BCS Introduction to FHIR

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Ewout Kramer, David Hay, Josh Mandel, Brett Marquard
et al.

Who are HL7 UK?

- HL7* is a standards body - like BSI, or ISO

- We produce FHIR

- HL7 UK is the UK branch of HL7 International

  – We are the UK "Affiliate", as it is known. https://www.hl7.org.uk

- We are an organisation consisting of our members

  – see https://www.hl7.org.uk/register/why-join

- All volunteers. A not for profit organization/ We do pay our admin staff occasionally ;-)

* Why is it called HL7? Back in the day exchange systems had 7 layers, from hardware, up to software, hence we are Health Level 7

FHIR!

Background to FHIR

Requirements for healthcare interoperability

- Has been a need to share healthcare information electronically for a long time

- Increasing pressure to broaden scope of sharing

  – Across organizations, disciplines, even borders

  – Mobile, Device & Cloud-based applications

- Faster – integration in days or weeks, not months or years

What we have – HL7 V2 (aka "HL7")

- Works relatively well within institutions

- But

  – Legacy, custom syntax (learning curve, tools)

  – Messaging design limits architectures

  – Doesn't scale well across organization boundaries

  – Security/privacy infrastructure is minimal

  – A potpourri of segments and fields with no means to distinguish the common from edge case
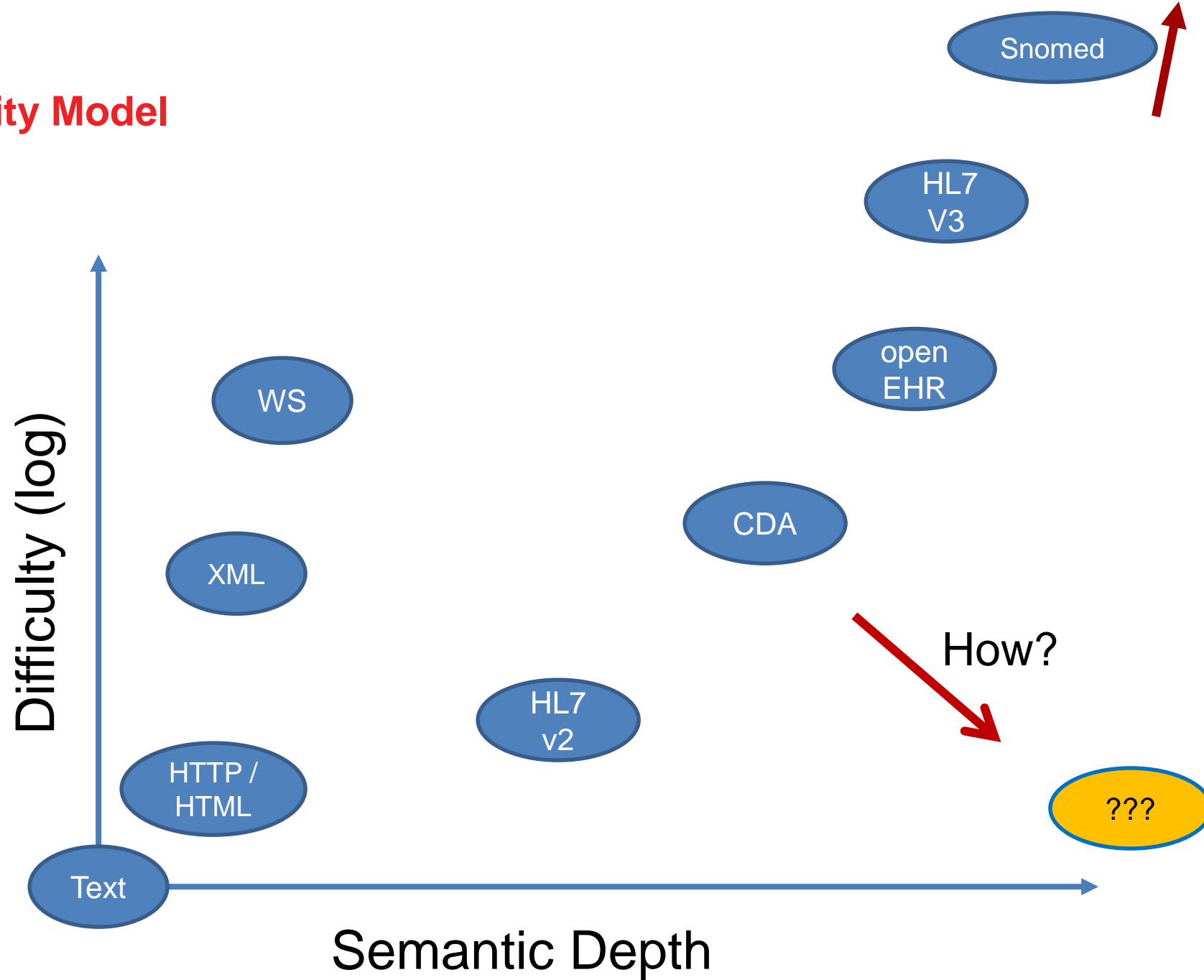
What we have – HL7 V3

- Newer technology and semi-robust reference model, but

    - Steep learning curve

        - Primary implementations by those with £££s

    - No inter-version wire compatibility

    - International specifications are too abstract, regional implementations don't interoperate

- As used in English national program (millions of V3 messages flow every day)

What we have - CDA

- Broad implementation, human-to-human interoperability, but:

    – Still a very steep learning curve

    – Interoperability beyond a human-to-human level is still a challenge, even with templates

    – Document architecture doesn't fit all problems

    – Still a diversity of implementations

    – Extensibility is difficult

Complexity Model

Difficulty (log)

Semantic Depth

Snomed

HL7 V3

open EHR

WS

CDA

XML

How?

HL7 v2

HTTP / HTML

???

Text

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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 in one slide

- Fast Healthcare Interoperability Resources

- New free and open healthcare data API

- Builds on simplicity of HL7 V2

- With modern (web) standards

    – JSON, HTTP, REST

    – Familiar to new generation of developers

- Easy to implement the basics, getting rapid take up

- hl7.org/fhir

FHIR in one bullet

FHIR is:

- a set of JSON (and/or XML) health data resources, plus a REST API for accessing them

Who's working with FHIR?

- Microsoft, IBM, Google, Amazon, Apple

- All the major healthcare system vendors

- Over 20000 participants on the FHIR Implementer's chat

  - http://chat.fhir.org

- 86 countries involved so far (source: Grahame Grieve, DevDays, June 2023)

The Goals of FHIR

- Implementer Focus

- Target the 80% (common stuff)

- Use today's web technologies

- Support human readability

- Paradigm & architecturally agnostic

- Open Source

Implementer Focus

- Specification is written for one target audience… Implementers

  - Rationale, modeling approaches, etc. kept elsewhere

  - Make the resources simple and easy to understand and use

  - Multiple Implementation tools to help get you started from day 1

    - Publicly available test servers

    - Starter APIs published with spec

      - C#, Java, Javascript etc.

  - Lots and lots of examples (and they're valid too)

Support the 80%

- Focus on scenarios that the implementers ask for

- Decision to include content into the core specification:

    – "We only include data elements if we are confident that most normal implementations using that resource will make use of the element" (80% rule)

- Other content is included through creation of extensions

Support "Common" Scenarios: Example: FHIR Address (before)

- isNotOrdered, updateMode, flavorId, nullFlavor, controlAct root & extension, validTime low and high, useable **period** (low, high) (GTS – no room on the slide), **use**

  - **home**, primary home, vacation home, **work**place, direct, public, bad, physical, postal, **temp**orary, alphabetic, ideographic, syllabic, search, soundex, phonetic, old

- 0..* parts, each with:text

  - value, code, code system, code system name, code system version, language, type:

    - address **line**, additional locator, unit identifier, unit designator, delivery address line, delivery installation type, delivery installation area, delivery installation qualifier, delivery mode, delivery mode identifier, street address line, building number, building number numeric, building number suffix, street name, street name base, street type, direction, intersection, care of, census tract, **country**, county or parish, municipality**city**, delimiter, post box, precinct, **state** or province, postal code**zip**, delivery point identifier

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- ~~0..* parts, each with:~~text

    – ~~value, code, code system, code system name, code system version, language, type:~~

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Support "Common" Scenarios: Example: FHIR Address (after)

- period (low, high)

- use

  – home, work, temp, old

- text

  – line, country, city, state, postalCode

Web Technologies

- Same technologies that drive Google, Facebook & Twitter

  – HTTP

  – DataTypes W3C complaint

  – XML, JSON, RDF

  – REST API

  – HTTPS, OAuth2, etc. for security functions

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Open Source

- Unencumbered – free for use, no membership required (but encouraged :-)

- 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

Free!

But what can I do with it?

- Expose data from your system (and/or consume data from other systems)

- FHIR is a blueprint for a healthcare data exchange mechanism

- Your system internals, data model, database, will probably never be FHIR (SQL probably)

- But you can build a FHIR REST façade, and walk and talk FHIR (open source toolkits exist)

- Or, if you are lucky enough to be "greenfield", start with a cloud FHIR data server (Microsoft, Google etc, open source) and build your app around it.

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FHIR RESOURCES

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 and outside of HL7
    - HL7: version 2, version 3 (RIM), CDA
    - Other SDOs: openEHR, CIMI, ISO 13606, IHE, DICOM

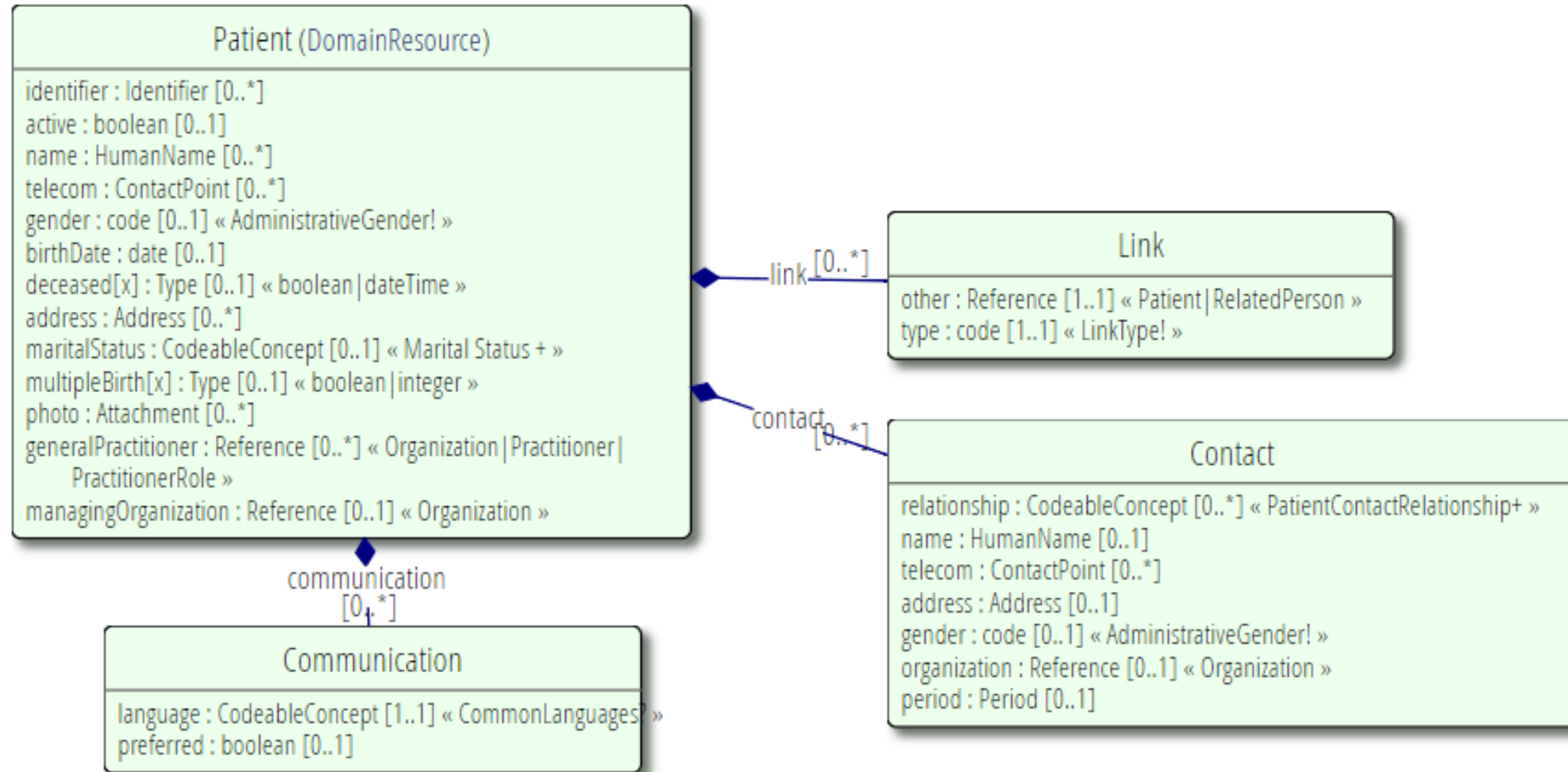# FHIR Resources

What makes a resource?

Examples

- Administrative
  - Patient, Encounter, Organization, Location
- Clinical Concepts
  - Condition, AllergyIntolerance, Procedure, CarePlan, Medication
- Infrastructure
  - Composition, MessageHeader, CapabilityStatement

Patient resource in JSON

```json
{
    "resourceType": "Patient",
    "text": {
        "status": "generated",
        "div": "<div xmlns='http://www.w3.org/1999/xhtml'><p>Harley Hobbs</p>...."
    },
    "identifier": [{
        "use": "official",
        "label": "SSN",
        "system": "http://hl7.org/fhir/sid/us-ssn",
        "value": "1"
    }],
    "name": [{
        "use": "official",
        "family": ["Hobbs"],
        "given": ["Harley"]
    }],
    "birthDate": "1966-06-07",
    "address": [{
        "use": "home",
        "text": "16 Pier Road, Salisbury, SY4 7IW",
        "line": ["16 Pier Road"],
        "city": "Salisbury",
        "zip": "SY4 7IW"
    }]
}
```
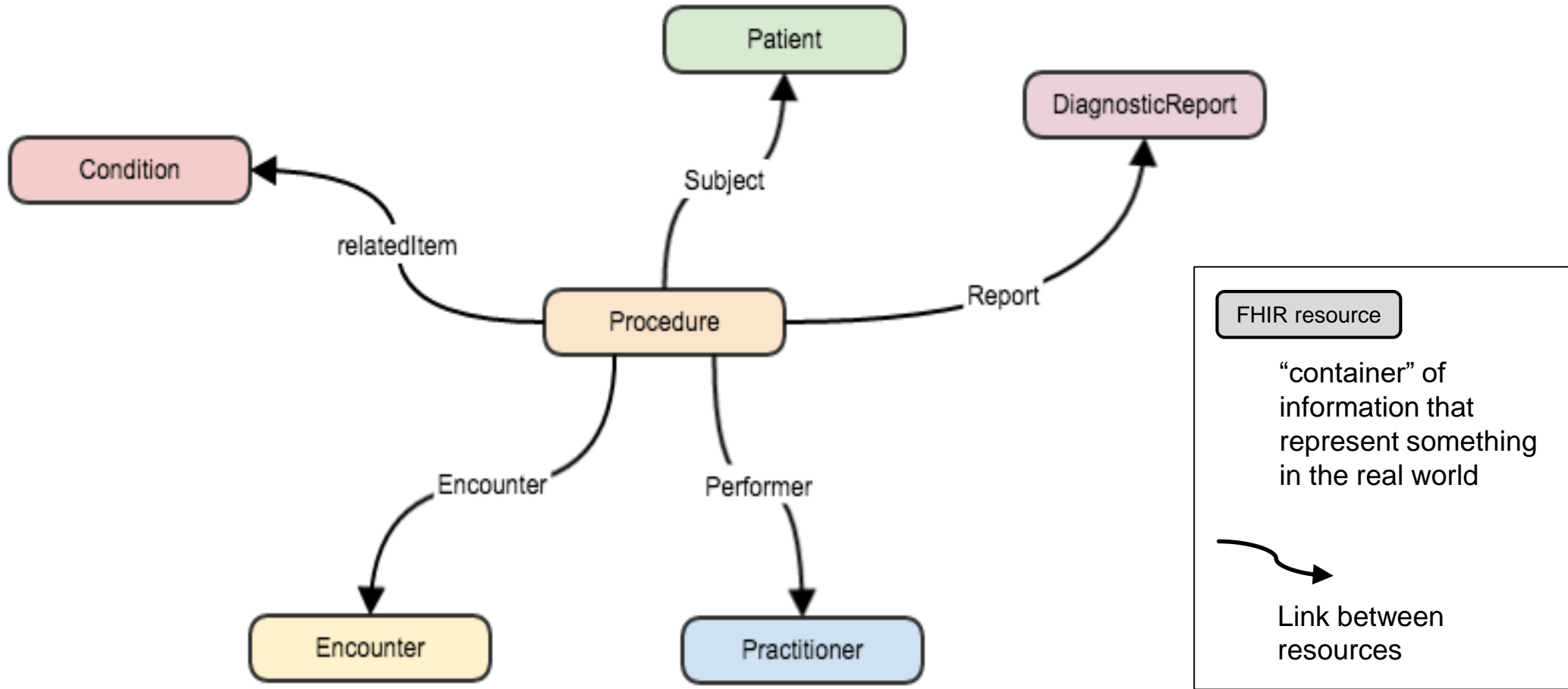
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Resource Definitions

Connecting Resources

- Resources are independent – don't need other resources to correctly interpret a resource

- But a single resource doesn't say very much, but a collection of resources taken together creates a useful clinical record.

Connecting Resources

A Resource's id

resource type
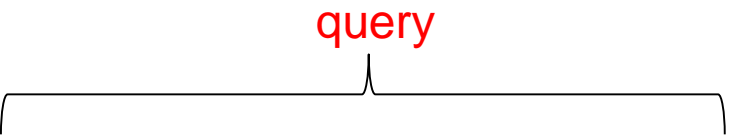
https://server.org/fhir/Patient/1234

endpoint

id

Note: This URL resolves to the current version of a resource
It's also specific to a server

Search is also via URL

query

```
https://.../Patient/search?name=Smith
```

This URL searches patient resources.

FHIR DEMO

fhirtest.com

FHIR PROFILES

Localised FHIR

- FHIR does - necessarily - have flexibility

- It lets you use any identifier, it lets you use different terminologies (codes)

- But in a given context you will probably want to lock these down

- Perhaps to mandate patient identifier = NHS number, or CHI number

  – or perhaps to have no number at all - if you want an anonymous research database

- So you have to decide how to use FHIR

- FHIR calls this selection process "profiling"

FHIR Profiling

- When we do some profiling (chose what parts of FHIR to use), we create FHIR "profiles"

- e.g. UK Core is a FHIR "Implementation Guide" – which is a set of FHIR profiles

- An "IG" is just a document that advises, or perhaps mandates, what projects do:

  – "Use this part of FHIR, in this way".
    "Use these codes and these extensions".
    "Don't use these other parts".

- It creates a local "flavour" of FHIR

- But it does not change FHIR itself, it is just a selection process (pic'n'mix).
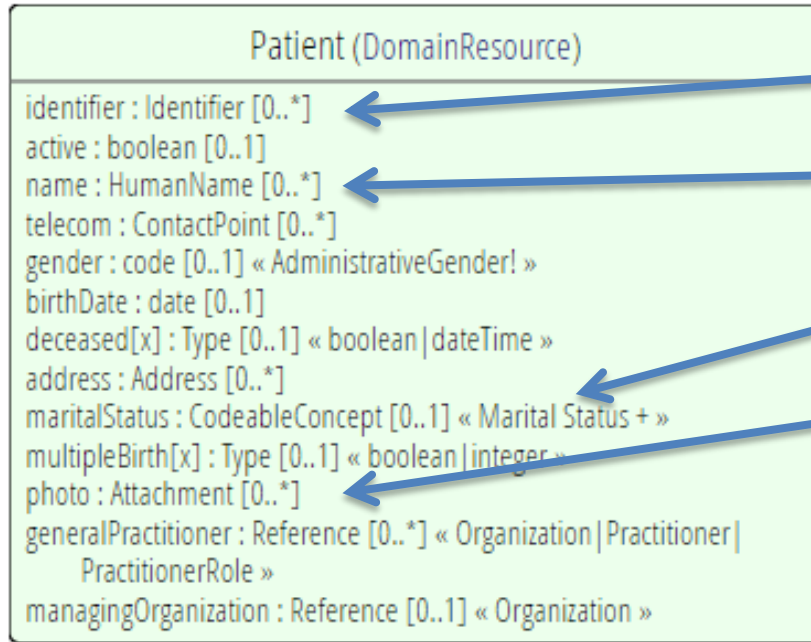
Quick Profiles FAQ

- So - I need profiles to use FHIR?

- In fact no, not necessarily

- FHIR exists regardless of any profiles. You can just use it now.

- But profiles help you, because they are someone's idea of what specific bits of FHIR you need. Someone who knows about your context.

- They guide you to certain parts of FHIR

- But that FHIR is always there already, and so are the other parts, if you choose to use them

- You still need to make your own choices!

The need for Profiles

- Profiles aren't mandatory for interoperability, but they improve the ability to achieve it

- Profiles never change meaning of the data

- The data means the same with or without the profile

  - The profile is a selection process, a sub-setting

  - Which bits of FHIR are we using on this project

  - You can check that data matches the profile, automatically

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Profiling a Patient resource

Original resource

List of constraints in the profile

Patient (DomainResource)

identifier : Identifier [0..*]
active : boolean [0..1]
name : HumanName [0..*]
telecom : ContactPoint [0..*]
gender : code [0..1] « AdministrativeGender! »
birthDate : date [0..1]
deceased[x] : Type [0..1] « boolean|dateTime »
address : Address [0..*]
maritalStatus : CodeableConcept [0..1] « Marital Status + »
multipleBirth[x] : Type [0..1] « boolean|integer »
photo : Attachment [0..*]
generalPractitioner : Reference [0..*] « Organization|Practitioner|
     PractitionerRole »
managingOrganization : Reference [0..1] « Organization »

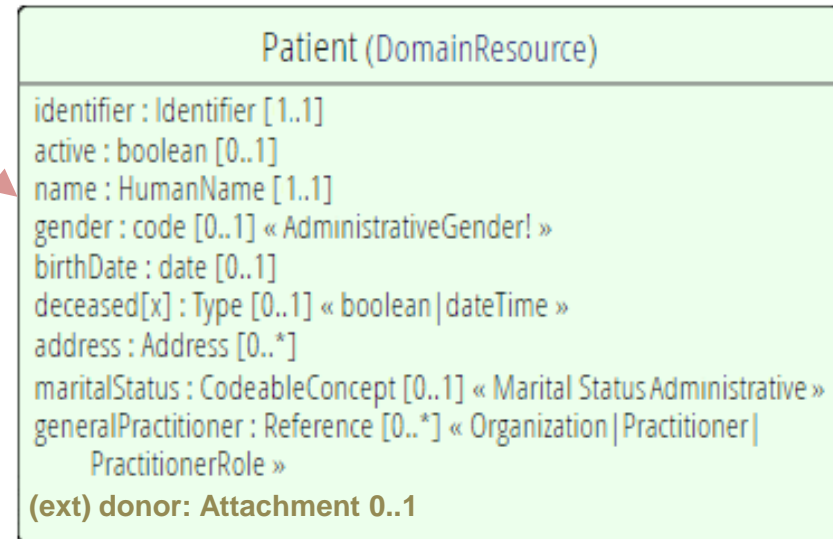The identifier must present and must be the NHS number

Limit names to just 1 (instead of 0..*)

Limit maritalStatus to another set of codes that extends the one from HL7 international

Constrain out "photo" [0..0], etc.

Add an extension to support "donor consent"

Note: hardly any mandatory elements in the core spec

Patient (DomainResource)

identifier : Identifier [1..1]
active : boolean [0..1]
name : HumanName [1..1]
gender : code [0..1] « AdministrativeGender! »
birthDate : date [0..1]
deceased[x] : Type [0..1] « boolean|dateTime »
address : Address [0..*]
maritalStatus : CodeableConcept [0..1] « Marital Status Administrative »
generalPractitioner : Reference [0..*] « Organization|Practitioner|
     PractitionerRole »
(ext) donor: Attachment 0..1

Profiled resource

Profiling – UK Core Patient

https://simplifier.net/guide/uk-core-implementation-guide?version=1.0.0

So what is a FHIR profile again?

- FHIR is set of data structures and exchanges

- Profiles are a way to document how to use FHIR in a given context

- UK Core is a set of FHIR profiles, from HL7 UK

- "Core" means it's a starting point

IMPLEMENTING FHIR

The FHIR ecosystem

- FHIR is more than a standard API.

- There are a huge amount of tools, open source, cloud platforms, forums, events etc.

- FHIR is for data exchange.

- Let's start with reading data, in REST mode

- But where to look?

Public FHIR servers

- https://confluence.hl7.org/display/FHIR/Public+Test+Server

- Open and free servers, test data

- Can use a browser (e.g. clickable demo at fhirtest.com)

- Or use

    – Postman, hoppscotch.io, insomnia.rest, MS Code REST plugin

    – Curl – command line tool

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Reading Data

- You can browse, and debug, with Postman etc.

- But FHIR is about machine-to-machine interop, and direct reading of data

- There is open source code for that in C#, Java, JavaScript, Swift, Python, Ruby, PHP, Dart/Flutter...

- http://hl7.org/fhir/downloads.html

- And also

https://confluence.hl7.org/display/FHIR/Open+Source+Implementations

Implementing FHIR – C# Code Example (FHIR Client)

```csharp
var client = new FhirClient
      (new Uri("http://fhir.example.com/fhir"));

var patEntry = client.Read<Patient>("12345");
var pat = patEntry.Resource;
var restId = patEntry.Id;
var tags = patEntry.Tags;

pat.Name.Add(HumanName.ForFamily("Kramer").WithGiven("Ewout"));

client.Update<Patient>(patEntry);
```

Implementing FHIR – C# (Firely)

- https://github.com/FirelyTeam/fhir-net-api

- The official support API for HL7 FHIR on the Microsoft .NET (dotnet) platform

- Provides:

    - Class models (POCOs) for the FHIR data model

    - JSON and XML parsers and serializers

    - FHIR compliant REST Client

    - Validation engine supporting FHIR Implementation Guides and Profiles

    - FHIRPath expression engine

Implementing FHIR – Java Code Example (FHIR Client)

```java
FhirContext ctx = FhirContext.forDstu3();
String serverBase = "http://fhirtest.uhn.ca/baseDstu3";

IGenericClient client = ctx.newRestfulGenericClient(serverBase);

// Perform a search
Bundle results = client.search()
      .forResource(Patient.class)
      .where(Patient.FAMILY.matches().value("duck"))
      .returnBundle(ca.uhn.fhir.model.dstu3.resource.Bundle.class)
      .execute();

System.out.println("Found " + results.getEntry().size() + " patients
named 'duck' ");
```

Implementing FHIR – Java (HAPI)

- FHIR – Java Reference Implementation

- HL7 Application Programming Interface for FHIR

- http://hapifhir.io & https://github.com/hapifhir/hapi-fhir

- Provides:

    - Open source projects and libraries

    - Feature rich implementation of a FHIR Client and Server

    - Deploys to many open and licensed Servlet Container: Tomcat, JBoss, Websphere, etc.

    - Leverages JPA Server for connection to many backend DBMS'

Servers?

- Any system that allows data to be read in FHIR format, via an API, is a FHIR server

- This means:

    – An HTTP(S) server

    – Receive resource-oriented requests (read, search, create, update, delete)

    – Convert to "native" format (e.g. map to *your* SQL) and fetch/create/update

    – Usually a façade (but native FHIR is possible)

    – More complex than being a client

- Open source for all this too...

Modes - Facade
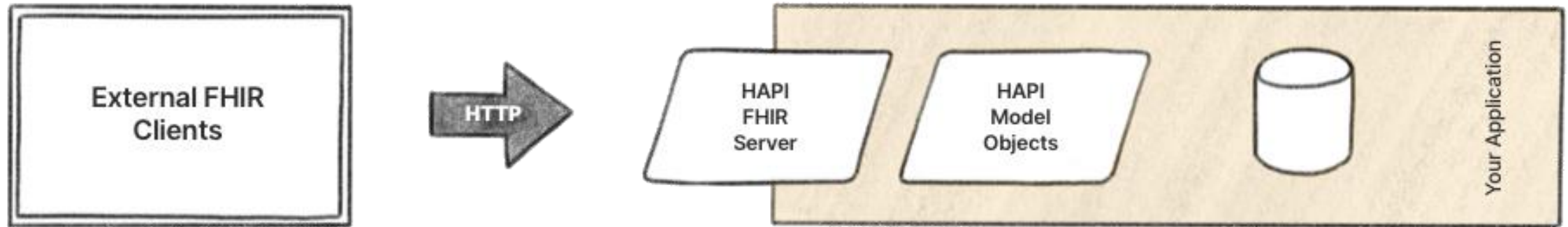
- Use (open source) code to host a server, parse urls, parse JSON/XML, convert to POJOs or POCOs, *convert data/query to your own format*, save data/execute query (then do it all in reverse)

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FHIR test data

- SyntheticMass

  - Simulates the health records of the population of Massachusetts

  - https://synthea.mitre.org/

  - 1 million patient records

  - Realistic FHIR data based on typical disease profiles etc.

  - Also a tool for generating your own data

  - https://github.com/synthetichealth

  - MITRE (also Crucible testing tool, and FSH "FHIR shorthand") is a not-for- profit organization funded by the US Government

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Tools to Visualize FHIR resources

- clinFHIR tool

  - http://clinfhir.com/

  - Educational tool

    - For non-techies (especially clinicians & BAs)

  - Resource Builder

    - View resources

    - Create example data

FHIR viewer app

- vhewer.com

- A front end for any FHIR server

- Visualize multiple resources

- A web page that links to any FHIR server URL, fetches and displays

- https://vhewer.azurewebsites.net/display-fhir?url=https://nprogram.azurewebsites.net/Patient/1

- Or you can paste data and display it

- http://vhewer.azurewebsites.net/display-fhir-paste

FHIR resource URL: https://vhewer.azu

Patient
Name: **Harley Hobbs** (official)
Gender: male
Date of Birth: 1966-06-07
Identifier: 1
Deceased: false
Active: true
Phone: 077 8169 8899 (Use: home)
Address: 16 Pier Road, STANWARDI
Text: 16 Pier Road, STANWARDINE I
General Practitioner
Organization
Identifier: 1
Name: Test Hospital
Contact
Phone: +44 121 123 4567 (Use:
email: reception@testhospital.or
Address: Mindelsohn Way, Birmi

```
<Patient xmlns="http://hl7.org/fhir">
  <id value="1"/>
  <meta>
    <versionId value="1"/>
  </meta>
</Patient>
```

Implementation Assistance

Jira Software

https://jira.hl7.org/

FHIR **Confluence**

https://confluence.hl7.org/

http://stackoverflow.com/questions/
tagged/hl7-fhir

chat.fhir.org ("Zulip")

Next Steps for you

- Read the spec: http://hl7.org/fhir
  Comment on the spec (link on each page)

- chat.fhir.org

- Follow #FHIR on Twitter

- Developer DevDays
    https://www.fhirdevdays.com/

- Shape the specification:

  - Try implementing it

  - Make "ballot" comments

  - Come to a Hack Day

- Official FHIR Training, like this but more, including "hands on" https://www.hl7.org.uk/training-online-courses/

Thank You – Questions?