General:

- AdverseReaction
- AllergyIntolerance
- CarePlan
- Condition
- FamilyHistory
- Procedure
- Questionnaire

### Administrative

#### Attribution:

- Patient
- RelatedPerson
- Practitioner
- Organization

### Infrastructure

#### Support:

- List
- Media
- Other
- Provenance
- SecurityEvent
- (Binary)

### Medications:

- Medication
- MedicationPrescription
- MedicationAdministration
- MedicationDispense
- MedicationStatement
- Immunization
- ImmunizationRecommendation

### Entities:

- Device
- Location
- Substance
- Group

### Document Handling:

- Composition
- DocumentReference
- DocumentManifest

### Diagnostics:

- Observation
- DiagnosticReport
- DiagnosticOrder
- ImagingStudy
- Specimen

### Workflow Management:

- Encounter
- Alert
- Supply
- Order
- OrderResponse

### Exchange:

- MessageHeader
- OperationOutcome
- Query

### Device Interactions:

- DeviceObservationReport

### Financial:

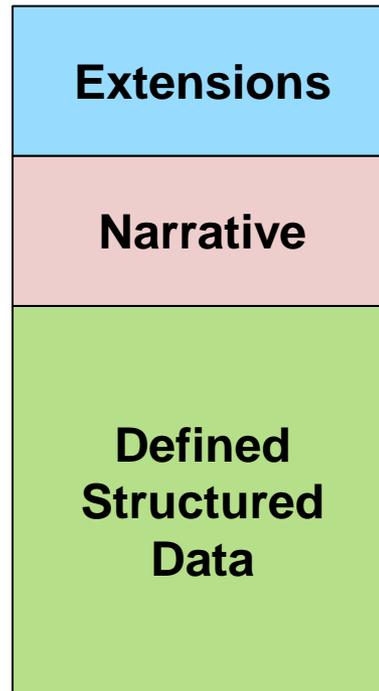
### Conformance:

- Conformance
- Profile
- ValueSet
- ConceptMap (informative)

# Resource anatomy



- Resources have 3 parts



```

<Patient xmlns="http://hl7.org/fhir">
  <extension>
    <url value="http://www.goodhealth.org/consent/trials"/>
    <valueCode value="renal"/>
  </extension>
  <text>
    <status value="generated"/>
    <div xmlns="http://www.w3.org/1999/xhtml">
      <p>Henry LEVIN the 7th, DOB 24-Sept 1932</p>
      <p>MRN: 123456</p>
    </div>
  </text>
  <active value="true"/>
  <identifier>
    <use value="usual"/>
    <label value="MRN"/>
    <system value="http://www.goodhealth.org/identifiers/mrn"/>
    <id value="123456"/>
  </identifier>
  <details>
    <name>
      <family value="Levin"/>
      <given value="Henry"/>
      <suffix value="The 7th"/>
    </name>
    <gender>
      <system value="http://www.hl7.org/v2/0001"/>
      <code value="M"/>
    </gender>
    <birthDate value="1932-09-24"/>
  </details>
  <provider>
    <type value="Organization"/>
    <url value="../organization/@1"/>
    <display value="Good Health Clinic"/>
  </provider>
45 </Patient>

```

Extension with  
reference to its definition

Human Readable  
Summary

Standard Data  
Content:

- MRN
- Name
- Gender
- Date of Birth
- Provider

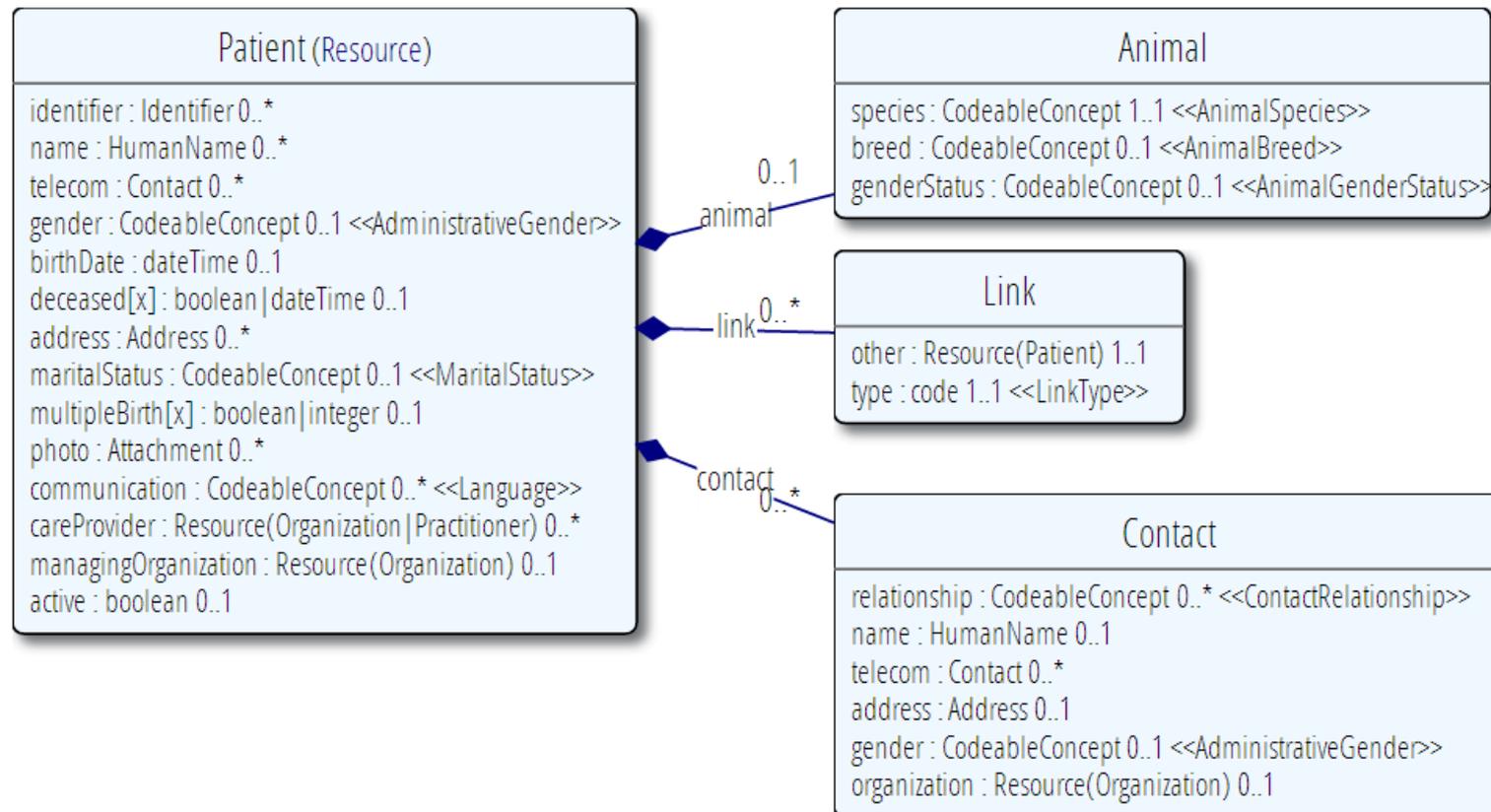
# Resource Documentation



For each Resource:

- Scope and Usage Notes
- Resource Content (UML and XML)
- Terminology Bindings
- Constraints
- Implementation Issues
- Search Parameters
- Examples, Profiles, Formal Definitions
- Mappings to RIM, CDA, v2, etc

# Example Resource Definitions



```

<Patient xmlns="http://hl7.org/fhir">
  <!-- from Resource: extension, narrative, and contained -->
  <identifier><!-- 0..* Identifier An identifier for the person as this patient § --></identifier>
  <name><!-- 0..* HumanName A name associated with the patient § --></name>
  <telecom><!-- 0..* Contact A contact detail for the individual § --></telecom>
  <gender><!-- 0..1 CodeableConcept Gender for administrative purposes § --></gender>
  <birthDate value="[dateTime]"/><!-- 0..1 The date and time of birth for the individual § -->
  <deceased[x]><!-- 0..1 boolean|dateTime Indicates if the individual is deceased or not § --></deceased[x]
  >
  <address><!-- 0..* Address Addresses for the individual § --></address>
  <maritalStatus><!-- 0..1 CodeableConcept Marital (civil) status of a person § --></maritalStatus>
  <multipleBirth[x]><!-- 0..1 boolean|integer Whether patient is part of a multiple birth § --></multipleBirth[x]
  >
  <photo><!-- 0..* Attachment Image of the person --></photo>
  <contact> <!-- 0..* A contact party (e.g. guardian, partner, friend) for the patient -->
    <relationship><!-- 0..* CodeableConcept The kind of relationship --></relationship>
    <name><!-- 0..1 HumanName A name associated with the person --></name>
    <telecom><!-- 0..* Contact A contact detail for the person --></telecom>
    <address><!-- 0..1 Address Address for the contact person --></address>
    <gender><!-- 0..1 CodeableConcept Gender for administrative purposes --></gender>
    <organization><!-- 0..1 Resource(Organization) Organization that is associated with the contact --></organization>
  </contact>
  <animal> <!-- 0..1 If this patient is an animal (non-human) § -->
    <species><!-- 1..1 CodeableConcept E.g. Dog, Cow § --></species>
    <breed><!-- 0..1 CodeableConcept E.g. Poodle, Angus § --></breed>
    <genderStatus><!-- 0..1 CodeableConcept E.g. Neutered, Intact § --></genderStatus>
  </animal>
  <communication><!-- 0..* CodeableConcept Languages which may be used to communicate with the patient --><

```

# Constraints & Notes



- **Inv-1:** On Patient.contact: Must at least contain a contact's details or a reference to an organization (xpath on f:Patient/f:contact: f:name or f:telecom or f:address or f:organization)

## Notes:

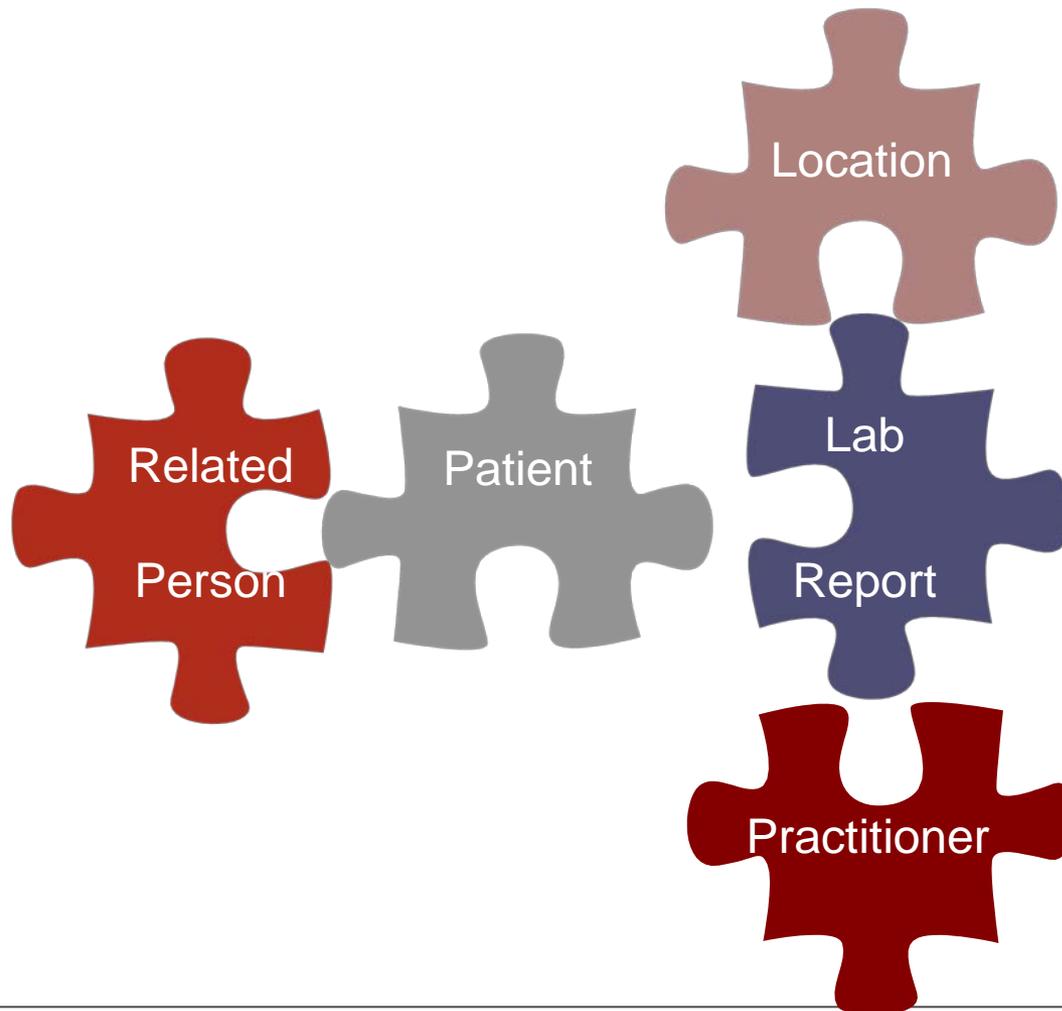
- multipleBirth can be either expressed as a boolean (just indicating whether the patient is part of a multiple birth) or as an integer, indicating the actual birth order.
- Patient records may only be in one of two statuses: in use (active=true) and not in use (active=false). A normal record is active, i.e. it is in use. Active is set to 'false' when a record is created as a duplicate or in error. A record does not need to be linked to be inactivated.
- The *link* element is used to assert that two or more Patient resources are both about the same actual person. See below for further discussion
- There should be only one preferred language (Language.preference = true) per mode of expression.
- The Contact for a Patient has an element *organization*, this is for use with guardians or business related contacts where just the organization is relevant.

# Resource elements

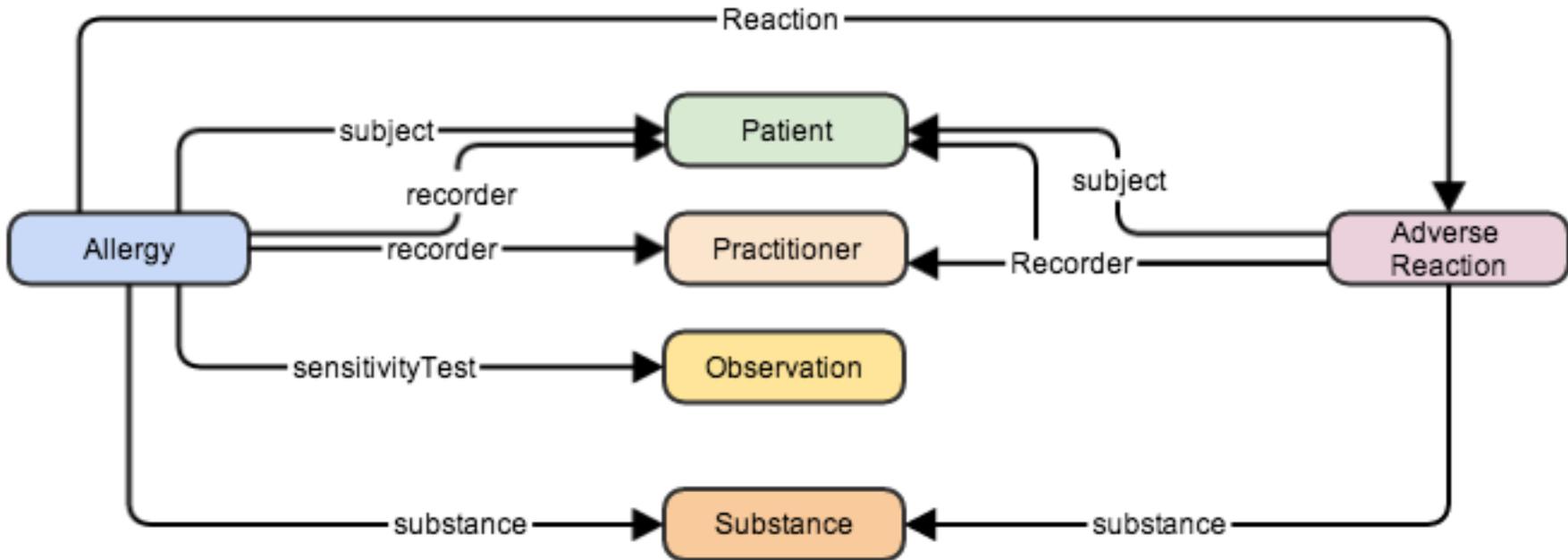


- 
- Resources are defined as an XML structure based on desired wire syntax
    - Hierarchy of elements
    - Each element has
      - Name
      - Either a datatype or nested elements
      - Cardinality
        - All collections are nested in a containing element
      - Definition
      - Mappings
  - But instances in XML or JSON

# It's all about the resources . . .



# References between resources



# References



- Resources are independent – don't need to other resources to correctly interpret a resource
- But resources reference each other extensively to form a web of information
- Need to resolve references to fully understand the data
- Reference is relative to server base URL

```
<Procedure xmlns="http://hl7.org/fhir">  
  <subject>  
    <reference value="Patient/23"/>  
  </subject>  
  ...
```

# Rules for references



- References can be relative or absolute
- References don't have to be to the same server
- Server does not have to enforce integrity
- Clients need to cater for broken links
- Targets can be 'contained' in the resource:

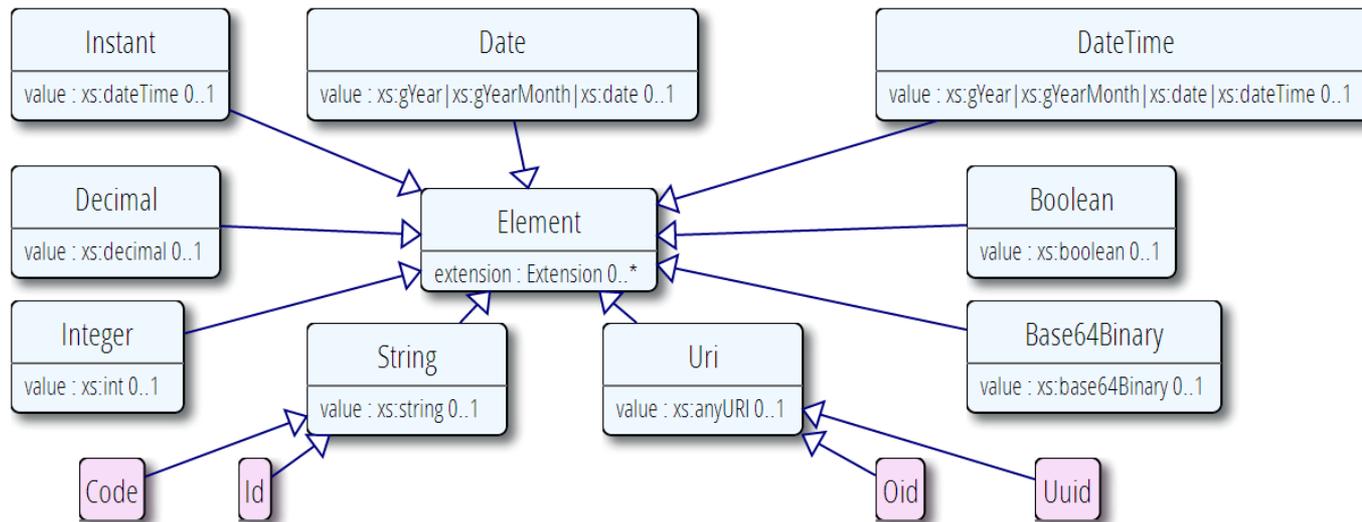
```
<Procedure xmlns="http://hl7.org/fhir">
  <contained>
    <Patient id="pat">
      </Patient>
    </contained>
  <subject>
    <reference value="#pat"/>
  </subject>
```

# Data types



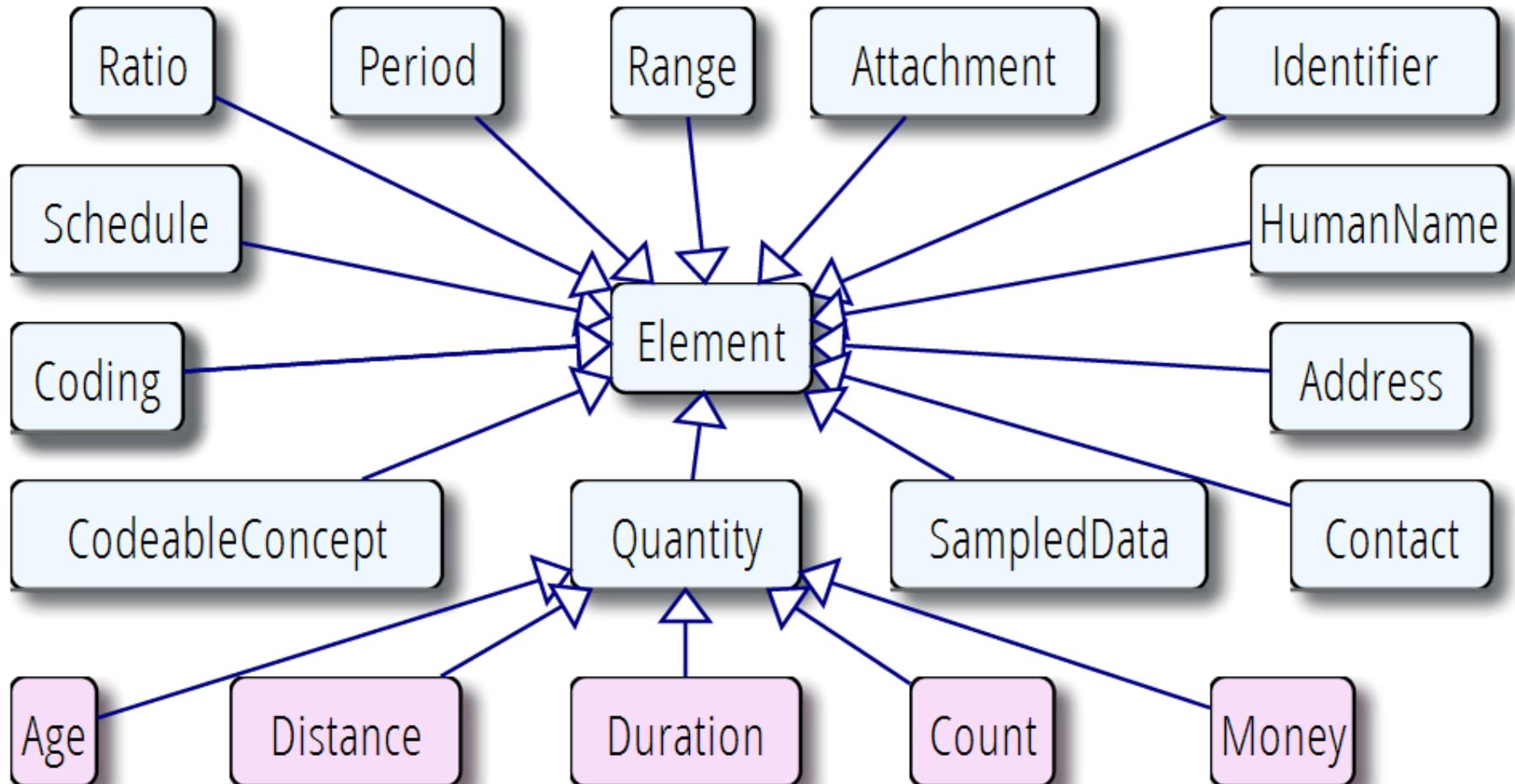
## Primitive Types

1.11.0.1



- Based on w3c schema and ISO data types
- Stick to the “80% rule” – only expose what most will use

# Data types (cont'd)



# CodeableConcept



```
<[name] xmlns="http://hl7.org/fhir">  
  <!-- from Element: extension -->  
  <system value="[uri]"/><!-- 0..1 Identity of the terminology system -->  
  <version value="[string]"/><!-- 0..1 Version of the system - if relevant -->  
  <code value="[code]"/><!-- 0..1 Symbol in syntax defined by the system -->  
  <display value="[string]"/><!-- 0..1 Representation defined by the system -->  
  <primary value="[boolean]"/><!-- 0..1 If this code was chosen directly by the user -->  
  <valueSet><!-- 0..1 Resource(ValueSet) Set this coding was chosen from --></valueSet>  
</[name]>
```



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



# Vocabulary



- Support for coded data of varying complexity
- Some codes defined as part of resource, others referenced from external vocabularies
  - LOINC, SNOMED, UCUM, etc.
- Recognition some will differ by implementation space
- Can use Value Set resource to define more complex code lists

# Bundles



- 
- When more than one resource needed
    - Query result
    - Document
    - Message
  - Atom 'feed'
    - With JSON representation

# Narrative



- All resources carry an html representation of their content
- It's a clinical safety issue
  - The receiver has a fall back option if the system is not sure it fully understands the content
- It is not mandatory, but **SHOULD** be present
- In a closed eco-system, with extremely tight control and strong conformance testing, it may not be necessary
  - But things often change over time
  - So using narrative is highly recommended
  - Saves a lot of money downstream from the author

# Narrative XHTML



- Narrative is XHTML. Formatting allowed:
  - Tables, lists, divs, spans
  - Bold, Italics, styles etc
  - E.g. all static content
- Features not allowed:
  - Objects, scripts, forms – any active content
  - Links, Stylesheets, iframes – web context
  - Local storage, Microdata (no active content)
- Concerns are security and clinical safety



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# FHIR EXTENSIONS

# The Case for Extensions



- Extensions are often problematic in existing HL7 specs
  - Z-segments in v2
    - What does this mean?
      - ZSB | 20080117 | Q^57 | 4.30^uL
  - Foreign namespaces in CDA/V3
    - Break schemas
- Simple choice – design for absolutely everything or allow extensions



# Extensions



- FHIR has a standard framework for extensions
- Every FHIR element can be extended
- Every extension has:
  - Reference to a computable definition
  - Value – from a set of known types
- Every system can read, write, store and exchange all legal extensions
- All extensions are valid by schema etc.

# Extensions without the pain...



- 
- Extensions are built into the wire format
  - All conformant systems can “handle” any possible extension - Just a bucket of “other stuff”
  - Extensions rendered in human readable portion

# Governing Extensions



- 
- Extensions are not a silver bullet
  - FHIR has a sliding scale governance for extensions
    - Local Projects
    - Domain standards (e.g. Best Practice Cardiology)
    - National Standards (e.g. Standard Finnish Extensions)
    - HL7 published extensions (corner cases with international scope)

# Example – CD datatype



## ■ ISO

- Code, code system, code system name, code system version, value set id, value set version, coding rationale, updateMode, flavorId, nullFlavor, controlAct root & extension, validTime low and high
- displayName with language and translations
- originalText with mediaType, language, compression, integrityCheck, thumbnail, description, translations, reference (can be text, video, whatever)
- Translations (most of same info as code)
- Source code

# Example – CD datatype



## ■ FHIR

- **Code, code system, ~~code system name, code system version, value set id, value set version coding rationale, updateMode, flavorId, nullFlavor, controlAct root & extension, validTime low and high~~**
- **displayName** ~~with language and translations~~
- **originalText** ~~with mediaType, language, compression, integrityCheck, thumbnail, description, translations, reference~~ (can be **text**, ~~video, whatever~~)
- **Translations** (most of same info as code)
- ~~Source code~~

# What's the goal here?



- 
- In most areas of healthcare standards, there is wide variability
    - Between systems, countries, institutions, clinicians
  - Choices:
    - Specification only supports core – no one can use it
    - Specification adds everything – no one understands it
    - Specification picks winners – only they can use it
    - Allow extensions that people can use
  - Extensions tame the specification

# Example Extension



Eye Colour to patient resource:

- Need to pick a URL
- Need to choose a type
- Have to declare and publish the extension (at the URL)

```
<Patient xmlns="http://hl7.org/fhir">  
  <extension url="http://acme.org/fhir/patient#eyecolor">  
    <valueCode value="brown"/>  
  </extension>  
  ...
```

# Publishing an Extension



Field	Value
Context	The patient resource
Name	Eye Colour
Definition	Eye Colour as chosen by clerical staff based on visual inspection
Requirements	Refer to policy 23B section A.1.2.3
Cardinality	0..1
Type	String
Binding	Codes: blue, brown, green, mixed, violet
Modifier	false
Constraints	
Mappings	.



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# FHIR OPERATIONS

# Business Operations



- Register a patient:
  - Create a Patient Resource
- Admit a patient:
  - Create an Encounter Resource
- Move a patient from one bed to another
  - Find and update the encounter resource
- Prepare a list of medications to administer
  - Search through the medication prescriptions for a patient (and then apply logic)

# FHIR Resource URLs



Template	Description	Example
[base]	Server URL	http://fhir.com
[base]/[type]	URL for type manager	http://fhir.com/Patient
[base]/[type]/[id]	URL for a resource	http://fhir.com/Patient/23
[base]/[type]/[id] /_history/[vid]	URL for a past version of a resource	http://fhir.com/Patient/23/_history/2

# Operations / Instance



Op	Description	Request Content	Response Content
read	Read the current state of the resource	–	Resource
vread	Read the state of a specific version of the resource (e.g. what it was in the past)	–	Resource
update	Update an existing resource by its id (or create it if it is new). Use the resource representation supplied	Resource	–
delete	Remove the resource so it is no longer present (note: it still has a history)	–	–
history	Get a list of all the past versions of the resource	–	Atom feed

# Operations / Type



Op	Description	Request Content	Response Content
create	Create a new resource with a server assigned id	Resource	–
search	Search through all resources of the type based on some filter criteria	Params	Atom Feed
history	Get a list of all the past versions of this resource type	–	Atom Feed
validate	Check that the content would be acceptable as an update	Resource	Resource (Operation Outcome)

# Operations / System



Op	Description	Request Content	Response Content
conformance	Get a conformance statement for the system	–	Resource
transaction	Update, create or delete a set of resources as a single transaction	Atom Feed	Atom Feed
history	Retrieve the update history for all resources (full pub/sub)	–	Atom Feed
search	Search through all resources of all types based on some filter criteria	Params	Atom Feeds



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# PROFILES & CONFORMANCE

# Conformance Resources

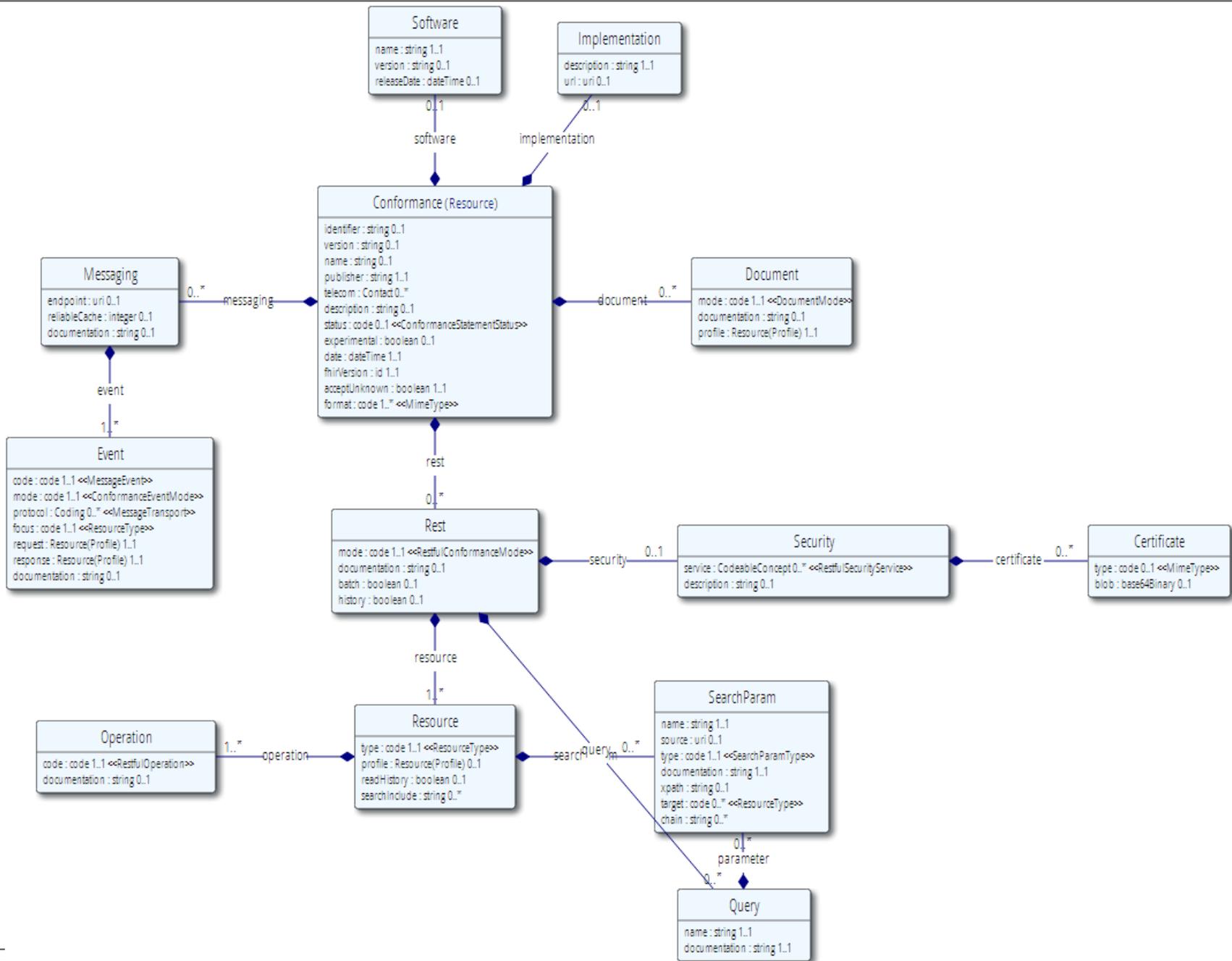


- 
- Conformance – a state of system capabilities
  - Profile – a set of rules about a resource is used
  - Value set – describes a set of codes that can be used for something

# Conformance



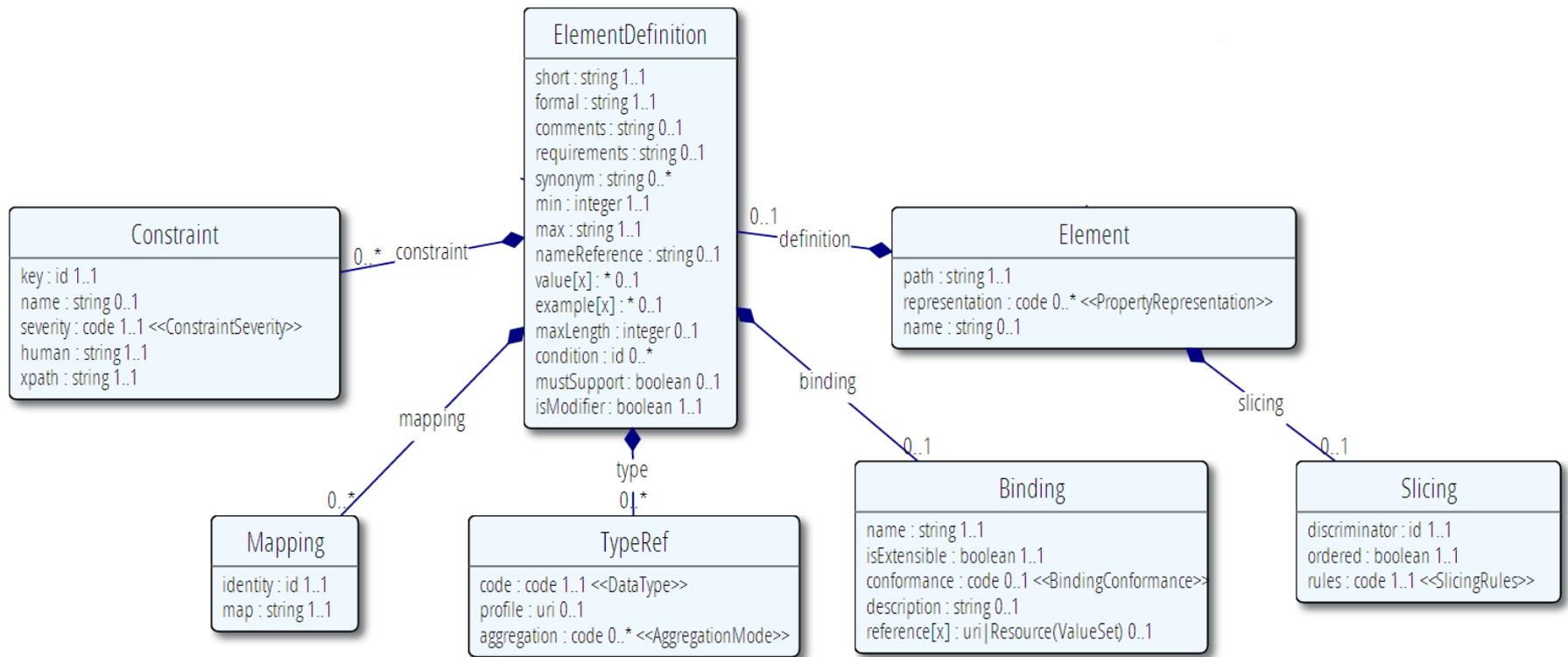
- There's a resource for documenting conformance to FHIR
- Can be used for:
  - Stating how a specific system instance behaves
  - Defining how a software system is capable of behaving (including configuration options)
  - Identifying a desired set of behavior (e.g. RFP)
- To declare themselves “FHIR Conformant”, a system **must** publish a Conformance instance



# Profiles



- Document constraints and extensions on one or more resources
- May also define new extensions search terms, new messaging events, etc.
- Subsumes: template, implementation profile, DCM (Detailed Clinical Model), etc.
- Looks an awful lot like the definition of the resources themselves
  - You can download profile XML for all resources



# Using Profiles



- 
- You can just go ahead and use a resource
    - No need for a profile
  - But you can write a profile
    - Document your usage in detail for partners
  - You can mark a resource with a profile
    - It's just a claim – can test conformance with that
    - Denormalization for performance



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# IMPLEMENTING FHIR

# Where can FHIR be used?



- Classic in-institution interoperability
- Back-end e-business systems (e.g. financial)
- Regional Health Information Organizations (RHIO)
- National EHR systems
- Social Web (Health) ← Near
- Mobile Applications ← Term

# Architecture



- Standalone FHIR Server
- A FHIR Server in front of an existing application (e.g. SQL)
  - FHIR as front end to an XDS server (“MHD”)
- An interface engine that ‘speaks’ FHIR
- A tablet/mobile phone application
- Web portal uses FHIR to access other systems
- A healthcare application that access information from multiple systems as well as it’s own server
- Smart-On-FHIR – an EHR plug-in framework

# Implementation Assistance



- Reference Implementations – object models, parsers, serializers, clients, validators, utilities
- Schema, Schematron, Validation Pack
- 1000's of examples
- Live Servers to test against
  - [http://wiki.hl7.org/index.php?title=Publicly\\_Available\\_FHIR\\_Servers\\_for\\_testing](http://wiki.hl7.org/index.php?title=Publicly_Available_FHIR_Servers_for_testing)
- Connectathons

# Servers



- 
- Use the servers to explore how it works
  - Write clients that use the test data
  - Test that you got your own system right
  - Most developers:
    - use the servers to learn
    - consult the documentation occasionally
    - I do recommend to read the specification a little

# Other Free software



## ■ See

[http://wiki.hl7.org/index.php?title=Open\\_Source\\_FHIR\\_implementations](http://wiki.hl7.org/index.php?title=Open_Source_FHIR_implementations)

## ■ Coming shortly:

- “Sprinkler” – a conformance test tool for servers
- “Forge” – an editor for conformance statements
- A Value set Editor
- Several implementation guide publishers

# Connectathons



- Open invitation to any interested party to come and write software that exchanges FHIR resources
- Always hold one before HL7 meetings (last week) + Others by invitation
- Mix of skills
  - Newbies (“where is the spec?”)
  - Old hands who’ve been to every connectathon
  - Experiment with new features
- We have a virtual connectathon all the time...

# Implementation Assistance



- Stack Overflow – ask implementation questions
  - Link from front page
  - Search for answers first
  - Don't ask for changes to the spec (get deleted!)
- gForge Tracker – ask for changes to the spec
  - Link from bottom of every page
  - But have discussion somewhere first
- Disqus – on every page of the specification
- Skype – implementers channel – 105 participants
- FHIR Email list, Connectathons, Tutorials

# Migration



- 
- No expectation that people will migrate existing interfaces any time soon.
  - Initial adopters will be green-field, new technology
  - FHIR may see use behind the scenes in v2 systems before it sees use over the wire
  - Forthcoming policy initiatives may necessitate revisiting existing interfaces

# Migration – v2



- 
- Already have an integration engine that supports translation between v2 and FHIR
  - Resources map to segments reasonably well
  - As always, the challenge with v2 mapping is the variability of v2 interfaces
    - “Common” mappings can be created, but they won’t be one size fits all

# Migration – CDA



- 
- Made more complex by human-readable nature
    - Need to ensure text <-> entry linkages are retained
  - Will best be handled on a template by template basis
    - Likely start with important ones like C-CDA

# FHIR Manifesto



- 
- Focus on **Implementers**
  - Target support for **common scenarios**
  - Leverage cross-industry **web technologies**
  - Require **human readability** as base level of interoperability
  - Make content **freely available**
  - Support multiple **paradigms & architectures**
  - Demonstrate best practice **governance**