Introduction to FHIR©

Viet Nguyen, MD

Clinical Informaticist

Stratametrics, LLC

STRATAMETRICS

FHIR | Agenda

- The basics: resources and references
- Structured Data
- Profiling
- Paradigms of Exchange
- Ecosystem

Why Interoperability

- Health information sharing is becoming increasingly important
  - Individuals involved in delivering care to consumers now expect the information they require to be available at the point of care
- Data collected in multiple places
  - Realistically need to move information around
- Interfaces are expensive
  - Especially if not standards based

Why FHIR?

- HL7 defines Interoperability Standards
- In 2011, the Board of HL7 noted:
  - Interoperability requirements are increasing
  - Need for real time access (API) – Mobile
  - Vast increase in the amount, type and source of data
    - e.g. Devices, Genomics
  - Analytics, population health
  - Implementer expectations

- Existing standards were lacking, a fresh look was needed…

Benefits of FHIR

Benefits to Implementers and Vendors

- Familiar tooling and technologies
  - XML/JSON, HTTP, REST, SSL, OAuth
- Predefined resources and APIs
  - With built in extensibility
  - Allows implementer to focus on the core application functionality
- Extensive documentation, samples and reference server implementations
- Validation services
- Active and supportive community
- Open Source code libraries
  - HAPI (Java) and Furore (.Net)
- Mobile friendly
- Increases commercial viability of app development as FHIR compliant apps will work with different FHIR Servers (EMRs, HIEs)

Benefits to Clinicians

- Clinicians can get involved in system design
- Tooling available
- Improved access to more complete, higher quality patient information incl. genomics
- Greater choice and variety of applications and devices to support clinical workflow
- Increased IT development speed – solving business problems faster in innovative ways
- Improving Decision Support
  - E.g. Immunization protocol
- Saving time

Benefits to Consumers

- Prospect of improved patient engagement apps, enabled through FHIR APIs to clinical systems
  - Can engage more deeply
- Clinician has access to a more complete patient record and improved decision making tools, leading to:
  - Better decision making
  - More efficient diagnosis and treatment
  - Higher quality care
- Overall improved patient experience – reducing wasted time

Benefits to Health Care Organisations

- Most vendors are committed to FHIR
- Should lead to:
  - faster deployments
  - lower cost interoperability
  - reduced vendor lock in as FHIR is adopted by source systems
- Standards based APIs to support internal application development
- Capture data for
  - Analytics and Decision Support
  - Population Management

Basics of FHIR

The goals of FHIR (FHIR manifesto)

- Implementer Focus
- Target the 80% (common stuff)
- Use today's web technologies
  - Spec & artifacts
- Support human readability
- Paradigm & architecturally agnostic
- Open Source

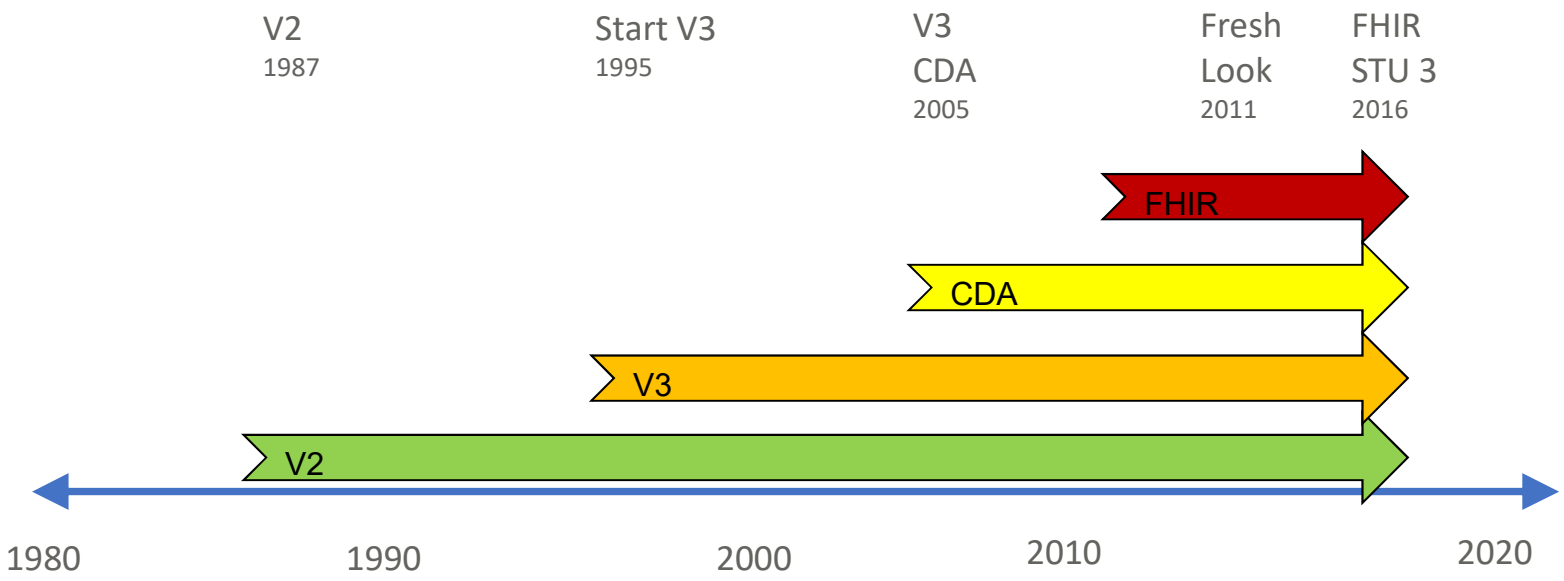
Overview of FHIR

- Fast Healthcare Interoperability Resources (FHIR)
- Consistent, simple to use content model (resources)
  - Controlled extensibility
- Supports all paradigms of exchange
  - Real-time APIs
  - Documents, Messages & Operations
- Designed with implementers in mind
- Freely available
- Detailed on-line, hyperlinked specification
- Freely available tooling, servers, libraries
- Strong endorsement and support from vendors, providers and regulatory community (e.g. NHS, INTEROpen, Project Argonaut)
- Massive supporting community

Related to other Healthcare Standards

- HL7
  - Version 2
  - Version 3
  - CDA
- openEHR
- CIMI
- IHE
- DICOM
- Terminologies
  - SNOMED
  - ICD

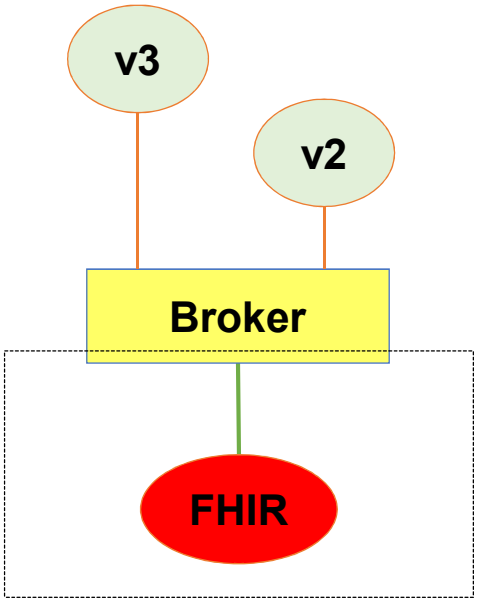
Timeline: Where does FHIR fit?

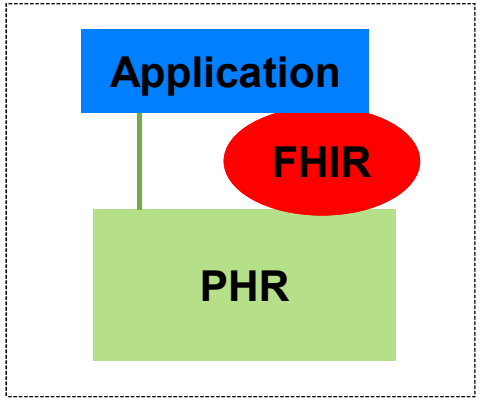


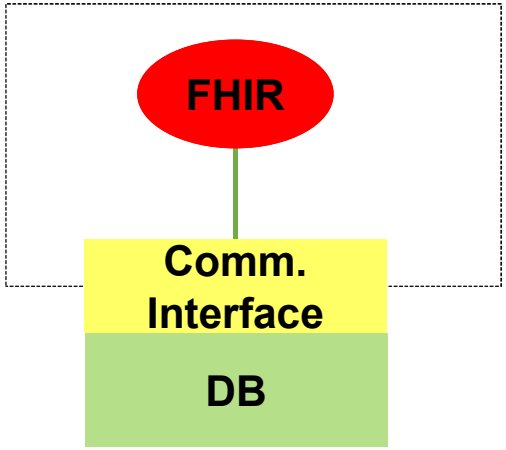
Why is FHIR different

- Implementer focus
- Community involvement
- Tested at Connectathons
- Based on other standards
- Test servers available
- Open Source Libraries
- Free tooling
  - clinFHIR
  - forge

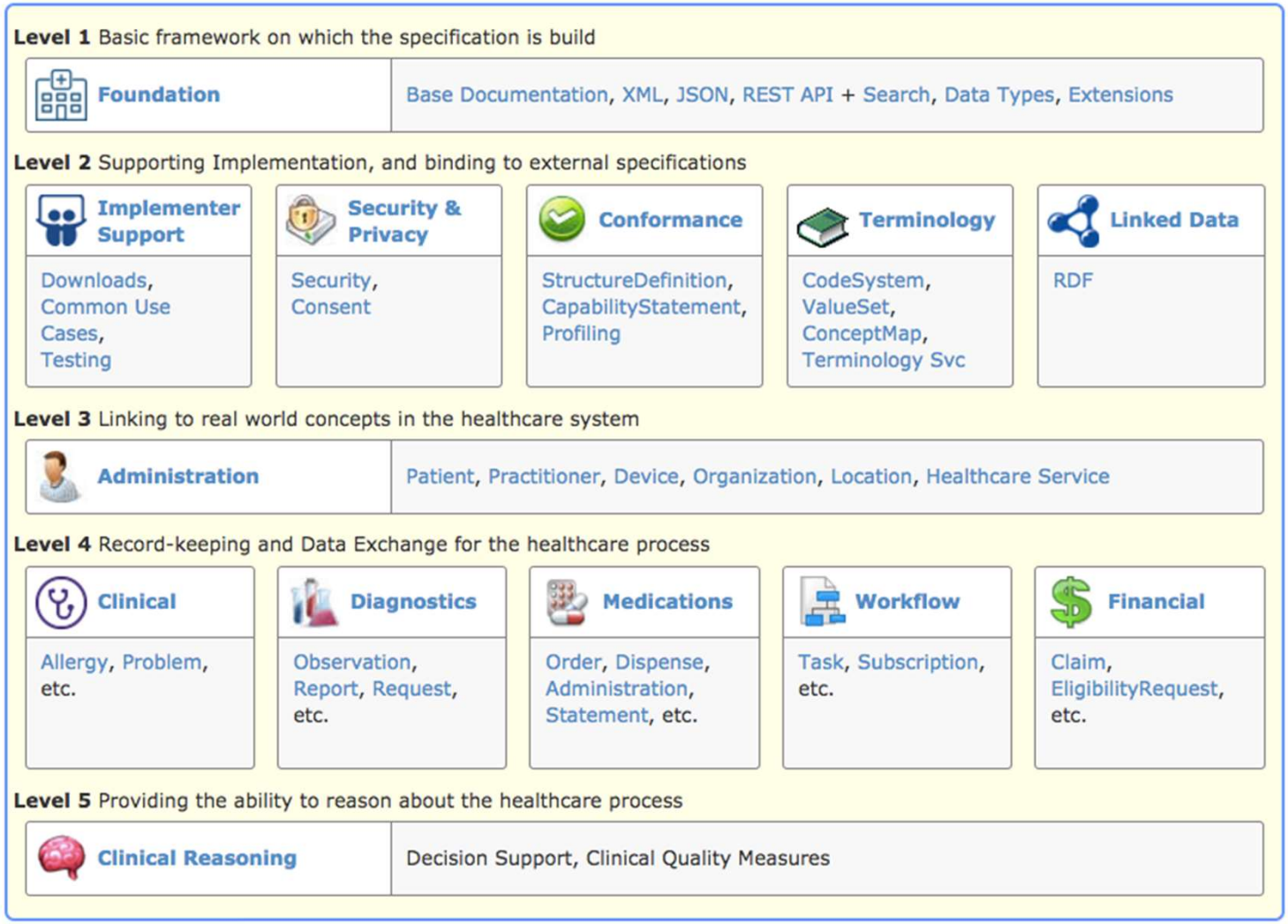
Where can you use FHIR







The Specification



http://hl7.org/fhir/index.html

Resources: What are they?

- The Content model
- The Thing that is exchanged
  - Via REST (FHIR Restful API), Messages, Documents
- Informed by much past work inside & outside of HL7
  - HL7: version 2, version 3 (RIM), CDA
  - Other SDO: openEHR, CIMI, ISO 13606, IHE, DICOM

Resources

General:

AllergyIntolerance

Condition (Problem)

Procedure

ClinicalImpression

FamilyMemberHistory

RiskAssessment

DetectedIssue

Care Provision:

CarePlan

CareTeam

Goal

ReferralRequest

ProcedureRequest

NutritionOrder

VisionPrescription

Medication & Immunization:

Medication

MedicationOrder

MedicationAdministration

MedicationDispense

MedicationStatement

Immunization

ImmunizationRecommendation

Diagnostics:

Observation

DiagnosticReport

DiagnosticOrder

Specimen

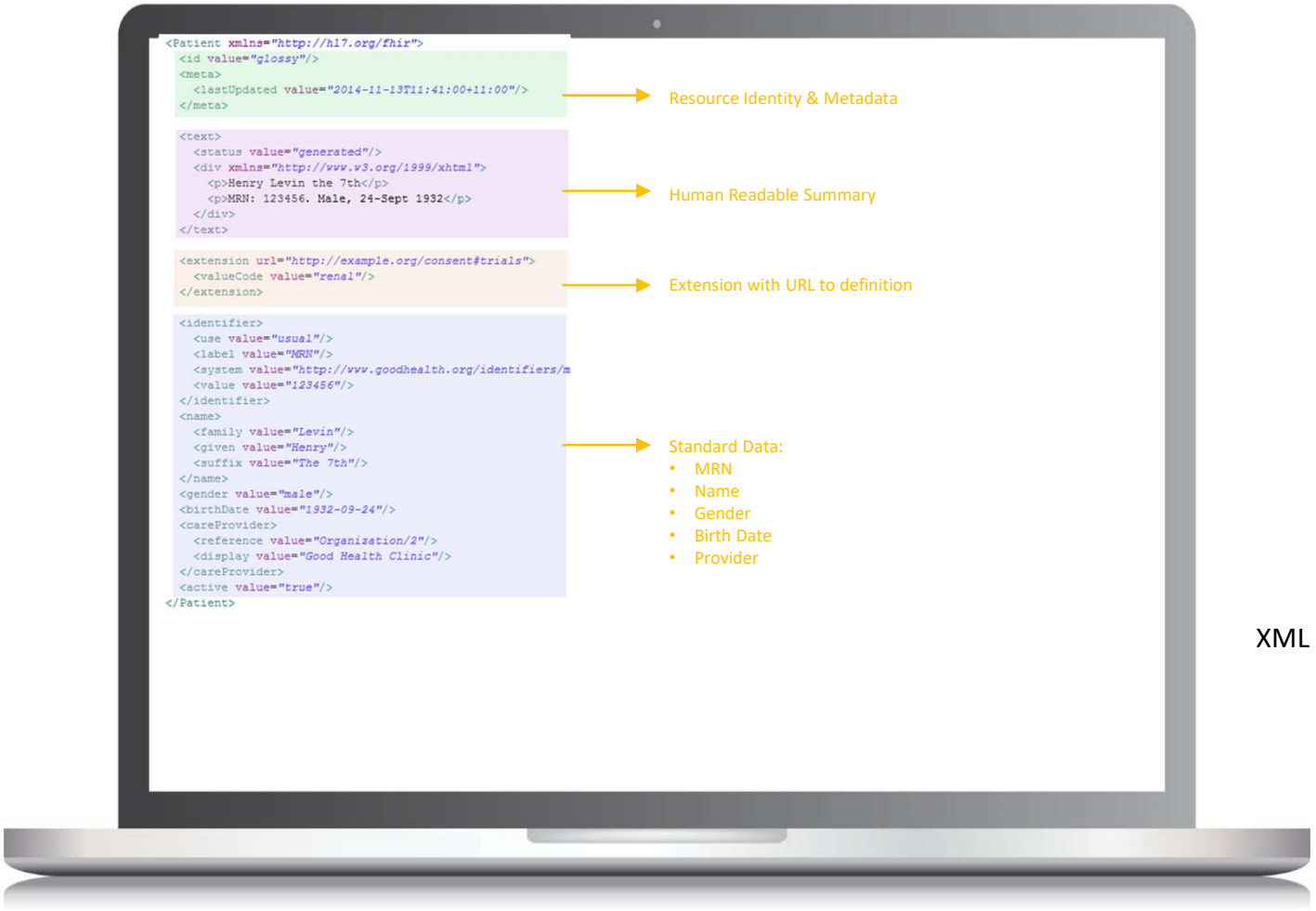
BodySite

ImagingStudy

ImagingObjectSelection

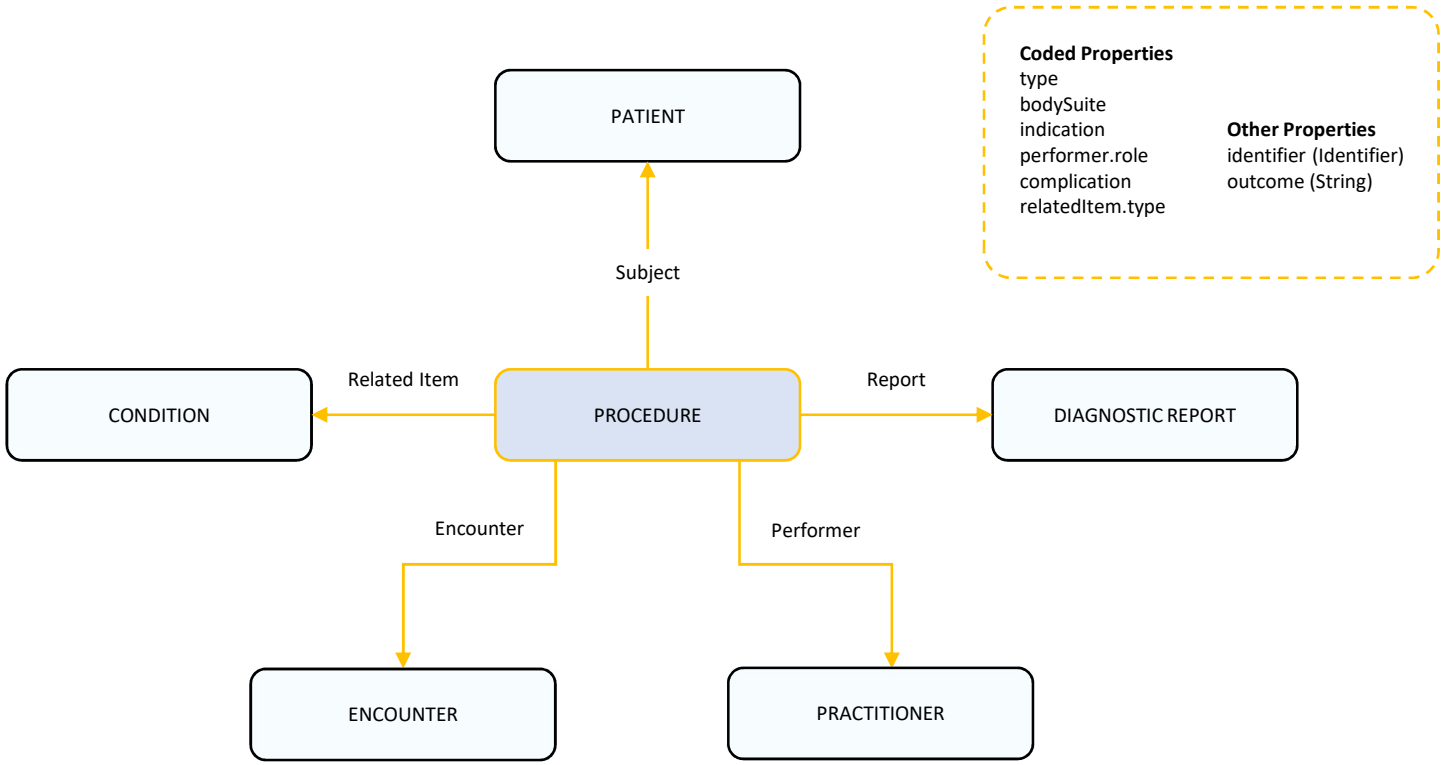
Maturity Model

FHIR the basics | Resource example



XML and JSON

FHIR the basics | References between resources

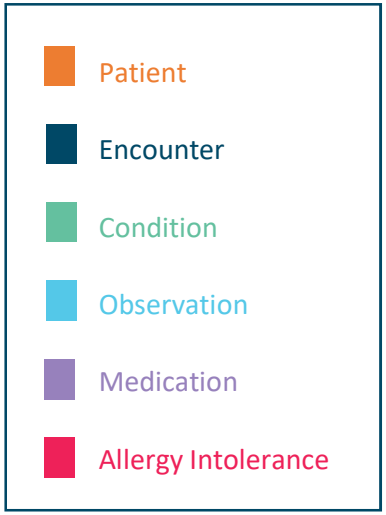


FHIR the basics | Recording a consultation

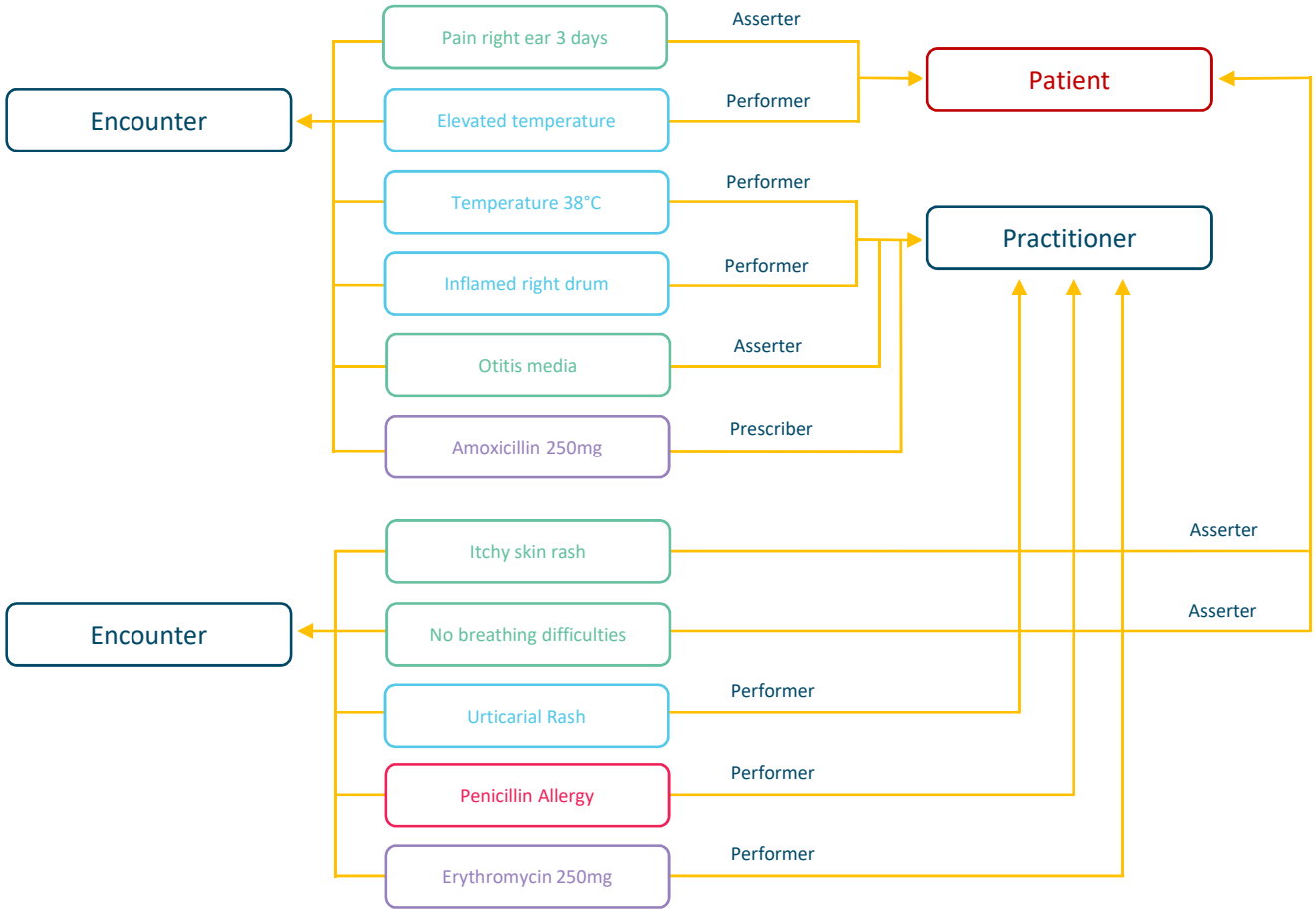
12-year-old-boy

First consultation
Complaining of **pain in the right ear for 3 days** with **an elevated temperature**. On examination, temperature **38°C** and an **inflamed right eardrum** with no perforation. Diagnosis **Otitis Media**, and prescribed **Amoxicillin 250mg 3 times per day for 7 days.**

Follow up consultation
2 days later returned with an **itchy skin rash**. No **breathing difficulties**. On examination, **urticarial rash** on both arms. No evidence meningitis. Diagnosis of penicillin **allergy**. Antibiotics changes to **Erythromycin 250mg 4 times per day for 10 days.**



As linked resources…



STRUCTURED AND CODED DATA

Why have structured / coded data

- Structured vs Coded
- Coded:
  - Improves UI possibilities
  - Improves exchange
  - ‘Secondary’ uses
    - Allows Decision Support
    - Population health

FHIR the basics | Resource example

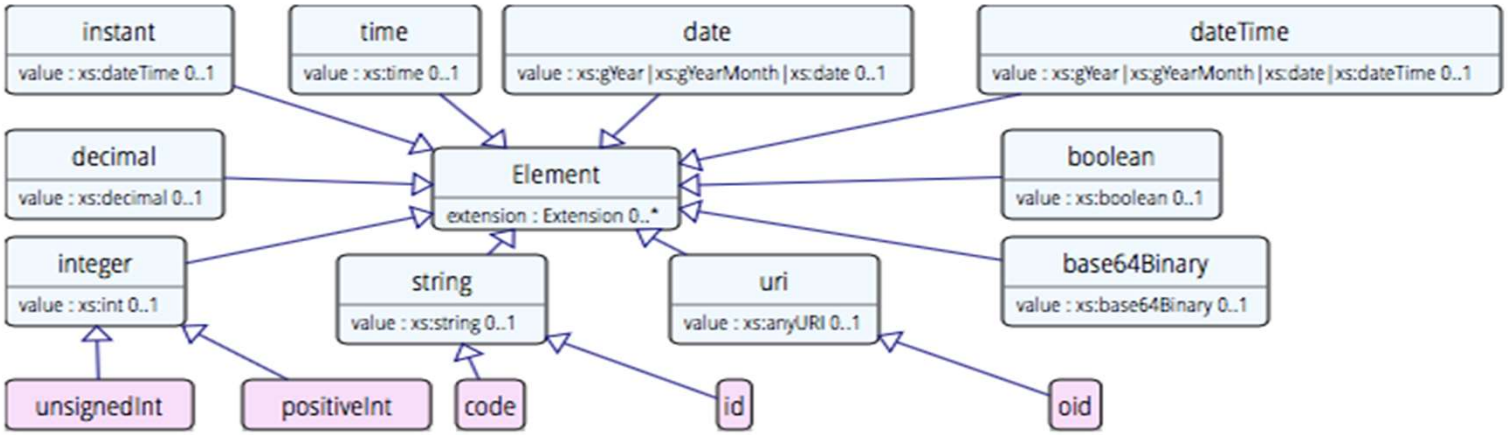
XML and JSON

Resource structure

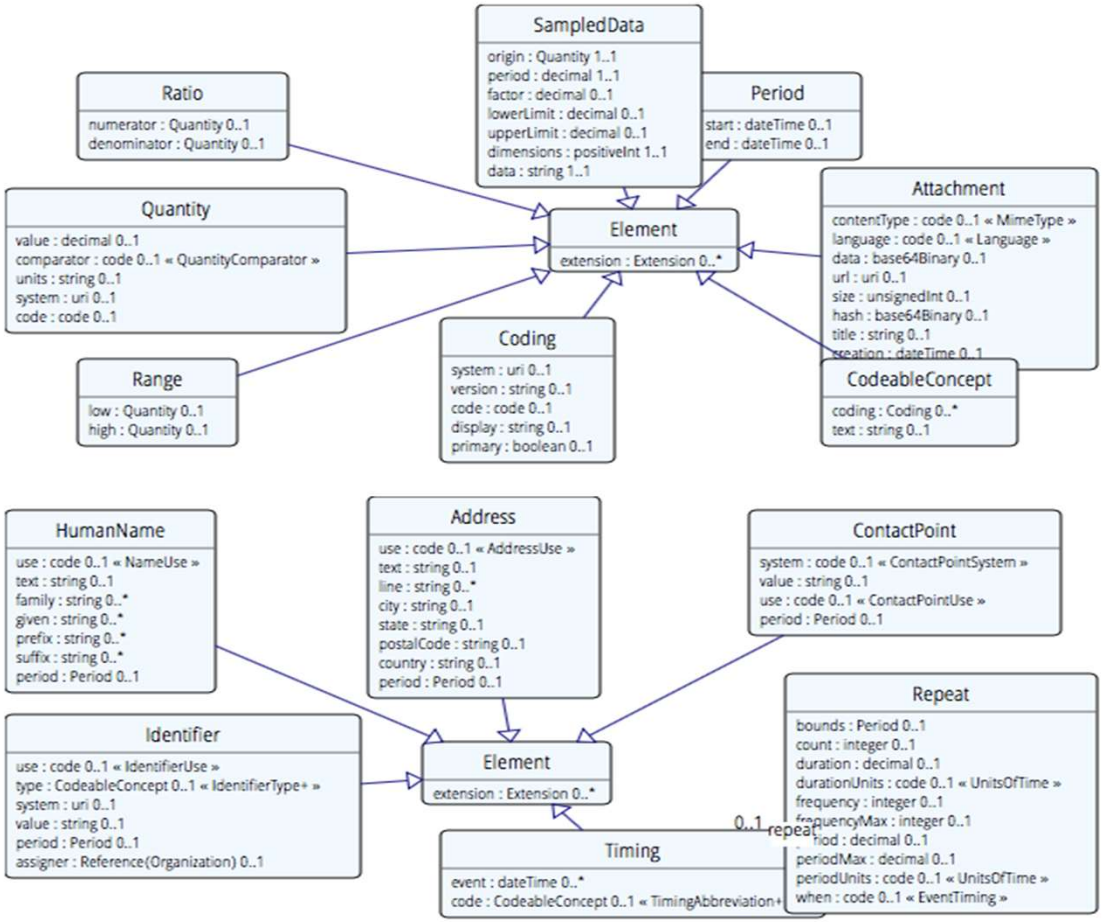
Name	Flags	Card.	Type	Description & Constraints
Patient			DomainResource	Information about an individual or animal receiving health care services Elements defined in Ancestors: id, meta, implicitRules, language, text, cont
identifier	Σ	0..*	Identifier	An identifier for this patient
active	?! Σ	0..1	boolean	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	Addresses for the individual
maritalStatus		0..1	CodeableConcept	Marital (civil) status of a patient Marital Status Codes (Extensible)
multipleBirth[x]		0..1		Whether patient is part of a multiple birth
multipleBirthBoolean			boolean	
multipleBirthInteger			integer	
photo		0..*	Attachment	Image of the patient
contact	I	0..*	BackboneElement	A contact party (e.g. guardian, partner, friend) for the patient *+ SHALL at least contain a contact's details or a reference to an organizatio*
relationship		0..*	CodeableConcept	The kind of relationship v2 Contact Role (Extensible)

Data types: Primitive

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



Data types: Complex



Datatypes

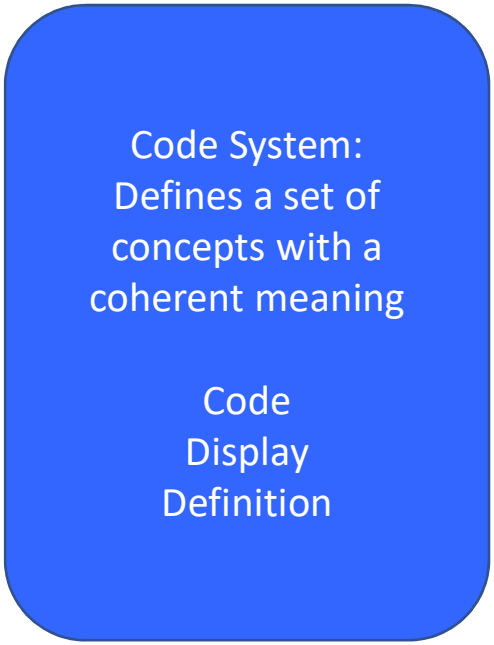
- Review datatypes in spec
  - Start from resource
- Datatypes in resource definition
  - Backbone element
  - ‘choice’ data types
- Identifiers
- Review coded data
  - ValueSet binding

Coded datatypes

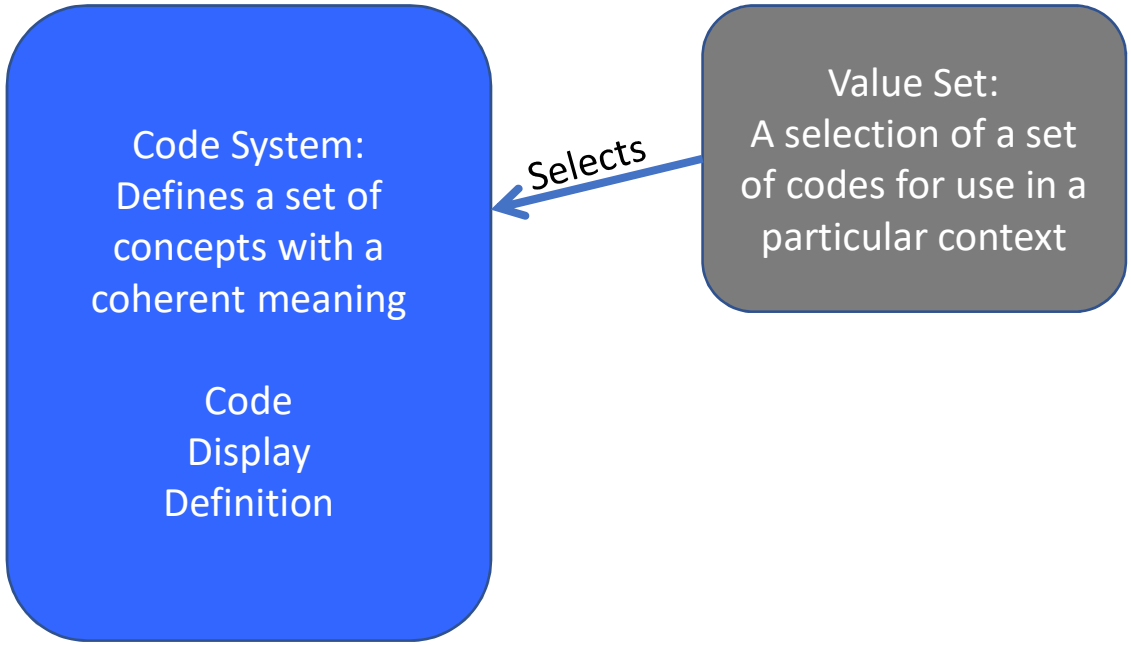
- Code: "status" : "confirmed"
- Coding: {
  "system": "http://www.nlm.nih.gov/research/umls/rxnorm",
  "code": "C3214954",
  "display": "cashew nut allergenic extract Injectable"
  }
- CodeableConcept: {
  "coding": [{
  "system": "http://snomed.info/sct",
  "code": "39579001",
  "display": "Anaphylactic reaction“
  }],
  "text" : "Anaphylaxis"
  }

Terminology Sub-system

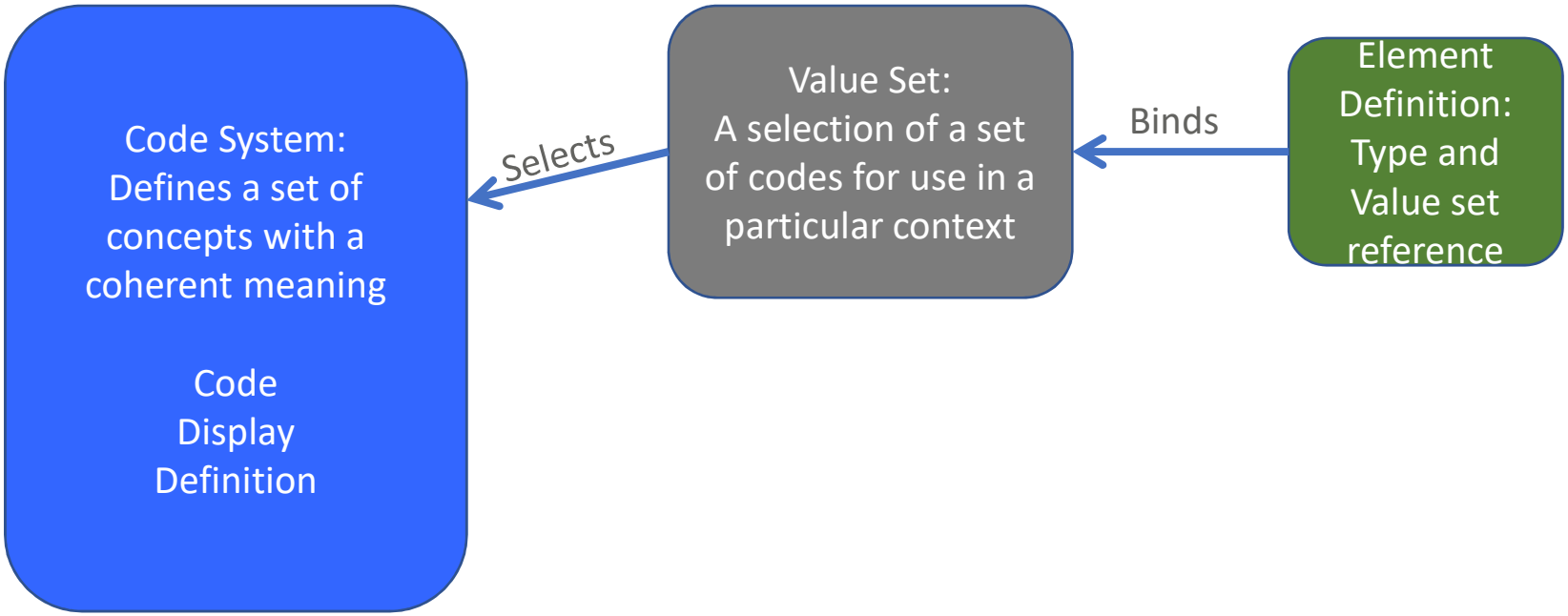
- SNOMED CT / LOINC / RxNORM
- ICPC, MIMS + 100s more
- ICD-X+
- A drug formulary
- Custom



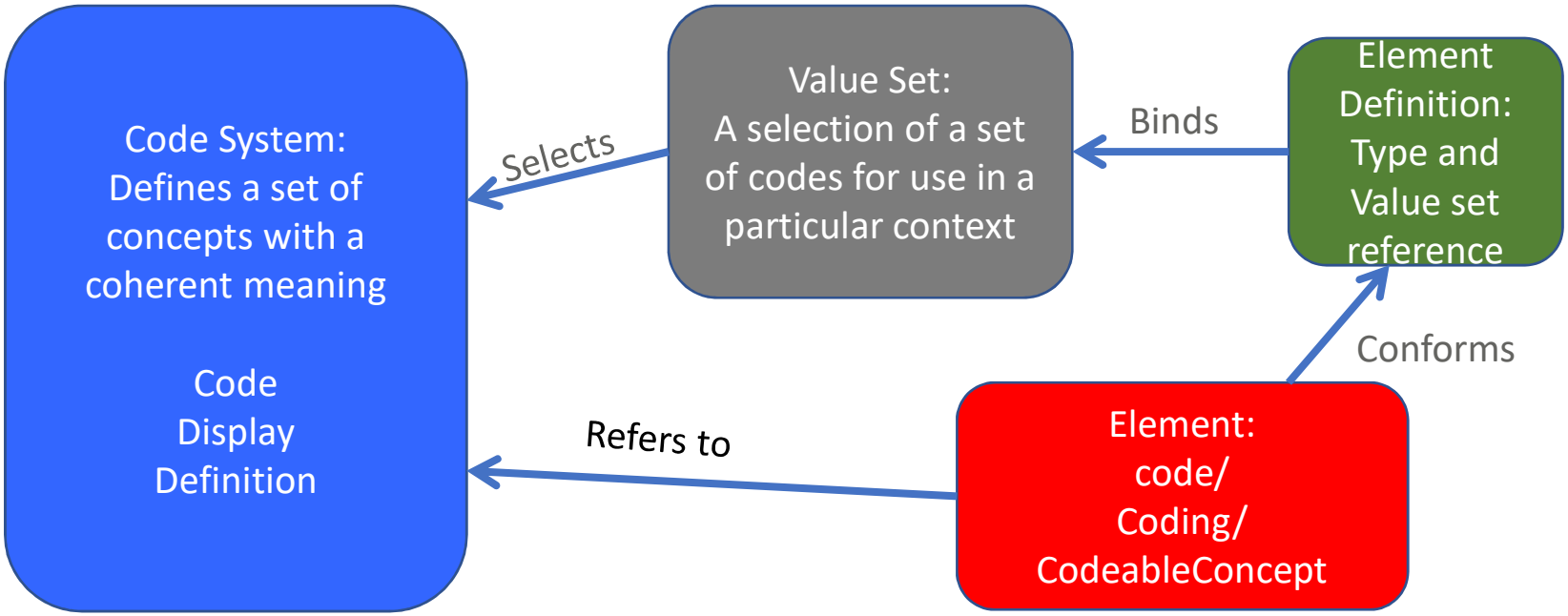
Terminology Sub-system



Terminology Sub-system



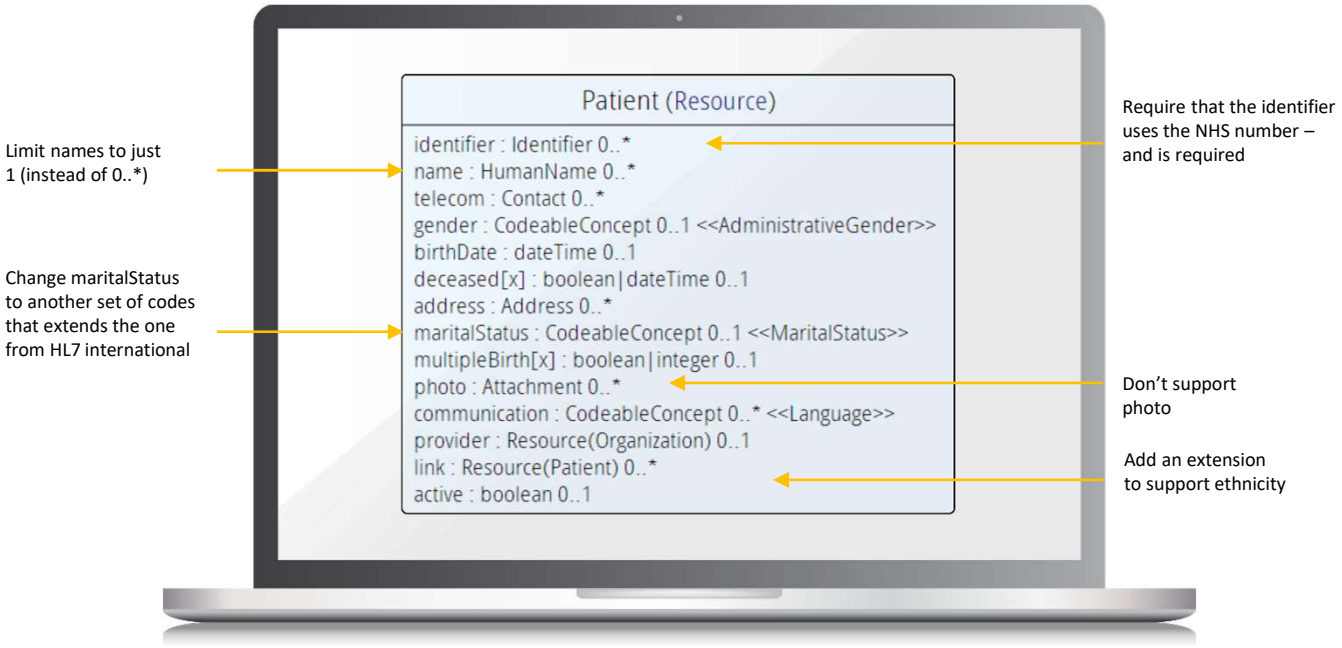
Terminology Sub-system



Adapting FHIR to your needs: Profiling

- Many different contexts in healthcare, but want a single set of Resources
- Need to be able to describe ‘usage of FHIR’ based on context
- Allow for these usage statements to:
  - Authored in a structured manner
  - Published in a registry & Discoverable
  - Used as the basis for validation, code, report and UI generation.
- 3 main aspects:
  - Constraining a resource - remove element, change multiplicity fix values
  - Change coded element binding
  - Adding a new element (an extension)
- Profiling adapts FHIR for specific scenarios

For example…



Note: Limited mandatory elements in the core spec

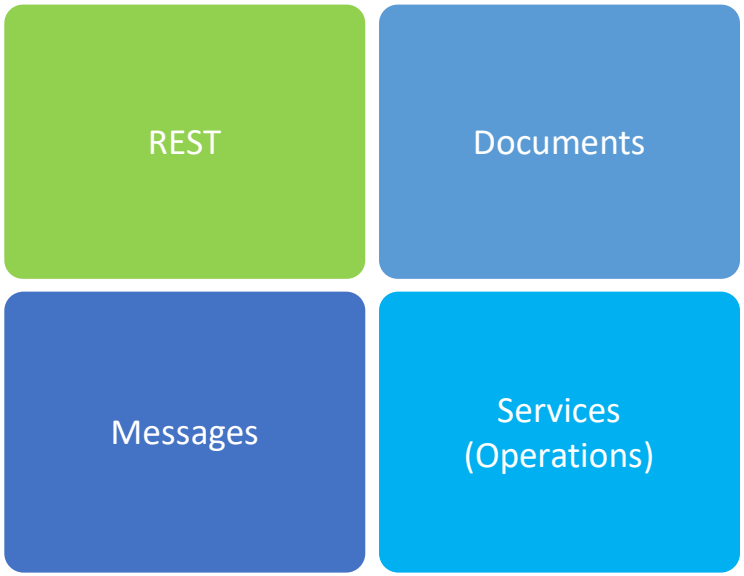
The ‘profile’

- Defined by StructureDefinition resource
  - Same as used for core resources
- Defines each element
  - Path, name, dataType, binding, multiplicity. mapping & much more
  - Including allowable extension points
- Can use Forge tooling to build
  - clinFHIR (and others) for learning/viewing
- US Core (was DAF)
  - http://hl7.org/fhir/us/core/index.html

Extension Definitions

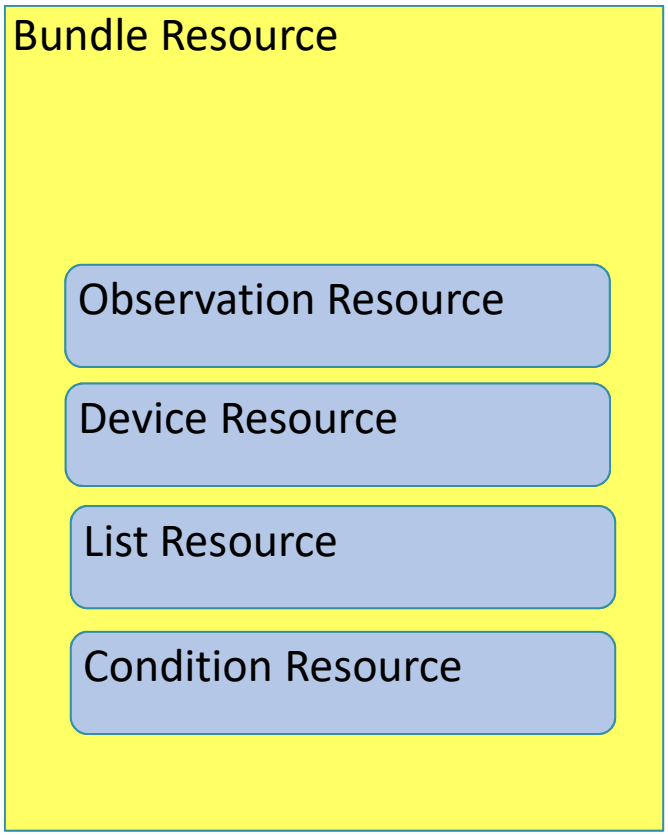
- Also a StructureDefinition
  - Defines the content of a single extension
- Simple or Complex
- Definition:
  - Available on the web
  - Canonical Url
    - Resolvable or Registry
- In resource instance:
  - Reference to Url
  - Extension or ModifierExtension

Exchange Paradigms



Bundles

- Container resource
- Types of Bundle
  - Searchset
  - Transaction
  - Document
  - Message
  - …



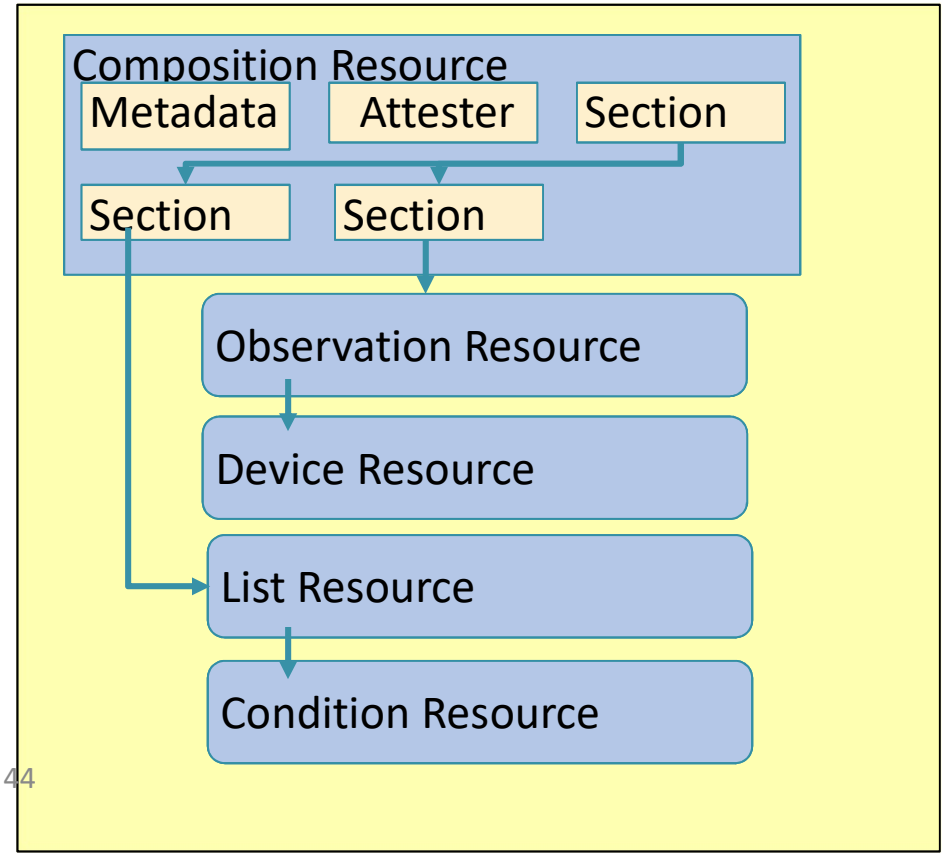
REST (API)

- “Representational State Transfer” – an architecture for how to connect systems in real time
- Uses HTTP/S
- Simple to use
- Very commonly used outside of healthcare – especially mobile
- For simple interactions
  - Create
  - Read (& Query)
  - Update
  - Delete
- A lot of tooling / experience available

Document paradigm

- Summary at a point in time
- Part of record
- Very common
- CDA
  - CDA on FHIR

Documents – are bundles

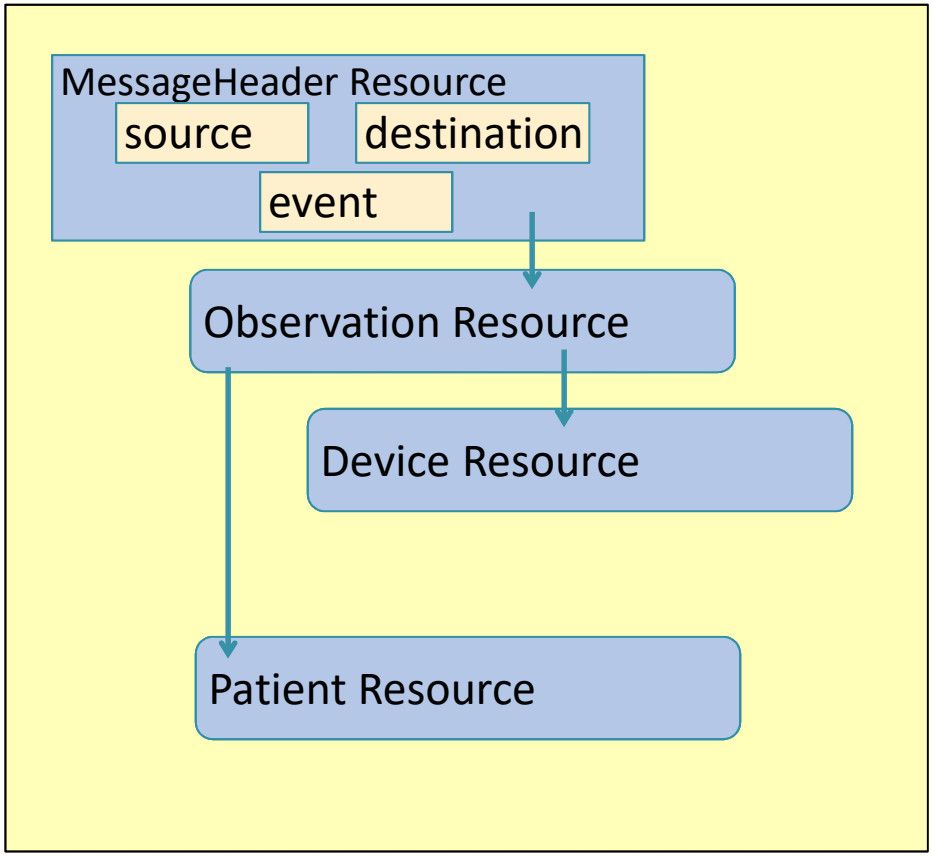



```
<Bundle>
  <entry>
      <Composition />
  </entry>
  <entry>
      <Observation />
  </entry>
  <entry>
      <Device />
  </entry>
  <entry>
      <List/>
  </entry>
  <entry>
      <Condition/>
  </entry>
</Bundle>
```

Messaging paradigm

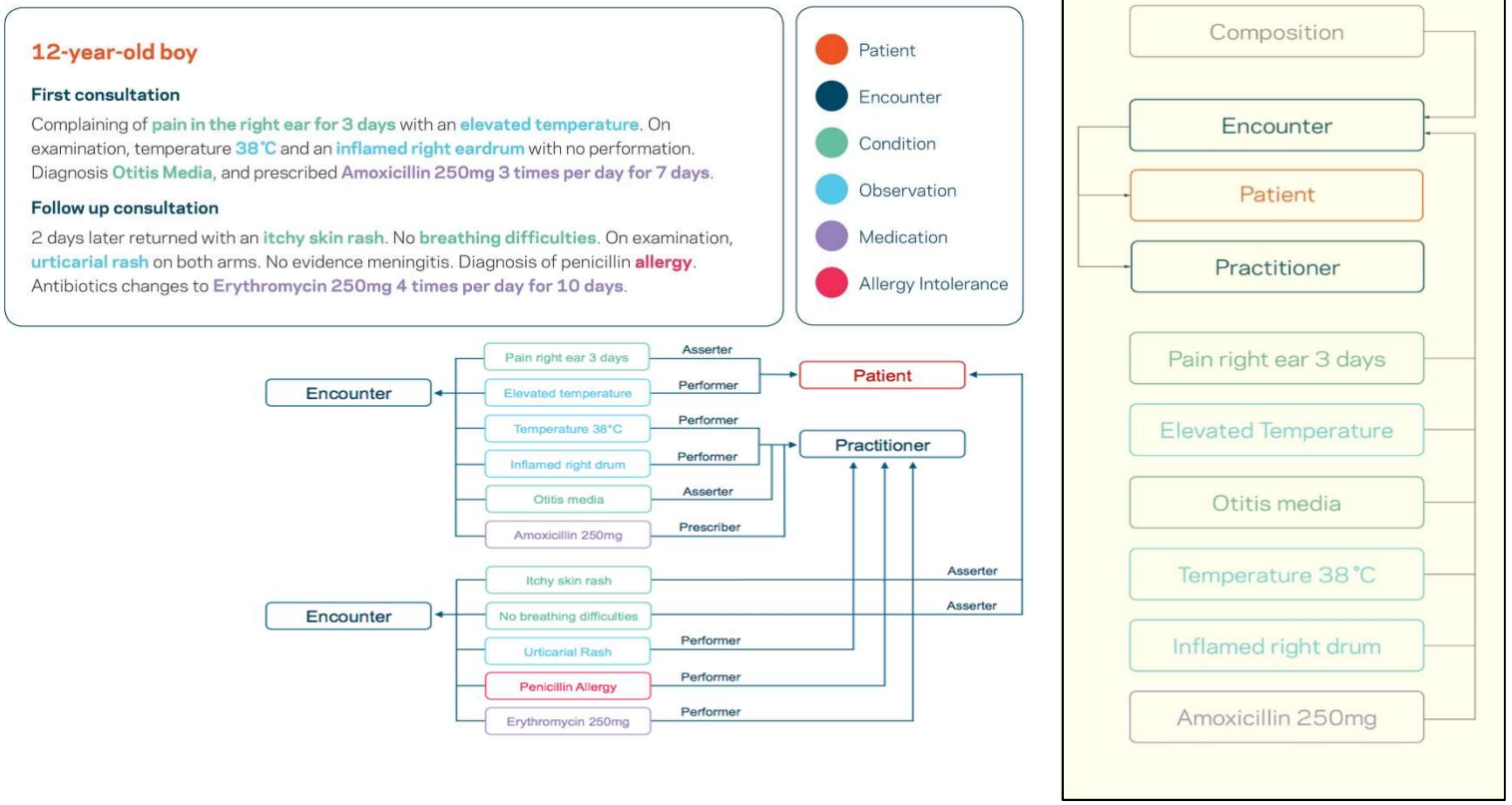
- Notification or instruction
- Not part of record
- HL7 v2
  - Good match with FHIR
    - Though implementations less common
- Work in progress

Messages – are bundles




```
<Bundle>
   <entry>
        <MessageHeader />
   </entry>
   <entry>
        <Observation />
   </entry>
   <entry>
        <Patient />
   </entry>
   <entry>
        <Device />
   </entry>
</Bundle>
```

Documents and Messages



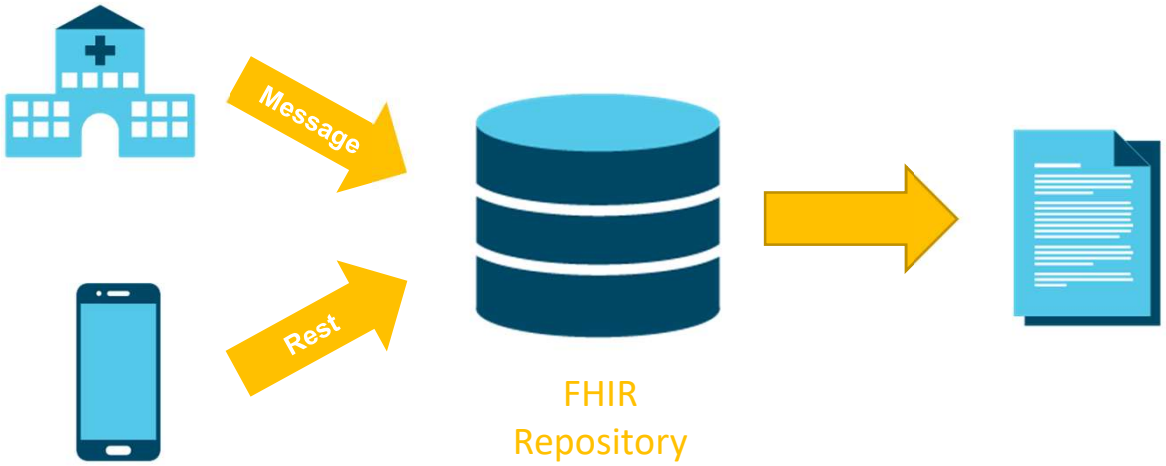
Services / Operations

- For more complex server side logic
- Can be Real-time
- Key part of ecosystem
- E.g.
  - Prescribing with Decision Support
  - Terminology
  - Immunization protocols

FHIR Operations

- When more complex server logic required than simple CRUD
  - Midway between REST & SOAP
- Some defined in spec. e.g.:
  - Get all data for a patient
  - Expand/filter terminology
  - CDS services
- Can define custom services
  - Still using FHIR resources
  - Resources to define / inputs

Regardless of paradigm, the content is the same



THE ECOSYSTEM

An ecosystem

- A digital ecosystem is a distributed, adaptive, open socio-technical system with properties of self-organisation, scalability and sustainability inspired from natural ecosystems.

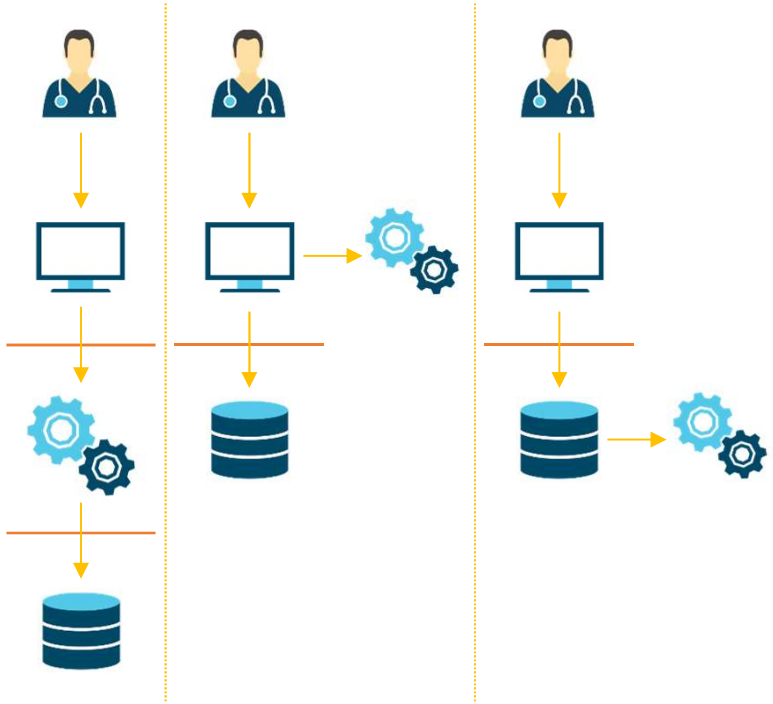
Wikipedia

Components


Terminology
Decision Support
Workflow
Services Directory
Conformance
Provider/Patient Registry
FHIR API and Resources
Repository
Authorisation

Security

- FHIR is not a security standard
  - Leverages existing standards – for example
    - TLS
    - OAuth2
- Support in the specification
  - Security tags (metadata)
  - Specialized resources
    - Provenance
    - AuditEvent
- More detail
  - http://hl7.org/fhir/security.html



More information

- From HL7
  - http://hl7.org/fhir/index.html
  - wiki.hl7.org/index.php?title=FHIR
  - http://www.fhir.org/
- Community
  - https://chat.fhir.org/
  - List server (fhir@lists.hl7.org)
  - Stack Overflow (tag FHIR)
- Blogs
  - www.healthintersections.com.au/
  - https://fhirblog.com/
  - https://thefhirplace.com/
  - https://brianpos.com
- Libraries
  - Java (http://hapifhir.io/)
  - C# (NuGet HL7.FHIR)
- Tooling
  - Forge (http://fhir.furore.com/Forge)
  - http://clinfhir.com/
- Test servers
  - http://wiki.hl7.org/index.php?title=Publicly_Available_FHIR_Servers_for_testing
  - https://fhirblog.com/2016/10/19/setting-up-your-own-fhir-server-for-profiling/

Questions?