



A E G I S



FHIR Overview

**2020 May 13-15 Virtual HL7® FHIR®
Connectathon**

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Session Goals

- Understand the basics of the FHIR specification
- Understand how to navigate through the FHIR specification website



A E G I O N

*Powerful Results.
Delivered.*

FHIR License & Terms of Use

<http://www.hl7.org/fhir/license.html>

2.20 License and Legal Terms

FHIR Infrastructure ↗ Work Group	Maturity Level: N/A	Standards Status: Informative
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2.20.1 Disclaimer and Warning of Use

FHIR Resource definitions developed by HL7 are derived from the considerable collective experience of the HL7 membership and wide community feedback from the development and application of a spectrum of health care interoperability solutions. However, Resource definitions are generalized to support multiple contexts of use. It is the responsibility of the persons or organizations using these Resources to ensure their use is fit for the particular purpose in which they are used, including validation for clinical and operational use.


See also the specific warnings associated with [use of the STU](#).

2.20.2 FHIR License

Copyright © 2011+ HL7.

This specification (specifically the set of materials included in the fhir-spec.zip file available from the Downloads page of this specification) is produced by HL7® under the terms of HL7® [Governance and Operations Manual](#) [↗](#) relating to Intellectual Property (Section 16), specifically its copyright, trademark and patent provisions.

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What is FHIR?

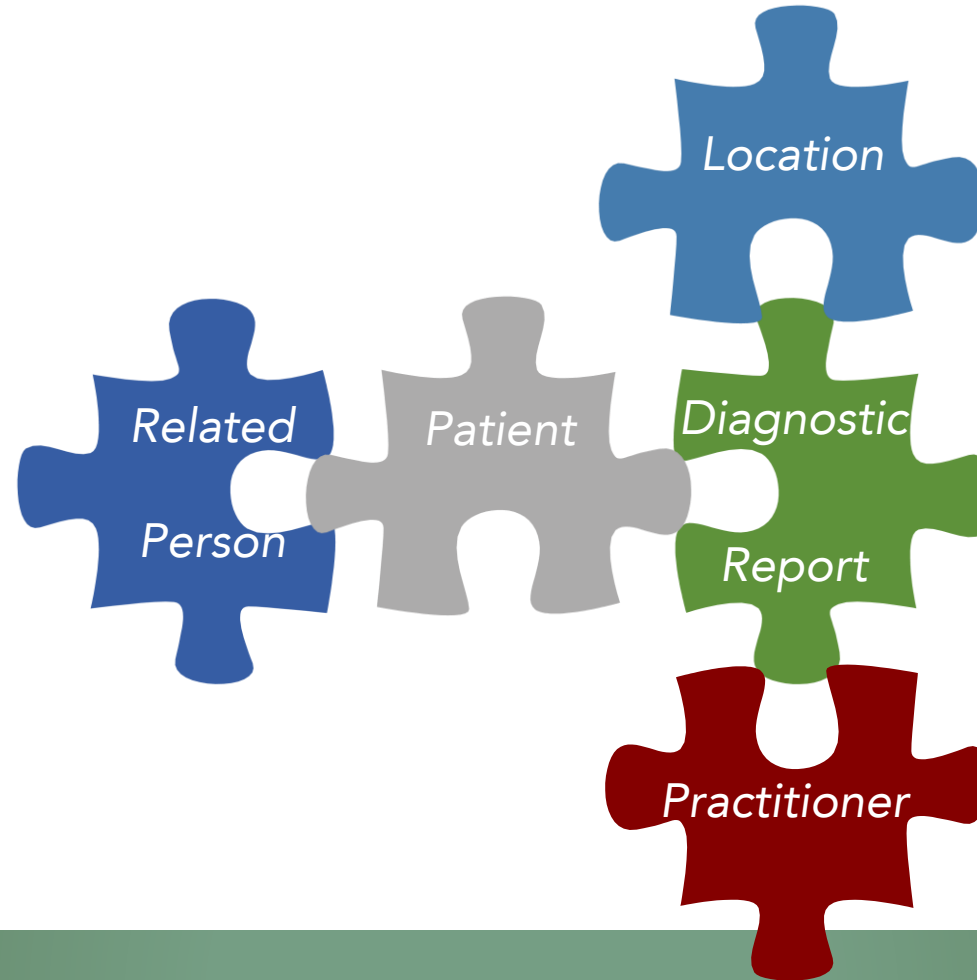
- The Next Generation Standards Framework from HL7
 - Resources (building blocks of independent, discrete data)
 - Extensions (custom data definitions within the specification)
 - Methodology (bundles, profiles, conformance)
 - Support for Multiple Formats: JSON, XML, Turtle(Terse RDF Triple)
 - Human Readable Text (derived from the data content)
- Defines a set of modular data components called "Resources"
- Offers flexibility in implementations; a simple framework to extend beyond the base specification

The Acronym

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

It's All About the Resources . . .

- Building blocks...



Resources

- Defined Structured Data
 - The logical, common contents of the resource
 - Mapped to formal definitions; e.g. RIM & other formats
 - Syntax – XML, JSON and Turtle(Terse RDF Triple)
 - Logical collections of data elements
- Extensions
 - Local requirements, but everyone can use
 - Additional data that isn't part of the original specification
 - Published and managed
- Narrative
 - Human readable



```

<Patient xmlns="http://hl7.org/fhir">
  <id value="example"/>
  <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


```

{
  "resourceType": "Patient",
  "id": "example",
  "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



What is a Resource Type?

FHIR Resource Types

- Administrative
Patient, Practitioner, Organization,
Location, Coverage, Invoice
- Clinical Concepts
AllergyIntolerance, Condition,
Family History, CarePlan
- Infrastructure/Conformance
 - ☆ CapabilityStatement,
 - ☆ StructureDefinition

Non-resource types

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

CapabilityStatement

- A resource for documenting the capabilities of a FHIR client and server.
- A client should examine the CapabilityStatement of a server to determine the supported behavior of the server.
- 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/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 reference bindings that specify the content of coded elements
- Describes the content defined in the specification
- Describes and constrains (Profiles) how these structures are utilized in implementations
- Published to and shared via registries for use in profile comparison and as the basis for code, report and UI generation

Scenario

- Example: A mother takes her child to Sunset Pediatric Office. The pediatrician needs to determine what vaccination shot(s) are due for the child.
 - What FHIR resources will be used to record this visit and forecast the shot(s) that are due?



Answers

Recording the visit

- Patient
- Practitioner
- Organization
- Location
- Observation
- Encounter

Forecasting the shots

- Patient
- Immunization
- Immunization Recommendation

Let's see how this would work...

Immunization Forecast Workflow

Sunset Pediatric Office



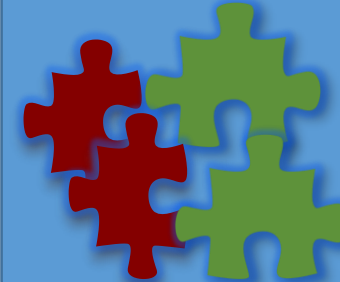
*Forecast Request
(patient & immunization(s))*



*Forecast Response
(recommendations)*



*Regional
Immunization
Forecast Service*



AEGIS WildFHIR Demo

<http://wildfhir4.aegis.net/fhir4-0-1-gui/index.jsf>




AEGIS WildFHIR - HL7® FHIR® Test Client

Supporting HL7® FHIR® Release 4 (v4.0.1-Official)

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WildFHIR Versions

- WildFHIR - FHIR DSTU2 v1.0.2
- WildFHIR - FHIR STU3 v3.0.2
- WildFHIR - FHIR R4 v4.0.1



ServicesOperationsToolsConformanceFHIR Providers

EverythingConvertGraphQLValidateCDSiSubscriptions

FHIR Operation - Clinical Decision Support Immunization Forecasting

***In collaboration with the Immunization Information Systems (IIS) community*

Select FHIR Provider: *

Enter Forecast Criteria:

Assessment Date (yyyy-mm-dd)

Patient Gender *

Patient DOB (yyyy-mm-dd) *

Vaccine 1 Administered Date (yyyy-mm-dd)

Vaccine 2 Administered Date (yyyy-mm-dd)

FHIR Defines Testing

- To ensure interoperability between applications claiming conformance to the specification, a testing framework has been established within the FHIR specification itself
 - <http://hl7.org/fhir/testing.html>
- This framework defines the TestScript resource as a natural language, computable format of a test case
- The TestScript resource represents an executable test definition for examining the results of FHIR RESTful API interactions
 - <http://hl7.org/fhir/testscript.html>

A FHIR Test Engine

- The FHIR TestScript defines the test but how do we run it? – A FHIR Test Engine
- What does a FHIR Test Engine need to be capable of doing?
 - Pre-Processing
 - Setup Execution
 - Test Execution(s)
 - Tear-Down Execution
 - Post-Processing
- AEGIS has built such an engine so that others can subscribe to it for testing without having to carry the overhead and expense of setting up their own

Public FHIR Servers for Testing

<https://confluence.hl7.org/display/FHIR/Public+Test+Servers>

- More than 30 publicly available test servers (and clients)
- Support for multiple versions:
 - Release 2 (DSTU2)
 - Release 3 (STU3)
 - Release 4 (R4)
 - Release 5 (Preview)
 - Current CI
- Maintained and supported by the FHIR community

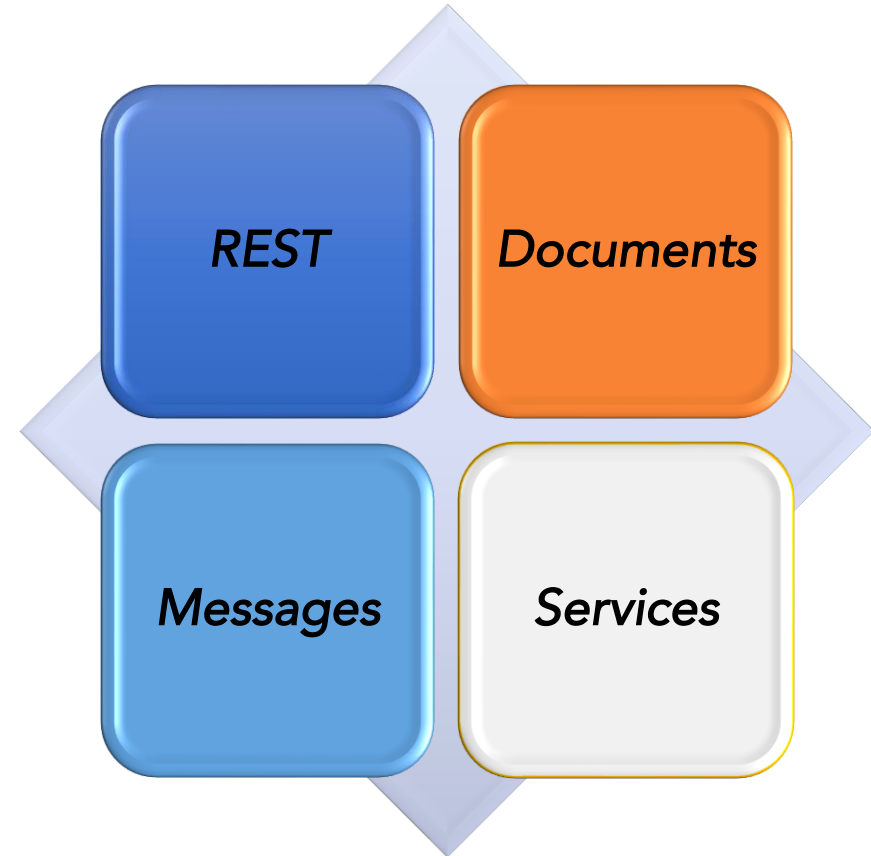
Servers

Note that these servers are testing servers. They may be sporadically unavailable, and as the FHIR specification evolves, they may become obsolete.

- <http://test.fhir.org/r2>, <http://test.fhir.org/r3> and <http://test.fhir.org/r4> - Grahame's test server
 - Supports all resource types, all operations, xml + json
 - implementation details: open source - see [\[\[2\]\]](#)
 - supports Smart on FHIR
- HSPC Sandbox
 - <http://sandbox.hspconsortium.org>
 - Free DSTU2 and STU3 open sandboxes with tools for managing data. Both personal and organizational
 - Supports both open and SMART on FHIR OAuth2 access
 - Supports app registration for SMART on FHIR apps
 - Supports all resource types, all operations
 - <http://hspconsortium.org/#/>
 - <https://healthservices.atlassian.net/wiki/display/HSPC/Healthcare+Services+Platform+Capabilities>
- Vonk - .NET based FHIR Server by Firely
 - Demo servers
 - Stable: <http://vonk.fire.ly> (STU3 + R4)
 - Experimental: <https://labs.vonk.fire.ly/> (Including R5 support)
 - Supports STU3, R4 and the R5 pre-release
 - Functionality
 - Generic FHIR Server, for all types of resources, all search parameters, xml + json
 - Supports validation (for example: POST /Patient/\$validate, with a Patient resource)
 - This test instance runs on MongoDB and therefore can do batch but not transaction
 - [Download your own instance](#) - [More information](#) - [Documentation](#)
- HAPI FHIR Reference Server

Paradigms

- FHIR supports four interoperability paradigms



REST

- Simple, out-of-the-box interoperability
- Leverages HTTP: GET, POST, etc.
- Pre-defined operations
 - Create, Read, Update, Delete
 - Also: History, Read Version, Search, Updates, Validate, Capabilities, Batch & Transaction
- Works best where control resides on client side and a trust relationship exists



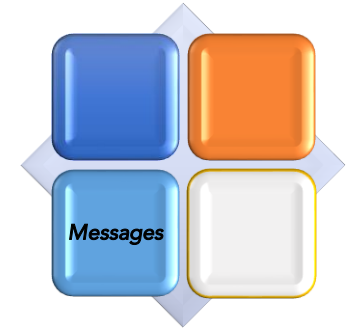
Documents

- Similar to CDA
- A 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.
- Requires human-readable representation of the data contents

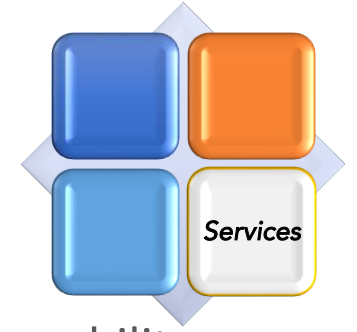


Messages

- Similar to v2 and v3 messaging
- Also a collection of resources
 - Sent as a Bundle (**FHIR Resource**)
- Allows for request and response behavior and payloads
- Event-driven
 - e.g. Send lab order, get back result
- Can be asynchronous



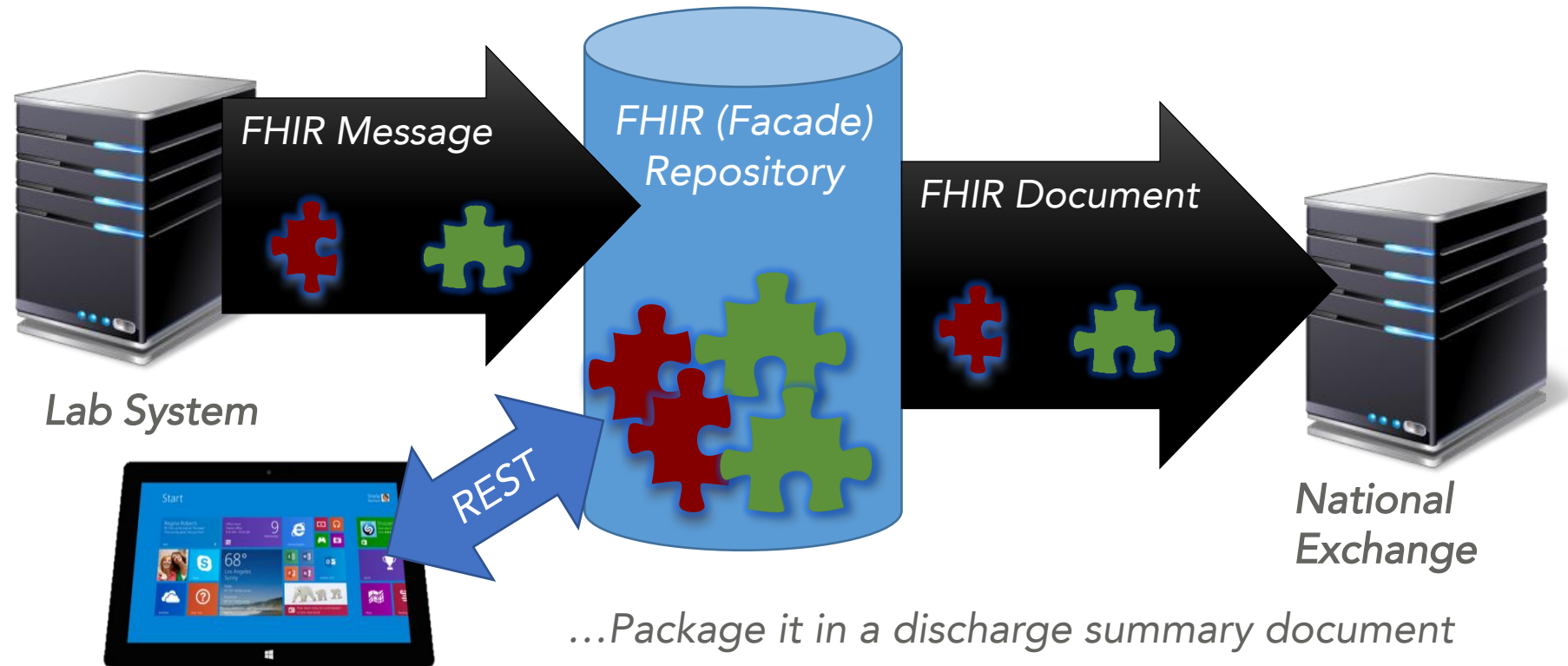
Service Oriented Architecture (SOA)



- Combination of previous paradigms
 - (based on SOA principles)
 - loose coupling, service abstraction, reusability, autonomy, statelessness, discoverability, composability, interoperability
 - Ultra complex workflows
 - Ultra simple workflows
 - Individual resources or collections (**in Bundle, contained resources or other formats**)
 - Use HTTP or other transport protocol
 - Only constraint is that you're passing around FHIR resources in some way, shape, manner or form























































Regardless of the paradigm the content is the same

Receive a lab result in a message...

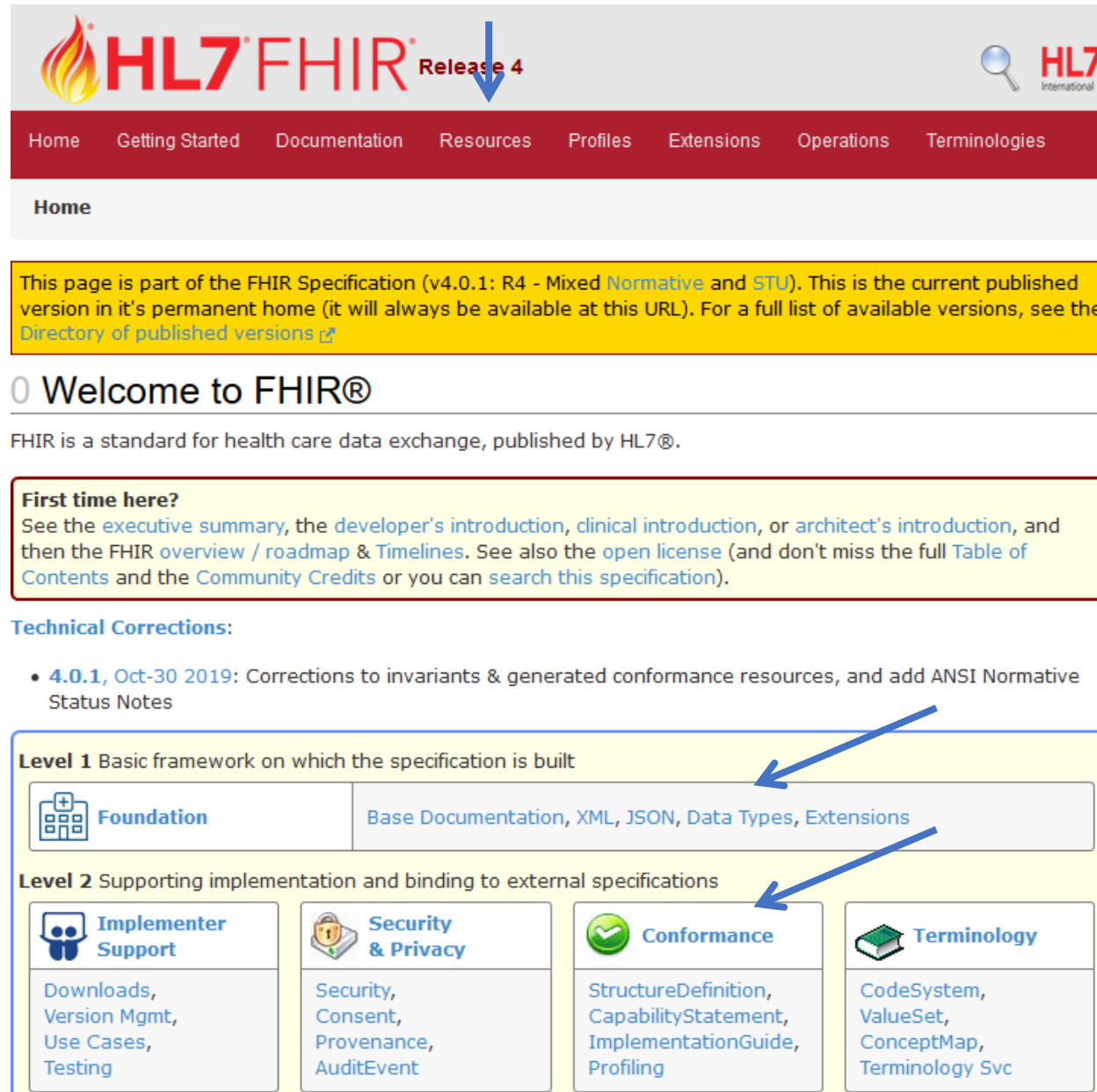


FHIR Specification

Directory to all FHIR versions: <http://hl7.org/fhir/directory.html>

Date	Version	Description	Links
Current Versions			
2019-10-30	4.0.1	FHIR Release #4: First Normative Content	       
(current)	(last commit)	Current Development build (about 30min behind version control, may be incoherent and change rapidly)	   
R5 Sequence (Work in Progress)			
2020-05-04	4.4.0	FHIR Release #5: Preview #2	    
2019-12-31	4.2.0	FHIR Release #5: Preview #1	    
R4 Sequence (Current)			
2019-10-30	4.0.1	FHIR Release #4 First Normative Content with 1 technical errata (Permanent Home) • Technical Errata Archive (zip): v4.0.0 (Permanent Home)	       
2018-11-09	3.5a.0	Special R4 Ballot #3 : Normative Packages for Terminology / Conformance + Observation	   
2018-08-21	3.5.0	R4 Ballot #2 : Mixed Normative/Trial use (Second Normative ballot + Baltimore Connectathon)	   
2018-04-02	3.3.0	R4 Ballot #1 : Mixed Normative/Trial use (First Normative ballot)	   
2018-04-02	3.2.0	Draft for comment / First Candidate Normative Content	   
STU 3 Sequence (Historical)			
2019-10-24	3.0.2	FHIR Release 3 (STU) with 2 technical errata (Permanent Home) • Technical Errata Archive (zip): v3.0.1 • Technical Errata Archive (zip): v3.0.0	       

Welcome to FHIR



The screenshot shows the HL7 FHIR Release 4 website. At the top, the logo features a flame icon next to 'HL7 FHIR' and 'Release 4' with a blue arrow pointing down. A navigation bar includes links: Home, Getting Started, Documentation, Resources, Profiles, Extensions, Operations, and Terminologies. Below this is a 'Home' section header. A yellow box contains a paragraph about the FHIR Specification (v4.0.1: R4 - Mixed Normative and STU) and a link to the 'Directory of published versions'. The main heading is '0 Welcome to FHIR®'. Below it, a paragraph states 'FHIR is a standard for health care data exchange, published by HL7®'. A yellow box titled 'First time here?' provides links to the executive summary, developer's introduction, clinical introduction, architect's introduction, FHIR overview / roadmap & Timelines, open license, Table of Contents, and Community Credits. Under 'Technical Corrections:', a bullet point for '4.0.1, Oct-30 2019' lists corrections to invariants & generated conformance resources and the addition of ANSI Normative Status Notes. The bottom section is divided into 'Level 1 Basic framework on which the specification is built' and 'Level 2 Supporting implementation and binding to external specifications'. Level 1 includes 'Foundation' (Base Documentation, XML, JSON, Data Types, Extensions). Level 2 includes four categories: 'Implementer Support' (Downloads, Version Mgmt, Use Cases, Testing), 'Security & Privacy' (Security, Consent, Provenance, AuditEvent), 'Conformance' (StructureDefinition, CapabilityStatement, ImplementationGuide, Profiling), and 'Terminology' (CodeSystem, ValueSet, ConceptMap, Terminology Svc). Blue arrows point from the 'Foundation' box to the 'Conformance' box, and from the 'Implementer Support' box to the left. A blue arrow also points from the 'Conformance' box to the 'Terminology' box.

HL7 FHIR Release 4

Home Getting Started Documentation Resources Profiles Extensions Operations Terminologies

Home

This page is part of the FHIR Specification (v4.0.1: R4 - Mixed Normative and STU). This is the current published version in it's permanent home (it will always be available at this URL). For a full list of available versions, see the [Directory of published versions](#)

0 Welcome to FHIR®


FHIR is a standard for health care data exchange, published by HL7®.

First time here?
See the [executive summary](#), the [developer's introduction](#), [clinical introduction](#), or [architect's introduction](#), and then the [FHIR overview / roadmap & Timelines](#). See also the [open license](#) (and don't miss the full [Table of Contents](#) and the [Community Credits](#) or you can [search this specification](#)).





Technical Corrections:

- **4.0.1, Oct-30 2019:** Corrections to invariants & generated conformance resources, and add ANSI Normative Status Notes

Level 1 Basic framework on which the specification is built

 Foundation	Base Documentation, XML, JSON, Data Types, Extensions
---	---

Level 2 Supporting implementation and binding to external specifications

 Implementer Support Downloads, Version Mgmt, Use Cases, Testing	 Security & Privacy Security, Consent, Provenance, AuditEvent	 Conformance StructureDefinition, CapabilityStatement, ImplementationGuide, Profiling	 Terminology CodeSystem, ValueSet, ConceptMap, Terminology Svc
--	---	---	--

RESTful API

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

3.1.0 RESTful API

FHIR Infrastructure [Work Group](#)

Maturity Level: Normative

Stable

FHIR is described as a 'RESTful' specification based on common industry level use only supports Level 2 of the [REST Maturity model](#) as part of the core specification conformance is possible through the use of [extensions](#). Because FHIR is a standard of resource structures and interfaces. This may be considered a violation of REST consistent interoperability across diverse systems.

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	Delete a resource
history	Retrieve the change history for a particular resource

Type Level Interactions

create	Create a new resource with a server assigned id
search	Search the resource type based on some filter criteria
history	Retrieve the change history for a particular resource type

Whole System Interactions

capabilities	Get a capability statement for the system
batch/transaction	Update, create or delete a set of resources in a single interaction
history	Retrieve the change history for all resources
search	Search across all resource types based on some filter criteria

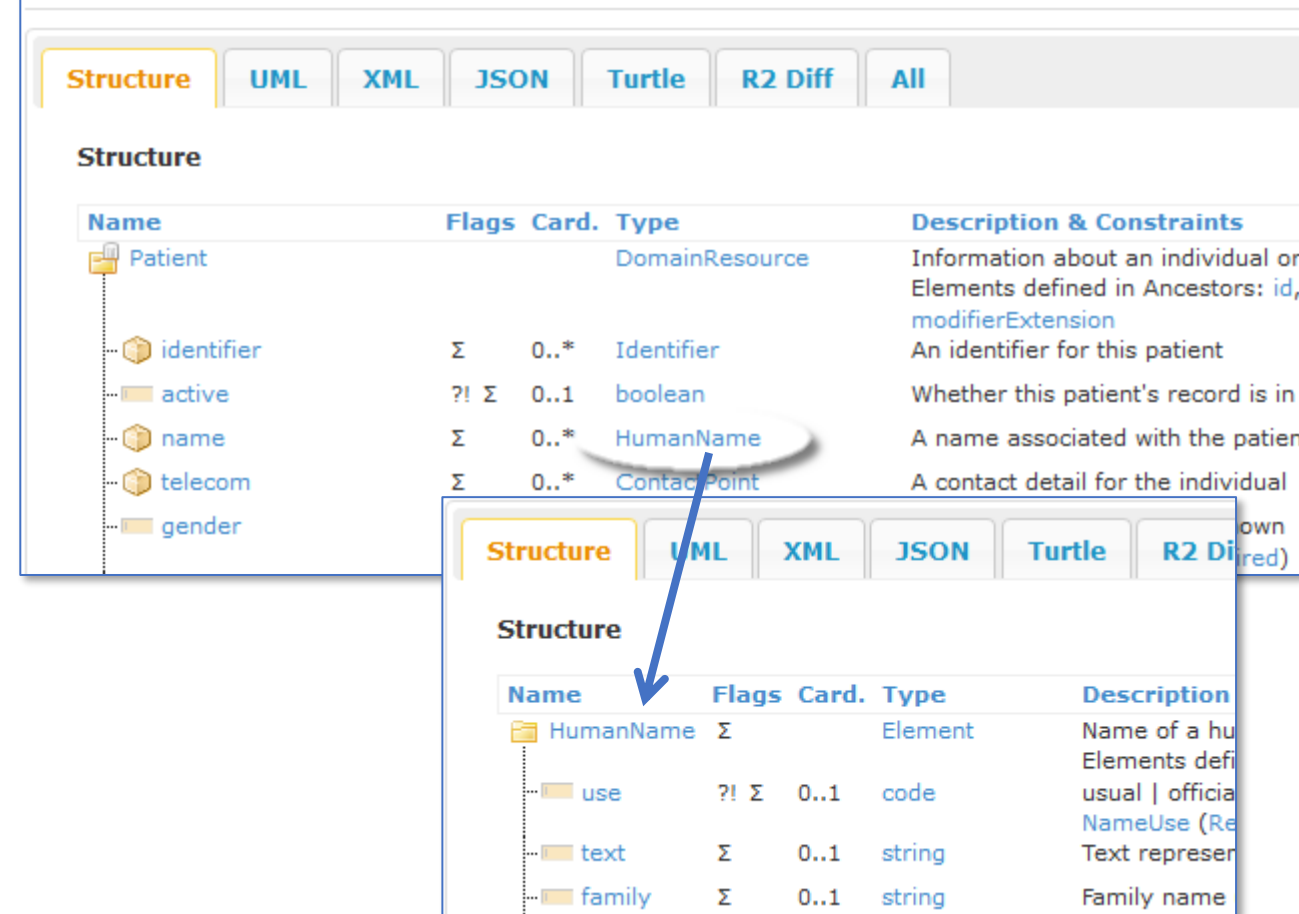
- The Instance Level, Type Level, and Whole System Interactions are listed at the top of the page.
- Clicking on any specific interaction will display the details of that interaction; e.g., update will show all of the FHIR requirements for updating resources.

Patient Resource Content

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

- The **Structure** tab shows how the resource type elements are organized
- The **Card.** stands for Cardinality and shows the minimum and maximum number of times an element can appear in an instance. For example, 0..1 means optional, maximum of 1 occurrence.
- The **Type** lists the FHIR data type of the elements; e.g. **name** is of type **HumanName**. Clicking on **HumanName** will show its structure.

8.1.2 Resource Content



Structure

Name	Flags	Card.	Type	Description & Constraints
Patient			DomainResource	Information about an individual or Elements defined in Ancestors: id, modifierExtension
identifier	Σ	0..*	Identifier	An identifier for this patient
active	?! Σ	0..1	boolean	Whether this patient's record is in
name	Σ	0..*	HumanName	A name associated with the patient
telecom	Σ	0..*	ContactPoint	A contact detail for the individual
gender				

Structure

Name	Flags	Card.	Type	Description
HumanName	Σ		Element	Name of a hu Elements defi
use	?! Σ	0..1	code	usual official NameUse (Re
text	Σ	0..1	string	Text represen
family	Σ	0..1	string	Family name

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.

2.24.0 Data Types

FHIR Infrastructure [Work Group](#)

Maturity Level: Normative

Standards Status: Part

The FHIR specification defines a set of data types that are used for the resource elements. There are four categories of data types

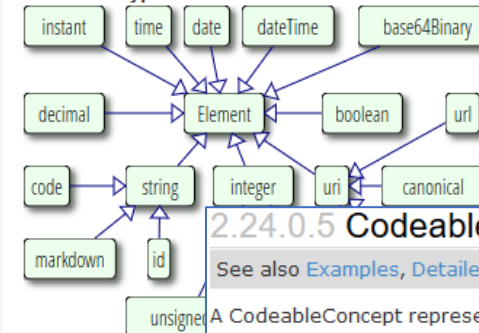
1. Simple / primitive types, which are single elements with a primitive value ([below](#))
2. General-purpose complex types, which are re-usable clusters of elements ([below](#))
3. Metadata types: A set of types for use with metadata resources
4. Special purpose data types - defined elsewhere in the specification for specific usages

This page describes the general-purpose data types (categories 1 and 2).

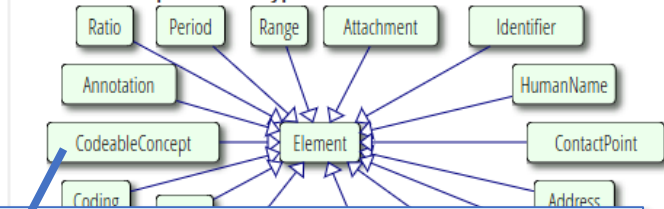
Data Types Summary.

Legend: see [Standards Status Colors](#)

Primitive Types



General-Purpose Data types



2.24.0.5 CodeableConcept

See also [Examples](#), [Detailed Descriptions](#), [Mappings](#), [Profiles & Extensions](#) and [R2 Conversions](#).

A CodeableConcept represents a value that is usually supplied by providing a reference to one or more of text. This is a common pattern in healthcare data.

This data type can be [bound](#) to a [ValueSet](#).

Structure

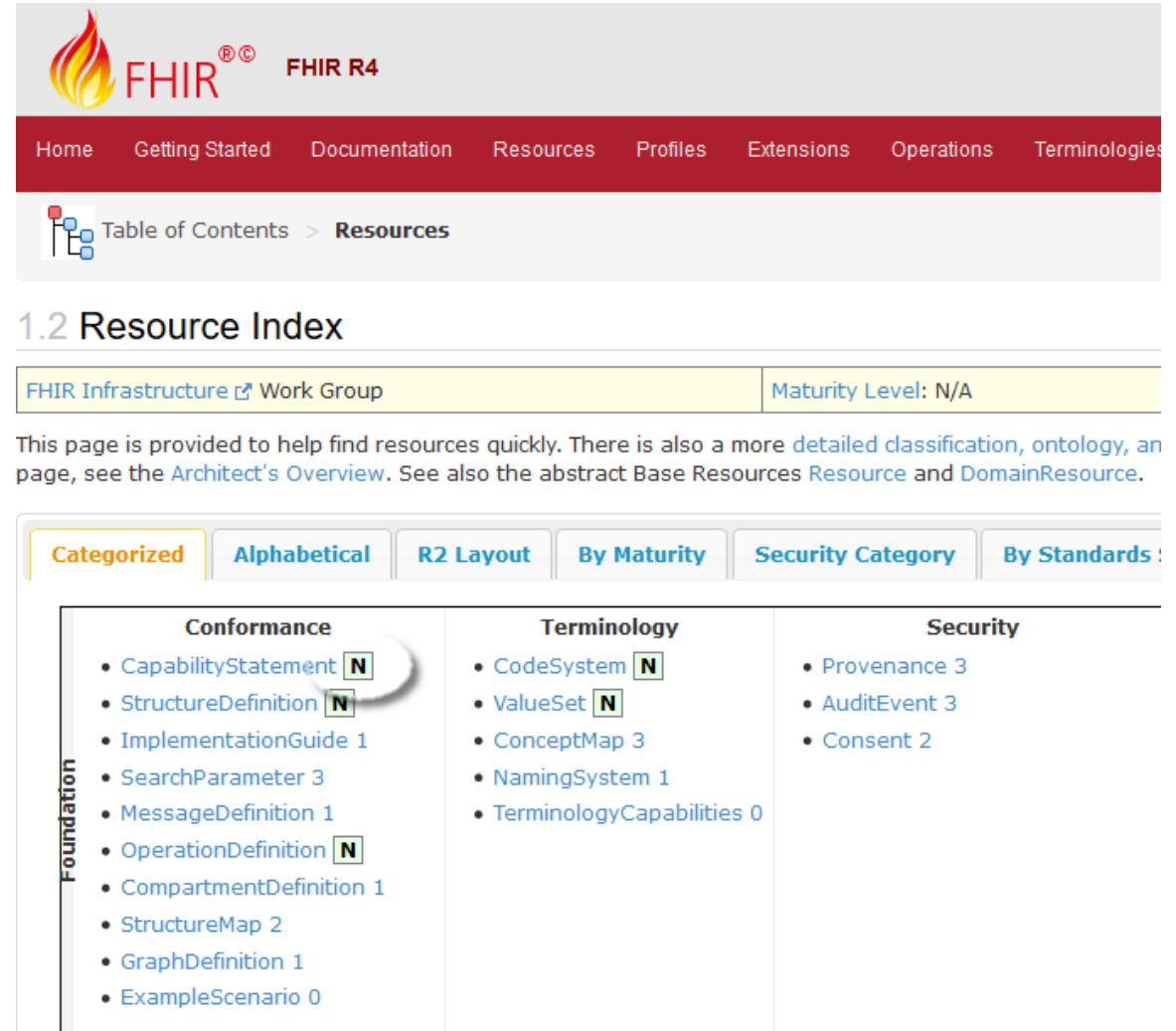
Name	Flags	Card.	Type	Description & Constraints
CodeableConcept	Σ N		Element	Concept - reference to a terminology or just text Elements defined in Ancestors: id , extension
coding	Σ	0..*	Coding	Code defined by a terminology system
text	Σ	0..1	string	Plain text representation of the concept

[? Documentation for this format](#)

FHIR Maturity Model

- 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 project
- 5: + Published 2+ release cycles; 5+ independent production deployments
- N: Normative

<http://hl7.org/fhir/versions.html#maturity>



The screenshot shows the FHIR R4 website header with the FHIR logo and navigation links: Home, Getting Started, Documentation, Resources, Profiles, Extensions, Operations, and Terminologies. Below the header, there is a breadcrumb trail: Table of Contents > Resources. The main heading is "1.2 Resource Index". A table shows "FHIR Infrastructure Work Group" and "Maturity Level: N/A". A paragraph explains the page's purpose: "This page is provided to help find resources quickly. There is also a more detailed classification, ontology, and page, see the Architect's Overview. See also the abstract Base Resources Resource and DomainResource." Below this is a filter bar with tabs: Categorized, Alphabetical, R2 Layout, By Maturity, Security Category, and By Standards. The main content area is a table with three columns: Conformance, Terminology, and Security. The Conformance column lists resources like CapabilityStatement (N), StructureDefinition (N), ImplementationGuide (1), SearchParameter (3), MessageDefinition (1), OperationDefinition (N), CompartmentDefinition (1), StructureMap (2), GraphDefinition (1), and ExampleScenario (0). The Terminology column lists CodeSystem (N), ValueSet (N), ConceptMap (3), NamingSystem (1), and TerminologyCapabilities (0). The Security column lists Provenance (3), AuditEvent (3), and Consent (2). A vertical label "Foundation" is on the left side of the table.

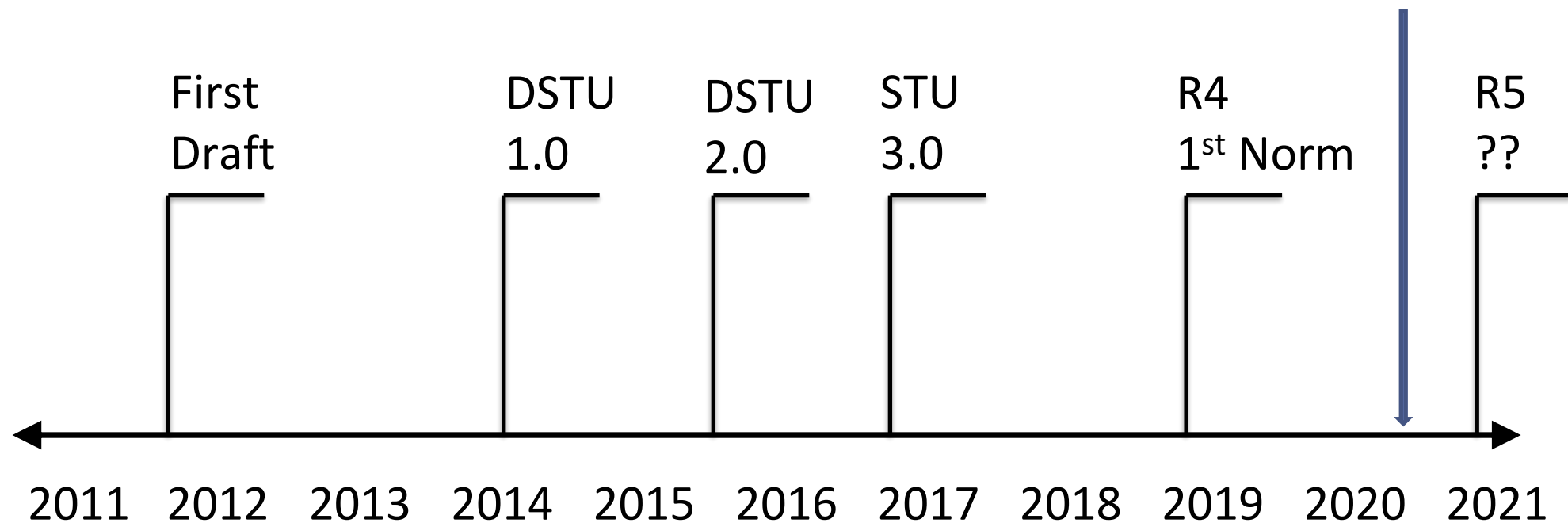
	Conformance	Terminology	Security
Foundation	• CapabilityStatement N	• CodeSystem N	• Provenance 3
	• StructureDefinition N	• ValueSet N	• AuditEvent 3
	• ImplementationGuide 1	• ConceptMap 3	• Consent 2
	• SearchParameter 3	• NamingSystem 1	
	• MessageDefinition 1	• TerminologyCapabilities 0	
	• OperationDefinition N		
	• CompartmentDefinition 1		
	• StructureMap 2		
	• GraphDefinition 1		
	• ExampleScenario 0		

Recap: What Does FHIR provide?

- Resources (Building Blocks)
- Extensions (Part of the Spec)
- Methodology
 - Bundles, Profiles, Conformance
- Syntax: XML, JSON, RDF(Turtle)
- Human Readability
- CapabilityStatement, StructureDefinition, Testing Framework
- Support for Multiple Paradigms
 - REST, Messaging, Documents, Services
- Extensive online documentation

FHIR Timeline

- FHIR R4 contains the first normative content released December 2018.





A E G I O N

Wrap Up

Discussion

Q&A