# HL7 **FHIR** DevDays 2018

HL7® FHIR®

## Introduction to FHIR
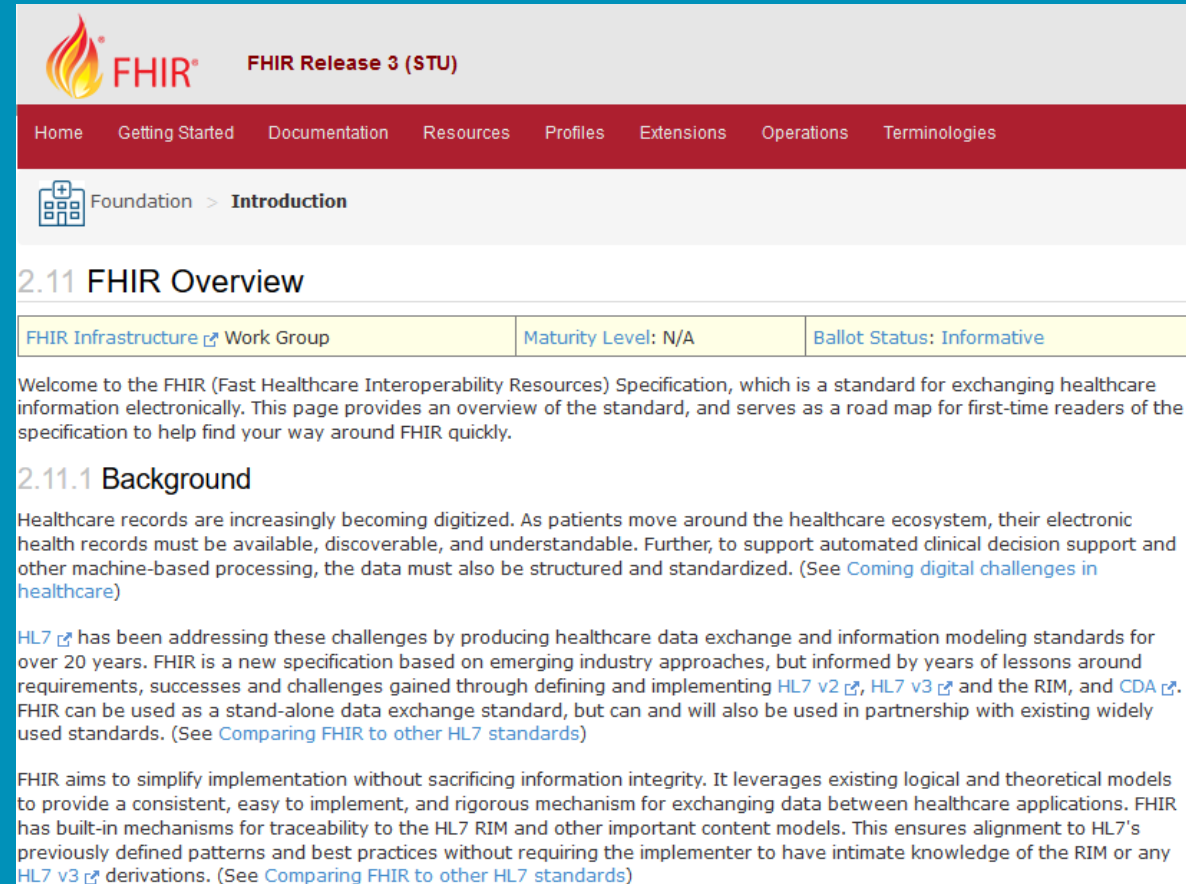
### Rik Smithies, NProgram Ltd., UK

# Who am I?

- Rik Smithies

- Independent Consultant (NProgram Ltd., UK)

- Technical Chair HL7 UK

- FHIR trainer @ HL7 International

- Programmer, (Data) Architect, in health for 20+ years

- rik@nprogram.co.uk

# What is FHIR?

- The latest HL7 standard for exchanging electronic healthcare information
- Defines a simplified approach to implementation w/o sacrificing information integrity
- Defines "Resource" as the basic building block of all exchangeable content
- hl7.org/fhir

# The Acronym

- F – Fast (to design and to implement)
  - Relative – No technology can make implementation as fast we like
- H – Healthcare
  - That's why we're here
- I – Interoperable
  - Ditto
- R – Resources
  - Building blocks (our next focus)

# 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, Pascal, ObjectiveC, Javascript
  - 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 Profiles and Extensions

# Web Technologies

- Same technologies that drive Google, Facebook, Twitter
  - HTTP
  - REST API
  - XML, JSON, RDF
  - Datatypes are W3C compliant
  - HTTPS, OAuth, etc. for security functions

# It's all about the Resources…

- Building blocks…
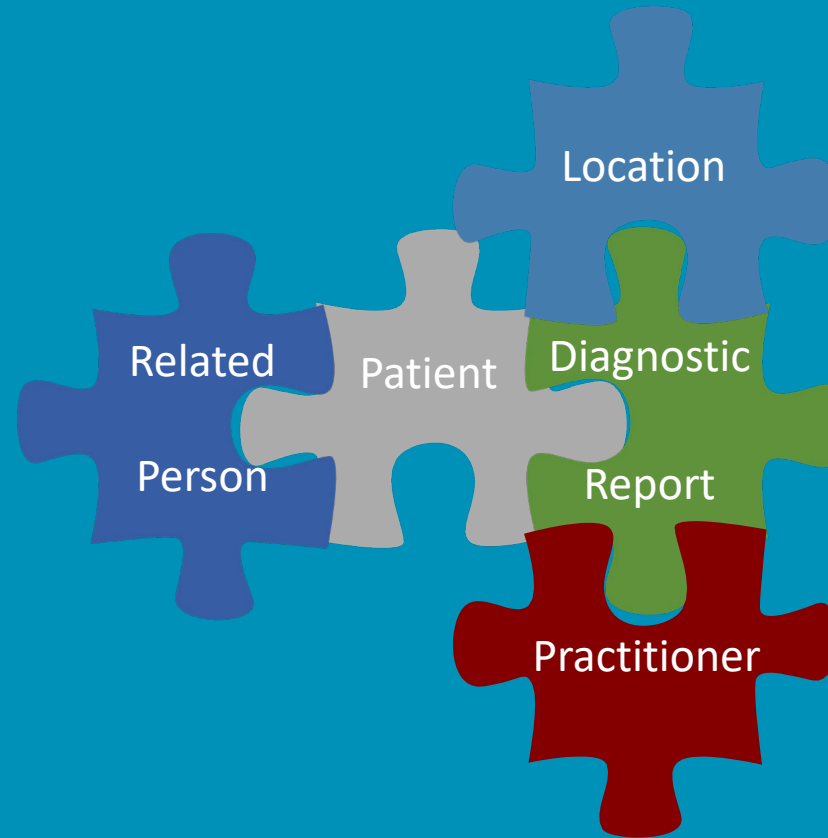
# Resources: What are they?

- 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
- Can be represented in multiple syntaxes: JSON, XML, Turtle
- May include Human-Readable Narrative (XHTML)
- Allow for extensions, and can be profiled

# Resource Definitions



**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 »

**Link**

other : Reference [1..1] « Patient|RelatedPerson »
type : code [1..1] « LinkType! »

link [0..*]

**Contact**

relationship : CodeableConcept [0..*] « PatientContactRelationship+ »
name : HumanName [0..1]
telecom : ContactPoint [0..*]
address : Address [0..1]
gender : code [0..1] « AdministrativeGender! »
organization : Reference [0..1] « Organization »
period : Period [0..1]

contact [0..*]

communication [0..*]

**Communication**

language : CodeableConcept [1..1] « CommonLanguages! »
preferred : boolean [0..1]

# What is a Resource?

**FHIR Resources**

Administrative

Patient, Practitioner, Organization, Location, Group

Clinical Concepts

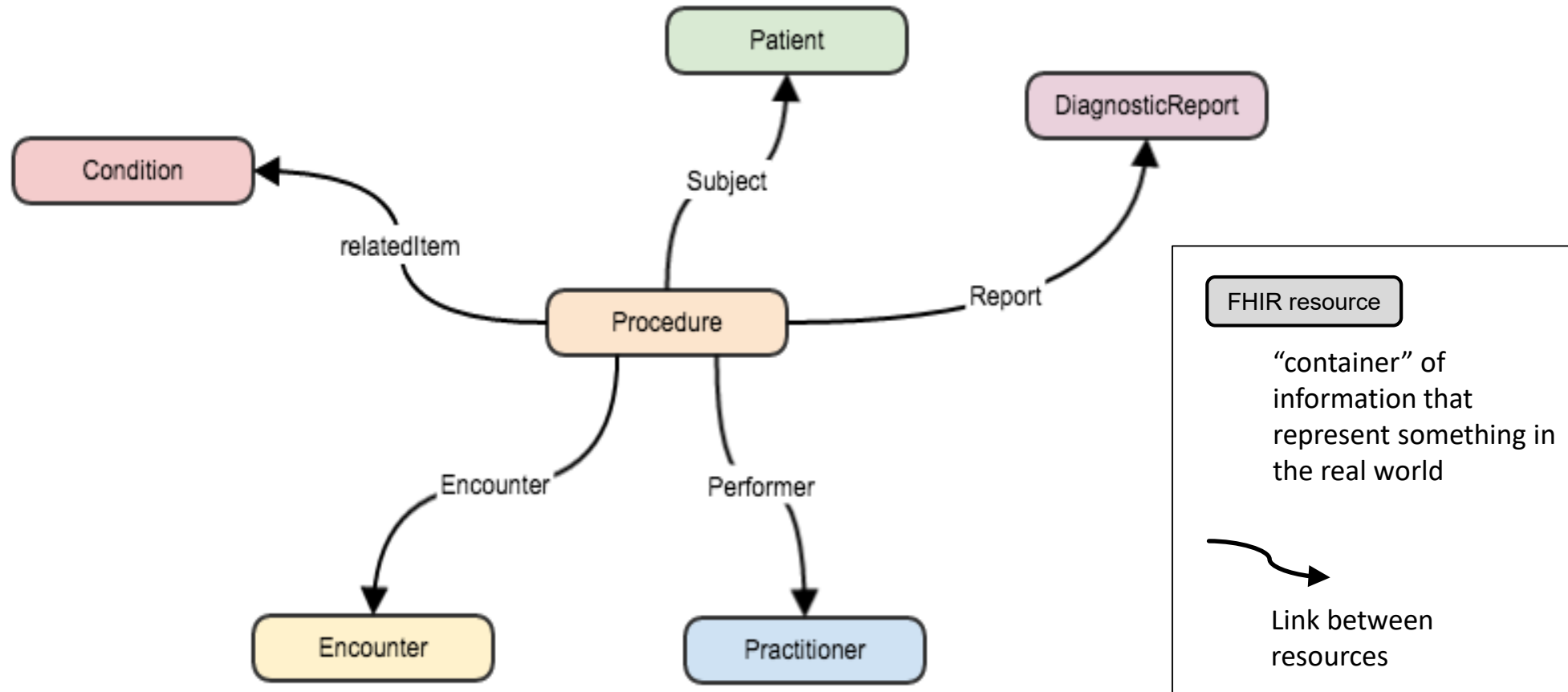AllergyIntolerance, Condition, Encounter, Medication

Infrastructure/Conformance

Composition, MessageHeader, CapabilityStatement

**Not FHIR Resources**

- Gender

  Too small

- Electronic Health Record

  Too big

- Blood Pressure

  Too specific

# Connecting Resources

```xml
<Patient xmlns="http://hl7.org/fhir">
  <id value="1234"/>
  <meta>
    <lastUpdated value="2017-01-14T09:14:33Z"/>
  </meta>

  <text>
    <status value="generated"/>
    <div xmlns="http://www.w3.org/1999/xhtml">
      <p>Henry Levin the 7th</p>
    </div>
  </text>

  <extension url="http://hl7.org/fhir/StructureDefinition/us-core-birthsex">
    <valueCode value="M"/>
  </extension>

  <identifier>
    <use value="usual"/>
    <system value="urn:oid:1.2.36.146.595.217.0.1"/>
    <value value="12345"/>
  </identifier>
  <active value="true"/>
  <name>
    <use value="official"/>
    <family value="Levin"/>
    <given value="Henry"/>
    <suffix value="the 7th"/>
  </name>
  <gender value="male"/>
  <birthDate value="1974-12-25"/>
  <managingOrganization>
    <reference value="Organization/example"/>
  </managingOrganization>
</Patient>
```

FHIR id & metadata

Human Readable Summary

Extension with reference to its definition

Standard Data Content:
- Patient Identity
- Name
- Gender
- Date of Birth
- Provider

```json
{
    "resourceType": "Patient",
    "id": "1234",
    "meta": {
        "versionId": "1",
        "lastUpdated": "2017-01-03T16:05:00.792Z"
    },
    "text": {
        "status": "generated",
        "div": "<div xmlns=\"http://www.w3.org/1999/xhtml\"><p>Henry Levin the
7th</p></div>"
    },
    "extension": [
        {
            "url": "http://hl7.org/fhir/StructureDefinition/us-core-birthsex",
            "valueCode": "M"
        }
    ],
    "identifier": [
        {
            "use": "usual",
            "system": "urn:oid:1.2.36.146.595.217.0.1",
            "value": "12345"
        }
    ],
    "active": true,
    "name": [
        {
            "use": "official",
            "family": "Levin",
            "given": [ "Henry" ],
            "suffix": [ "the 7th" ]
        }
    ],
    "gender": "male",
    "birthDate": "1974-12-25",
    "managingOrganization": {
        "reference": "Organization/example"
    }
}
```
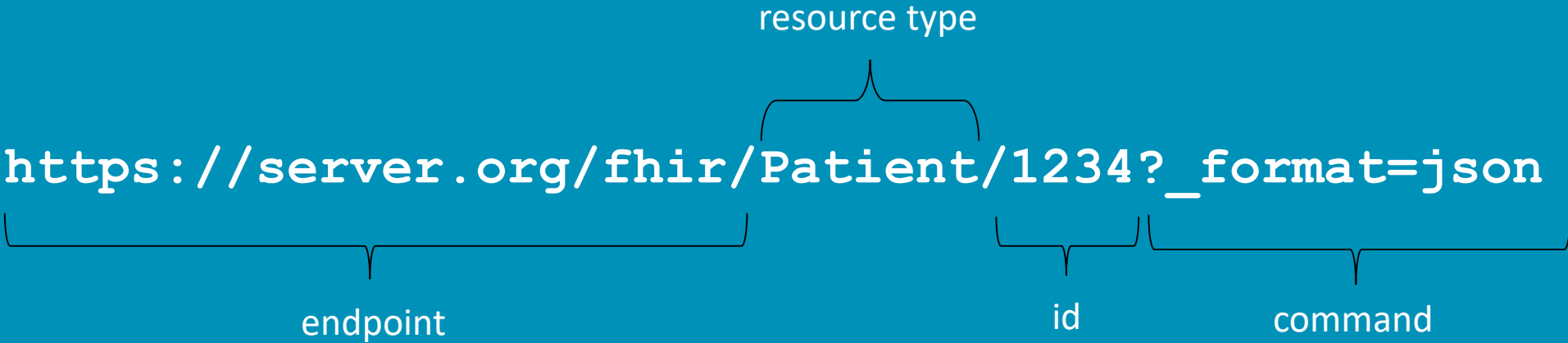
FHIR id & metadata

Human Readable Summary

Extension with reference to its definition

Standard Data Content:
- Patient Identity
- Name
- Gender
- Date of Birth
- Provider

# REST – Data at a location - 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.
May give XML, or JSON, depending on server default

# REST: JSON

resource type

`https://server.org/fhir/Patient/1234?_format=json`

endpoint

id    command

Gets the same patient but returns as JSON instead

# REST: Search

resource type

**`https://server.org/fhir/Patient?name=smith`**

endpoint
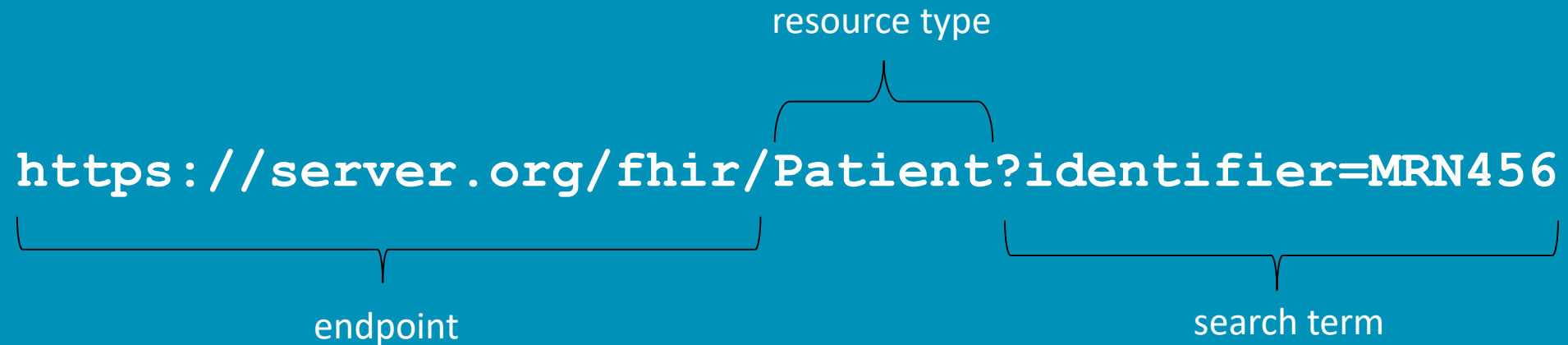
search term

Note – no id specified.
Search terms are pre-defined, for each resource type

# Resource Identifiers

- 2 different 'sorts' of identity
  - "Id" identifies a resource on a (REST) server
    - Is Metadata
    - Will change between servers
  - Identifier
    - Business identifier
    - Is an element in the (core) resource

# REST: Search, by identifier

resource type

**`https://server.org/fhir/Patient?identifier=MRN456`**

endpoint

search term

Note – no id specified, but instead a query, by identifier.
Also possible (not shown here) to specify what *type* of identifier it is.

# Public FHIR Servers for Testing
http://wiki.hl7.org/index.php?title=Publicly_Available_FHIR_Servers_for_testing

- More than a dozen publicly available test servers (and clients)
- Support for multiple FHIR versions (DSTU2, STU3, and current R4 draft/CI)
- Maintained and supported by the FHIR community

# Paradigms

FHIR supports four interoperability paradigms

# REST

- Simple, out-of-the-box interoperability

- Leverages HTTP methods: GET, POST, etc.

- Pre-defined operations
  - Create, Read, Update, Delete
  - Also: History, Read Version, Search, Patch, Validate, Capabilities, Batch & Transaction

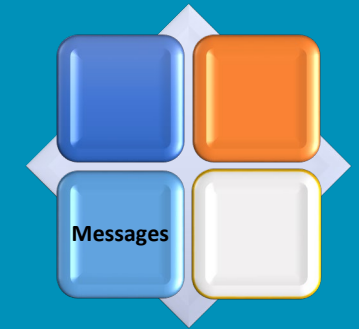- Works best where control resides on client side and a trust relationship exists

# Documents

- Similar to CDA

- Collection of resources bound together
  - Root is a "Composition" resource
  - Just like CDA header

- Sent as a Bundle **(FHIR Resource)**

- Single context

- Can be signed, authenticated, etc.

# Messages

- Similar to v2 and v3 messaging
- Also a collection of resources in a Bundle **(FHIR Resource)**
  - Root is a "MessageHeader" resource
- Allows request/response behavior for both request and response payloads
- Event-driven
  - e.g. Send lab order request, get back result
- Can be asynchronous
  - Requires agreement between partners on protocols and responsibilities

# Service Oriented Architecture (SOA)

Combination of previous paradigms

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

Services

Regardless of **paradigm** the content **is the same**

Receive a lab result in a message…

Lab System

FHIR Message

FHIR (facade) Repository

REST

FHIR Document

National Exchange

…Package it in a discharge summary document
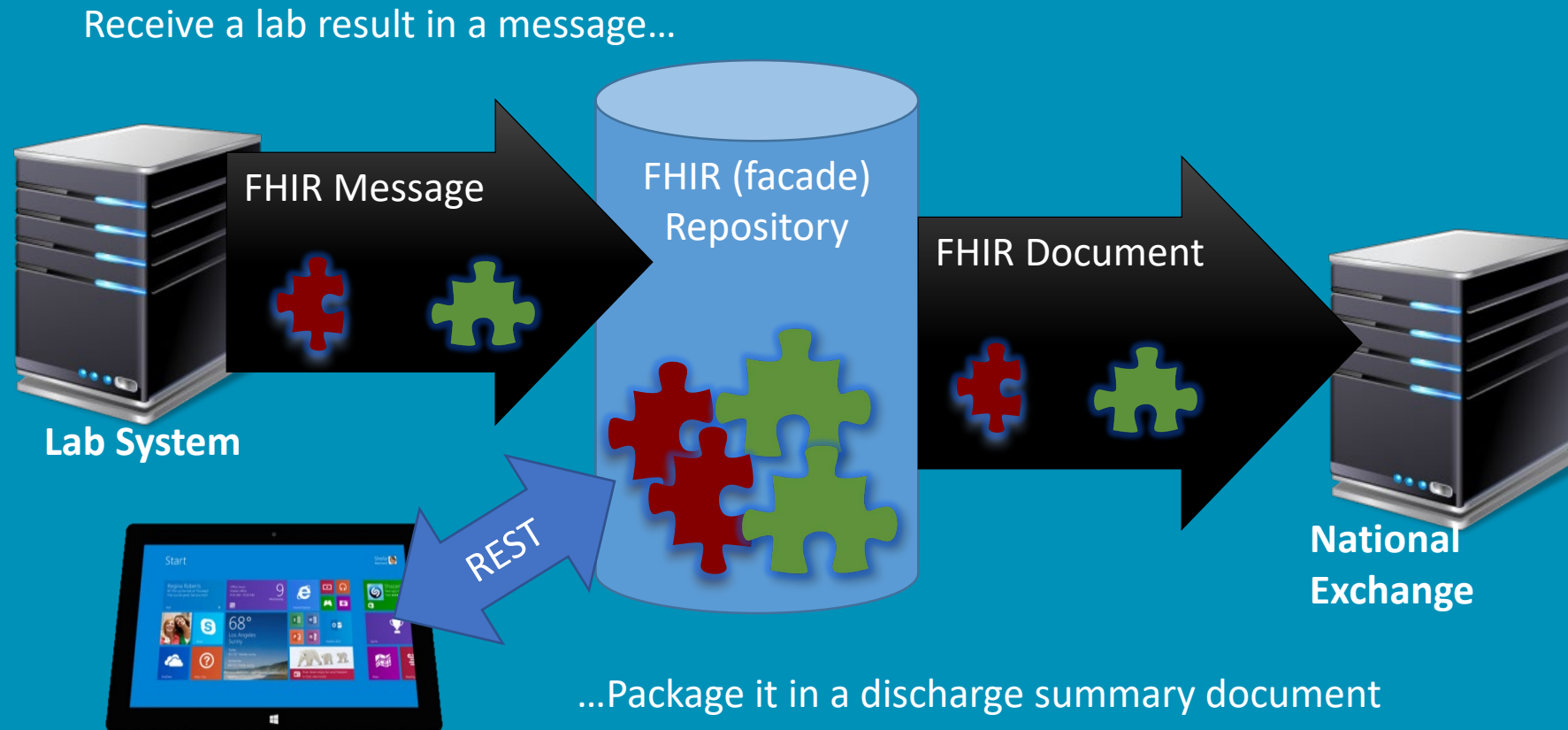
# FHIR Specification (hl7.org/fhir)
## Useful links: Resources, introductions, REST API

# FHIR Publication Directory

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

**FHIR Publication Directory**

## All Published Versions of FHIR

This table provides a list of all the versions of FHIR (Fast Health Interoperability Resources) that are available. See also the directory of FHIR Implementation Guides.

| Date | Version | Description |
|------|---------|-------------|
| **Current Versions** | | |
| Apr 19, 2017 | 3.0.1 | Current Official Published Version *(Currently: Release 3 with 1 technical errata)* |
| (current) | (last commit) | Current Development build (about 30min behind version control, may be incoherent and change rapidly) |
| **R4 sequence** | | |
| Aug 21, 2018 | 3.5.0 | R4 Ballot #2 : Mixed Normative/Trial use (Second Normative ballot + Baltimore Connectathon) |
| Apr 3, 2018 | 3.3.0 | R4 Ballot #1 : Mixed Normative/Trial use (First Normative ballot) |
| Dec 20, 2017 | 3.2.0 | Draft for comment / First Candidate Normative Content |
| **STU 3 sequence** | | |
| Apr 19, 2017 | 3.0.1 | **FHIR Release 3** (STU) with 1 technical errata (Permanent Home) *Technical Errata Archive (zip): v3.0.0* |
| Dec 6, 2016 | 1.8.0 | FHIR STU3 Candidate + Connectathon 14 (San Antonio) |

# RESTful API

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

- The Instance Level, Type Level and Whole System Interactions are listed at the top of the page.

- Clicking on any specific interaction will display the details of that interaction; e.g. update will show all of the FHIR requirements for updating resources.

## 2.21.0 RESTful API

| FHIR Infrastructure ⟋ Work Group | Maturity Level: 5 |
|---|---|

FHIR is described as a 'RESTful' specification based on common industry level use of the term RES part of the core specification, though full Level 3 conformance is possible through the use of exte resource structures and interfaces. This may be considered a violation of REST principles but is k

The following logical interactions are defined:

**Instance Level Interactions**

| read | Read the current state of the resource |
|---|---|
| vread | Read the state of a specific version of the resource |
| update | Update an existing resource by its id (or create it if it is new) |
| patch | Update an existing resource by posting a set of changes to it |
| delete | |

ⓘ hl7.org/fhir/http.html#update

### 2.21.0.10 update

The update interaction creates a new current version for an existing resource or interaction is performed by an HTTP PUT command as shown:

    PUT [base]/[type]/[id] {?_format=[mime-type]}

The request body SHALL be a Resource with an id element that has an identica server SHALL respond with an HTTP 400 error code, and SHOULD provide an Ope ignore the provided versionId and lastUpdated values. If the server supports correct values. Servers are allowed to review and alter the other metadata value that there is no support for updating past versions - see notes on the history int

# Patient - Resource Content

http://hl7.org/fhir/patient.html#resource

- The Structure tab shows the element organization

- The Card. stands for cardinality and defines the min and max occurances of an element

- The Type lists the FHIR data type; e.g. name is of type HumanName. Clicking on HumanName will show its structure

# Data Types

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

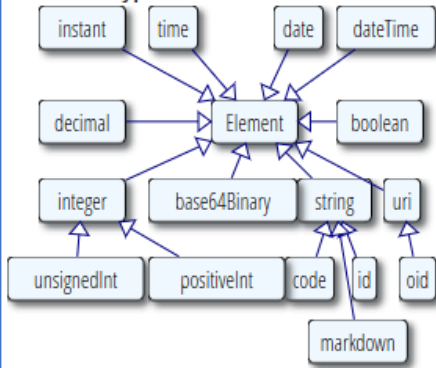- The Primitive and Complex Types are displayed at the top of the page.

- Clicking on any specific data type will display the details of that type; e.g. CodeableConcept will show the structure of that data type.

# FHIR Maturity Model

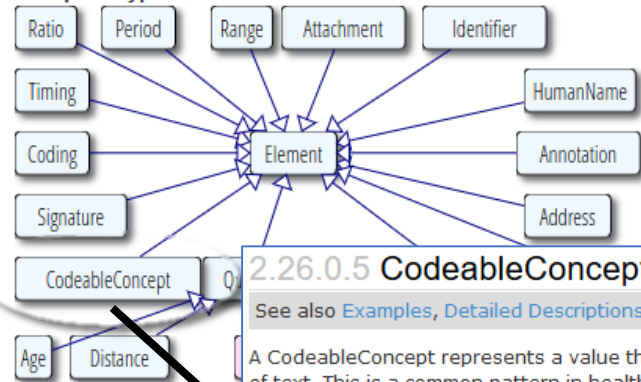http://hl7.org/fhir/versions.html#maturity
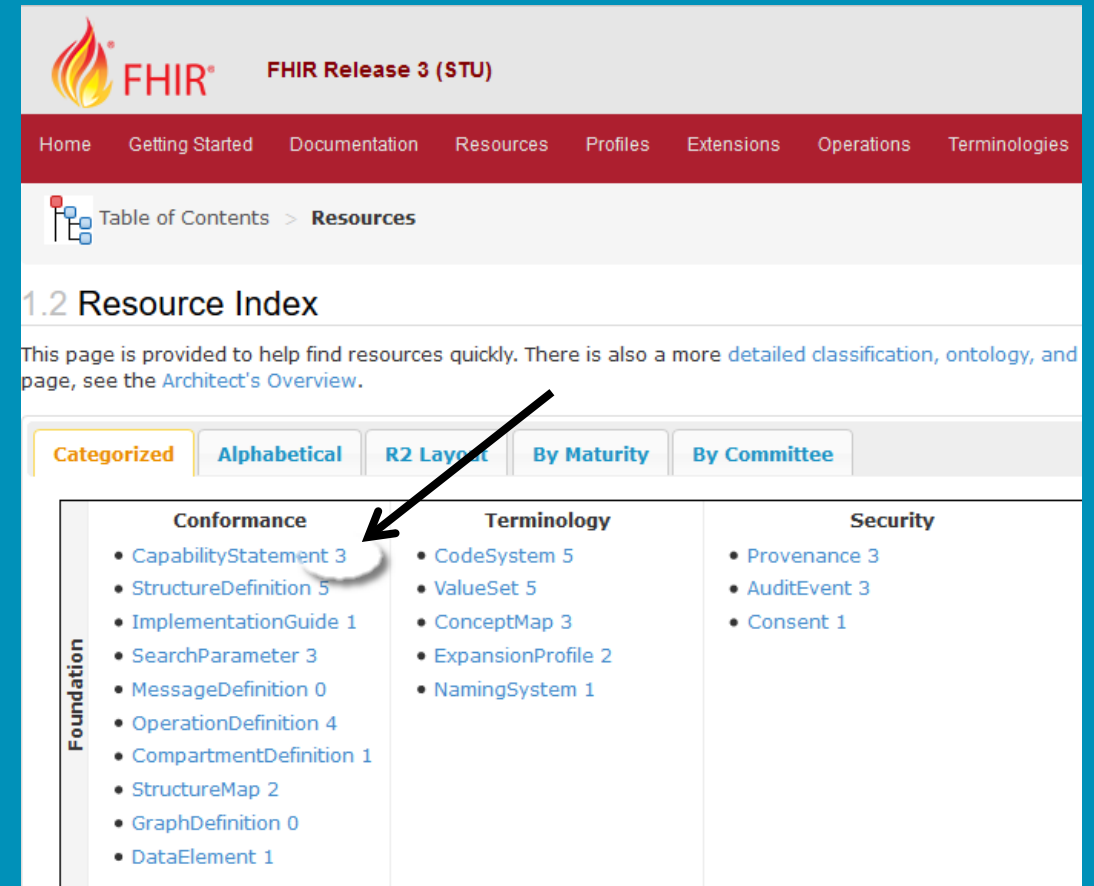
0: Draft

1: + No build warnings

2: + Successfully exchanged/tested between 3 systems (Connectathon)

3: + Verified by WG; formally balloted

4: + Scope tested; formal publication; multiple projects

5: + Published 2+ release cycles; 5+ independent production deployments

6: Normative

# CapabilityStatement

- Documents the capabilities of a FHIR client and server

- A client should examine the CapabilityStatement of a server to determine its supported behavior

- The CapabilityStatement:
    - is a key part of the FHIR conformance framework
    - is a statement of the features, rules and behaviors of a FHIR system
    - may be used for system compatibility testing, code generation, or as the basis for conformance testing

- To declare themselves "FHIR Conformant", a system **MUST** publish a CapabilityStatement: http://hl7.org/fhir/STU3/http.html#capabilities

# StructureDefinition

- A resource that describes a structured set of data element definitions and their associated rules of usage
  - how resource elements and/or data types are used or not used
  - resource or data type extensions
  - Value Set references that specify the content of coded elements
- Describes (Profiles) the base content defined in the specification
- Describes (Profiles) how these structures are utilized in implementation guides

# FHIR Timeline

- The first normative content is scheduled for FHIR R4 this year (2018).

First
Draft

DSTU
1.0

DSTU
2.0

STU
3.0

R4
1st Norm*   ...

2011   2012   2013   2014   2015   2016   2017   2018   2019   2020
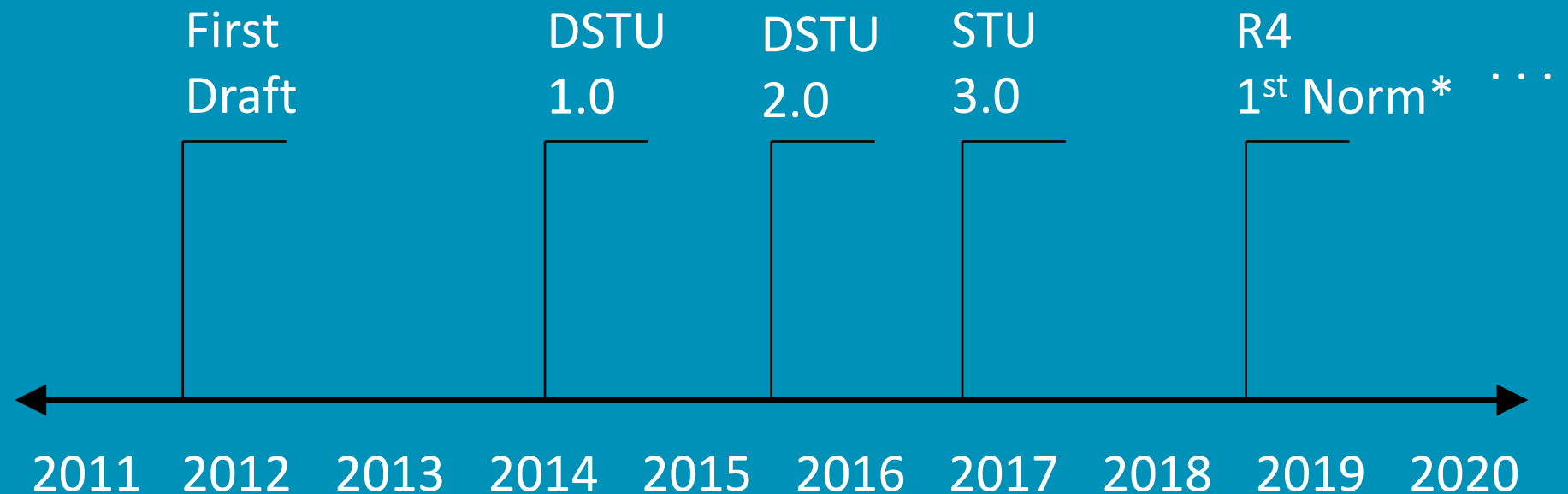
# Recap: What Does FHIR provide?

- Resources (building blocks)

- Extensions (embrace these :-)

- Methodology: Bundles, Profiles

- Syntax: XML, JSON, RDF(Turtle)

- Human Readability

- CapabilityStatement, StructureDefinition

- Multiple Paradigms: REST, Messaging, Documents, Services

- Extensive online documentation

# Discussion (Q & A)

HL7 FHIR DevDays 2018

Thank you!