

Computing for Medicine

Lecture 10: Storyboarding, HL7 & FHIR

Step 1: Define the Purpose, Gather the Requirements and Storyboard the Experience

Improving Patient Flow: The Esther Project in Sweden

"Esther" is not a real patient, but her persona as a gray-haired, ailing, but competent elderly Swedish woman with a chronic condition and occasional acute needs has inspired impressive improvements in how patients flow through a complex network of providers and care settings in Höglandet, Sweden.

Esther was invented by a team of physicians, nurses, and other providers who joined together to improve patient flow and coordination of care for elderly patients within a six-municipality region in Sweden. The productive work that has been done on Esther's behalf recently led the Jönköping County Council, responsible for the health care of 330,000 residents living around Höglandet, to become one of two international teams participating in the [Pursuing Perfection](#) initiative. This program, launched by The Robert Wood Johnson Foundation, is designed to help physician organizations and hospitals dramatically improve patient outcomes by pursuing perfection in all their major care processes. The Institute for Healthcare Improvement (IHI) serves as the National Program Office for this initiative.

Storyboarding Saves Lives!

PROJECT ESTHER

- Hospital admissions fell 22 % from 9300 in 1998 to 7300 in 2003.
- Hospital days for heart failure patients fell 28% from 3500 in 1998 to 2500 in 2000.
- Waiting times for referral appointments with neurologists fell 84 % from 85 days in 2000 to 14 days in 2003.
- Waiting times for referral appointments with gastroenterologists fell 71 % from 48 days in 2000 to 14 days in 2003.

Step 2: Create a Conceptual Model

What is a Model and a Meta-Model?

A model is a description of what the modeler thinks to be relevant of a system.

- modeling syntax and semantics i.e. the modeling language
- the representation of the concepts (how the concepts are represented in a concrete model, e.g., in a graphical way)
- the modeling rules (e.g., the modeling steps), i.e. the guideline for applying the language.

Types of Meta- Models

- Functional: describe the functioning of the hospital
- Technical: describes the information processing
- Organizational: organizational structure of the health information system
- Data: structure of data stored in an HIS
- Business processes: Chronological and logical flow
- Information system: Integrative, enterprise wide view

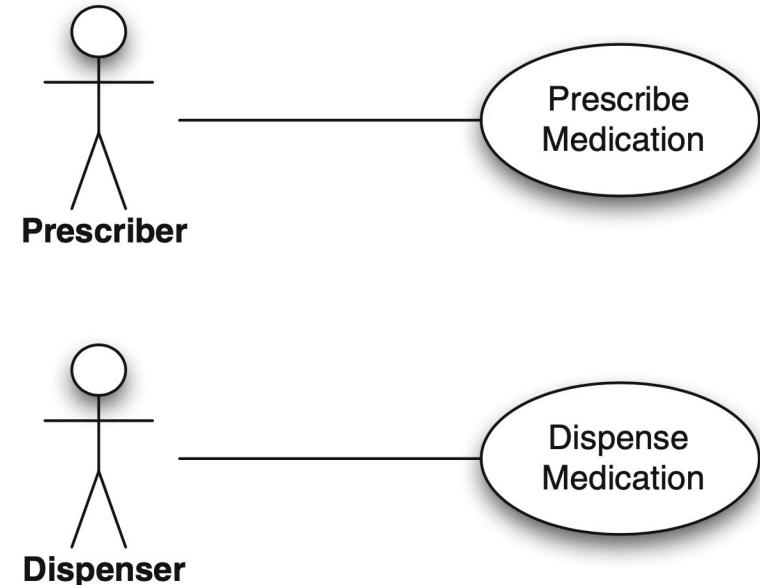
System, Use cases, Actors, Scenarios

Use case:

- A specific way of using the System.
- Non-technical persons should be able to understand it

Actor: Person, computer or device that interacts with the system

Scenario: A particular instance of the use case



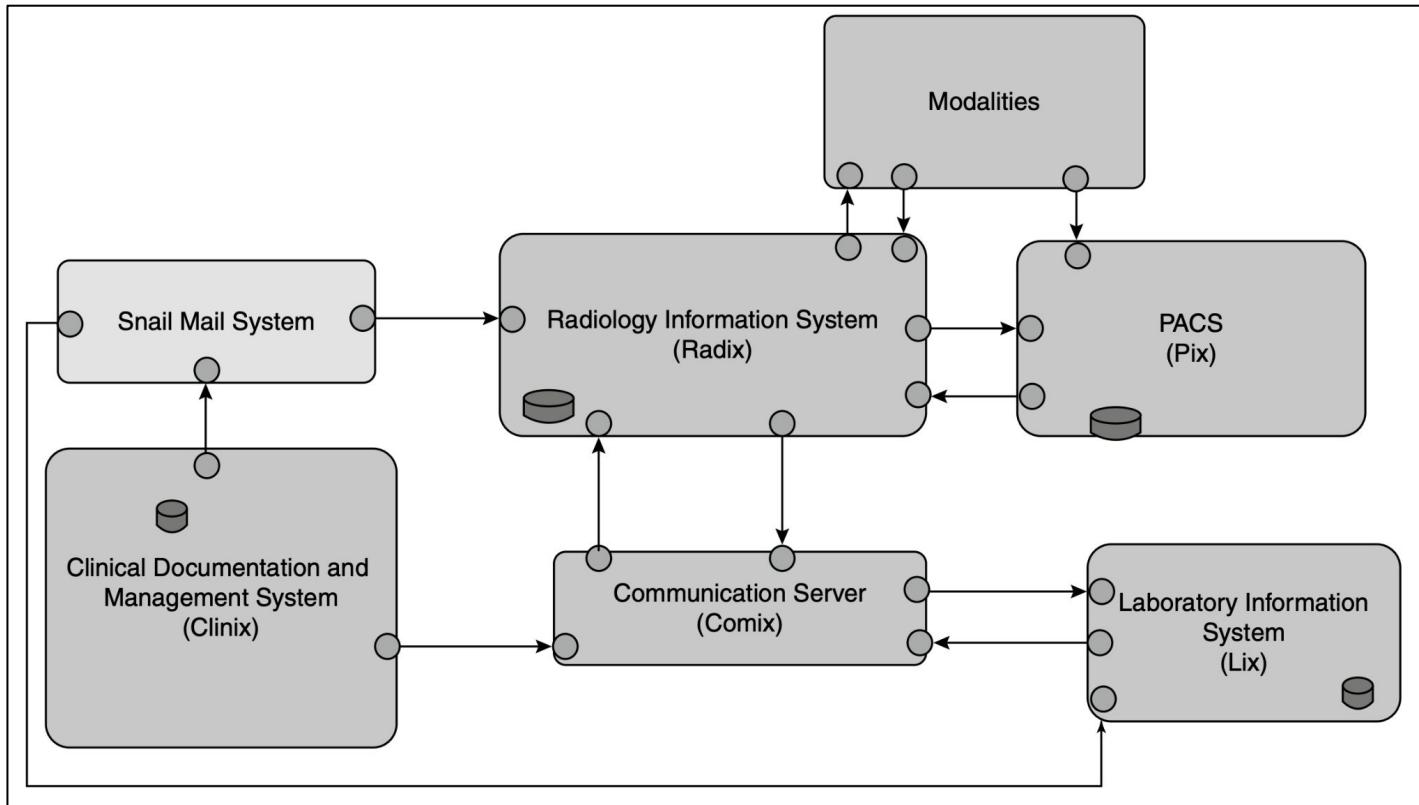
Functional Components

Patient care	Order entry	Preparation of an order Appointment scheduling
	Patient discharge and transfer to other institutions	Administrative discharge and billing Medical discharge and medical report writing Nursing discharge and nursing report writing
Hospital administration	Patient administration	Patient identification and checking for recurrent Administrative admission Visitor and information service
Information Management		Strategic information management Tactical information management Operational information management

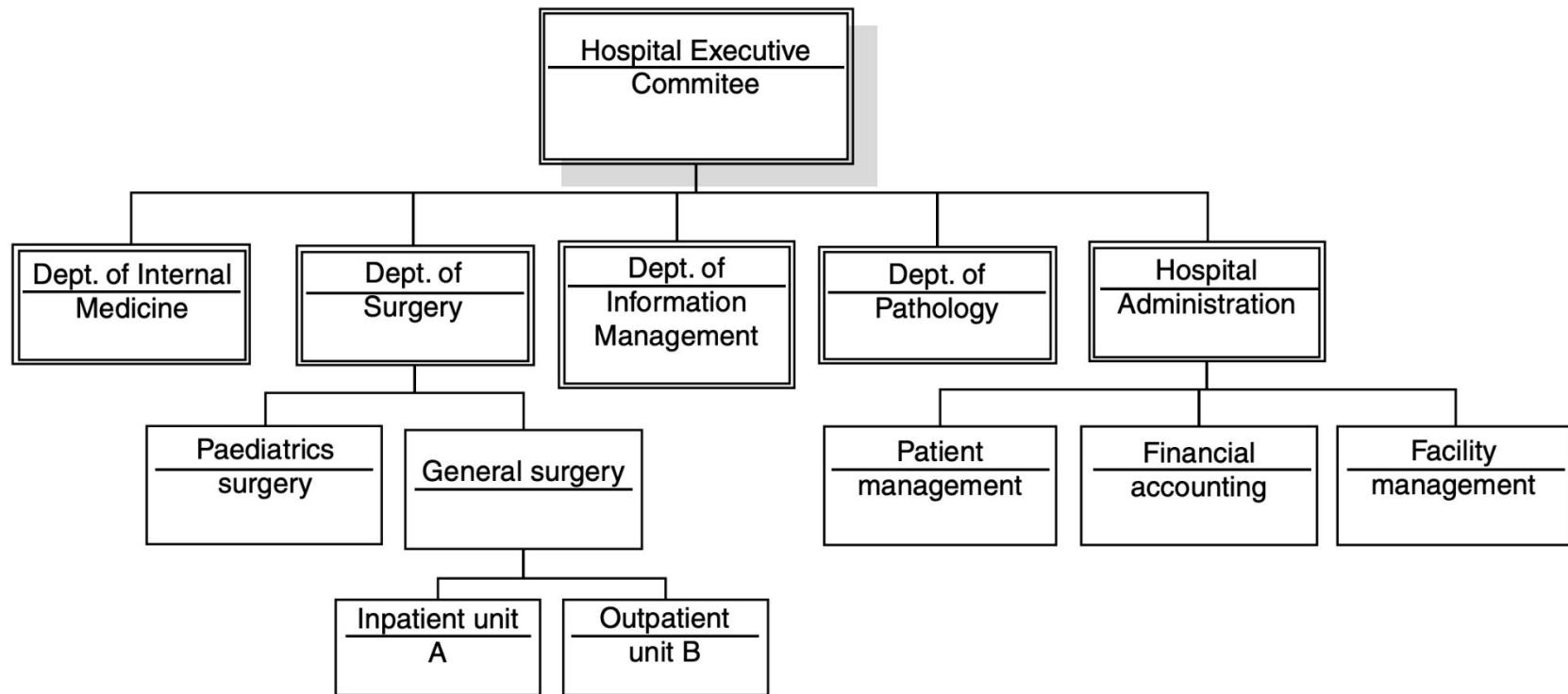
Technical Components

- Which information processing tools are used?
- Which application components communicate with each other?
- What are the data transmission connections between the physical data processing systems?
- What does the network technology look like?
- What technical solutions are used to guarantee the security and reliability of information processing tools?

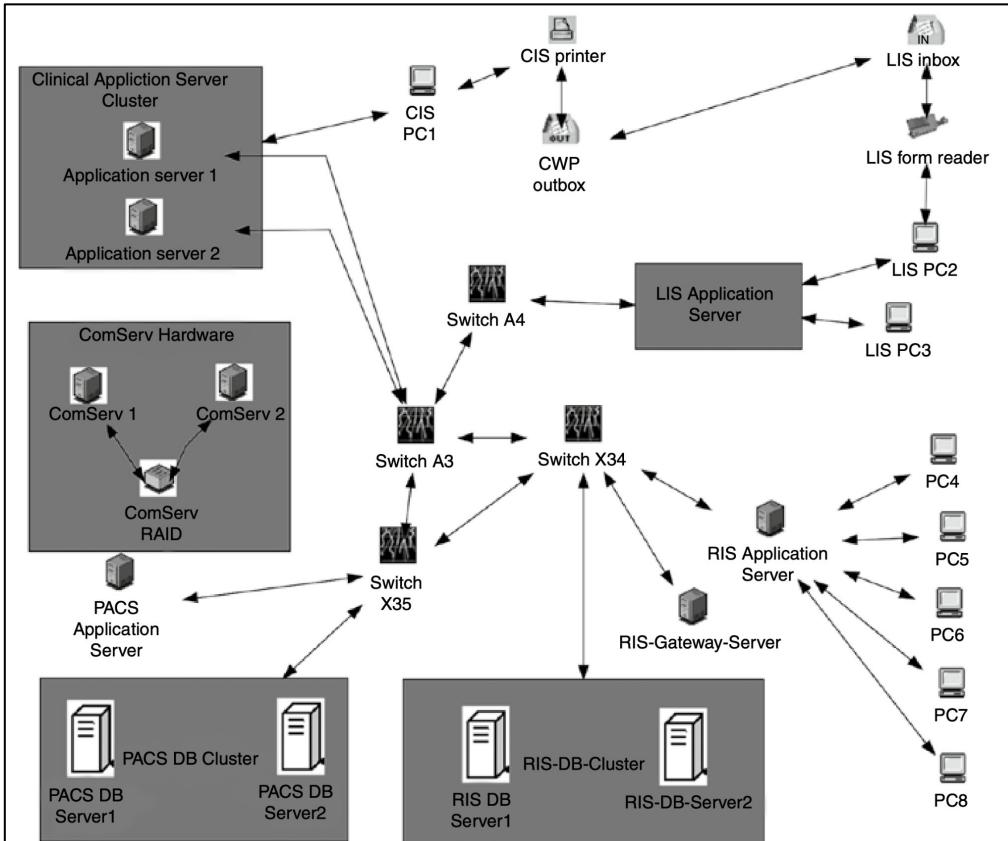
Technical Model



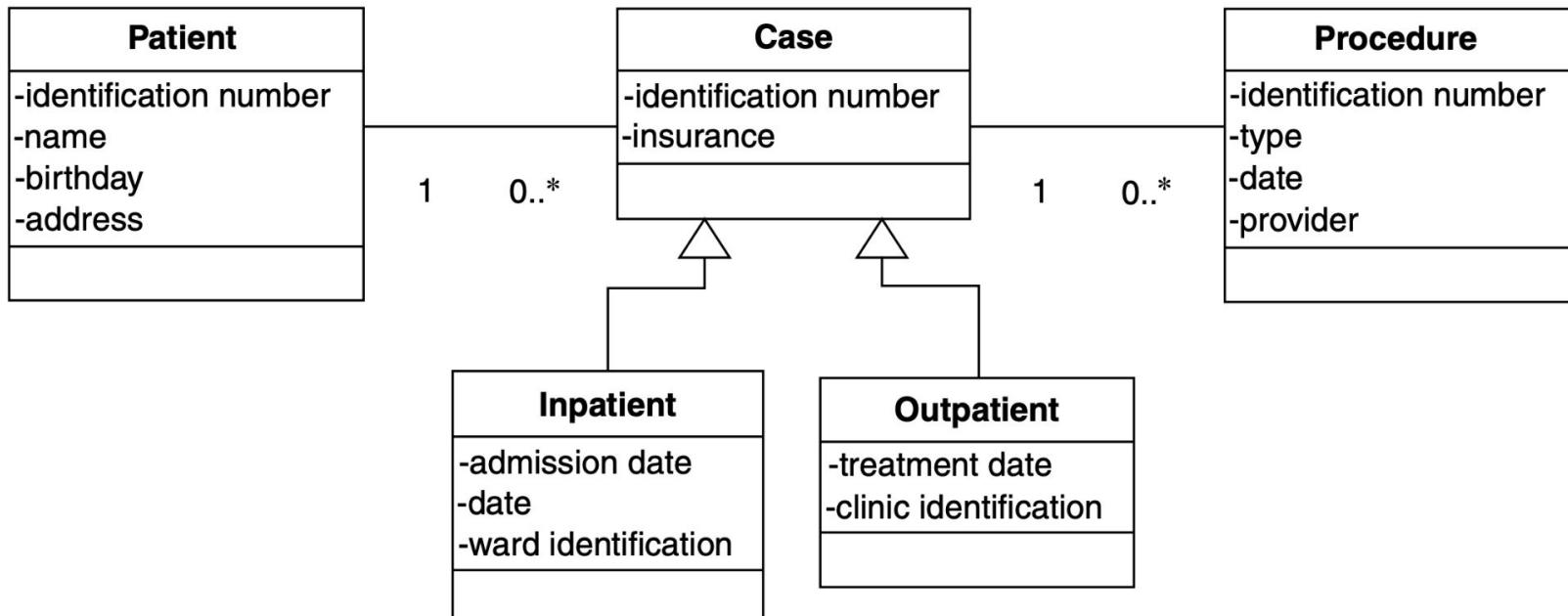
Organizational Model



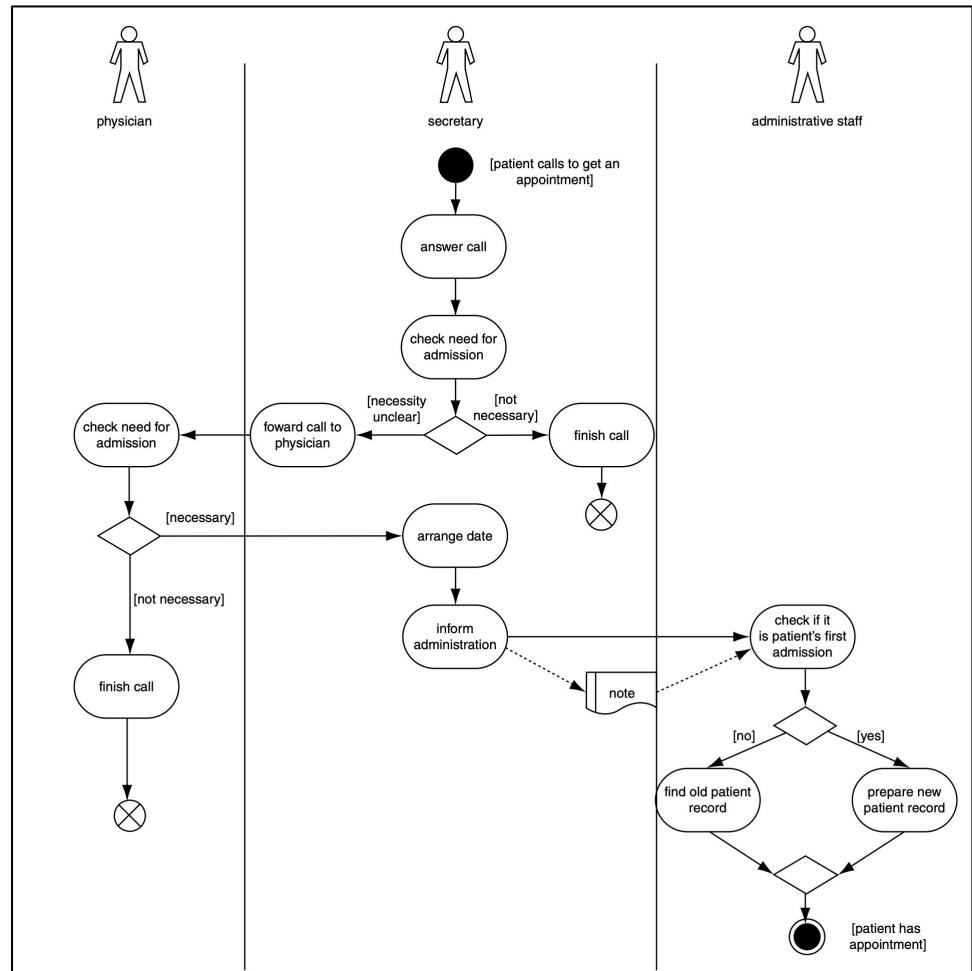
Organizational Components



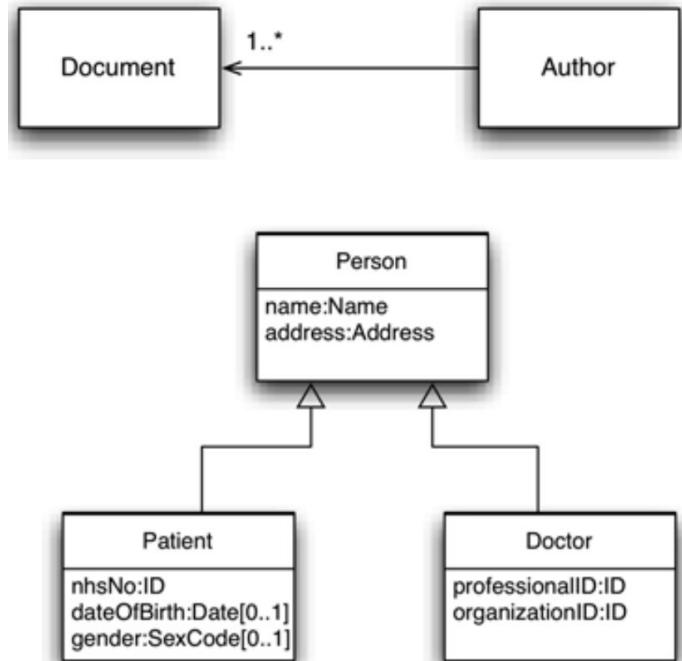
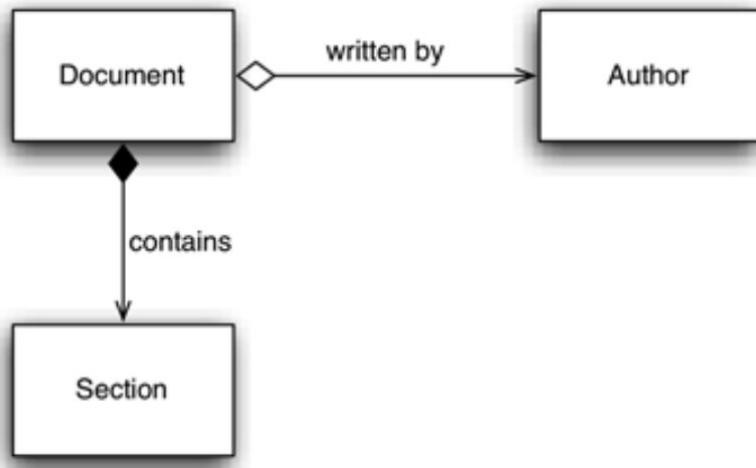
Data Model: UML Diagram



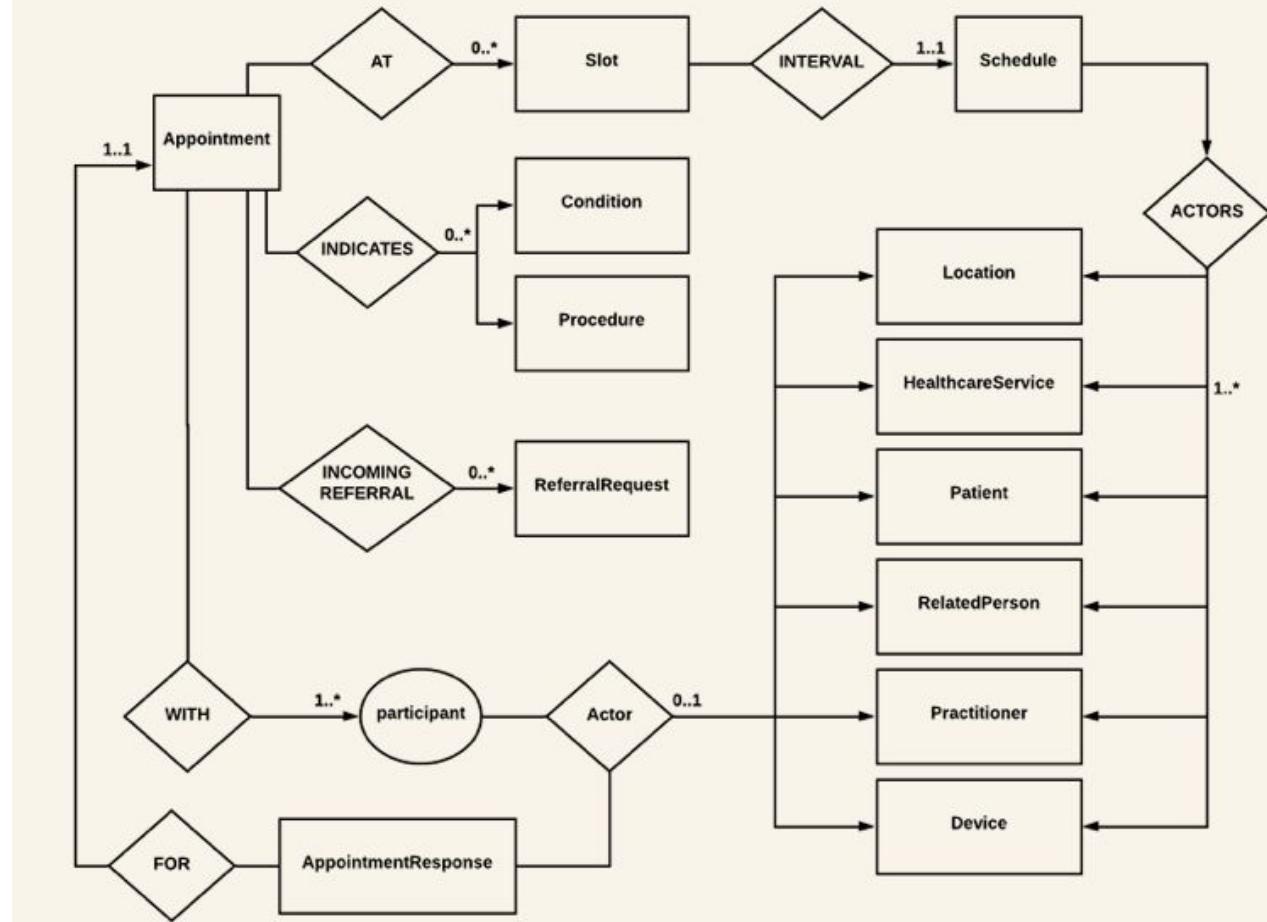
Business Process Model



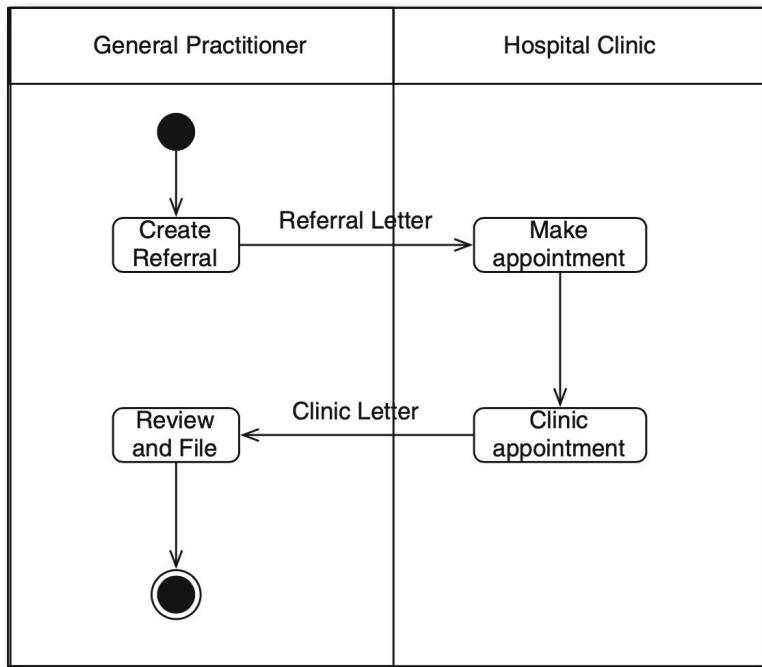
Other approaches from storyboarding



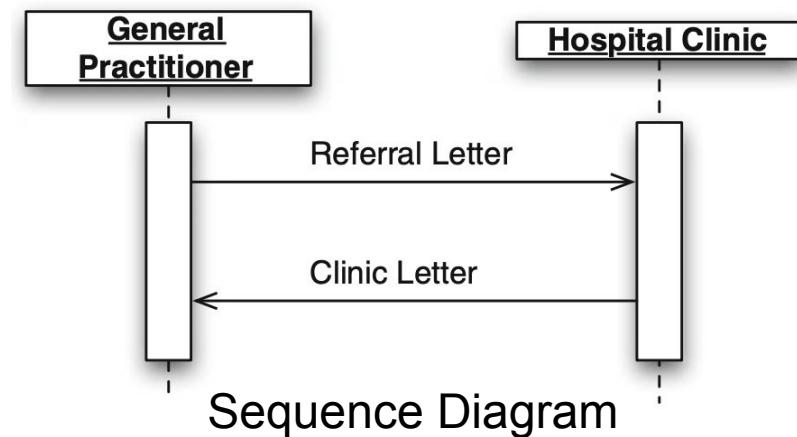
Data Model



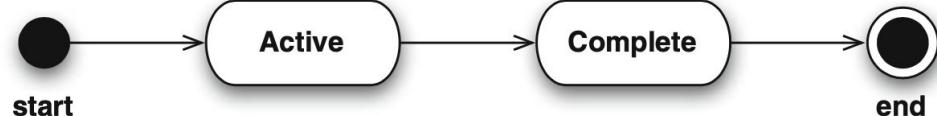
Activity Diagram, Sequence Diagrams, Statecharts



Activity Diagram



Sequence Diagram



Statecharts

Step 3: Choose a Technical Framework, e.g. FHIR

What we want

Report from Lab123457, 15:30 14-Aug-2008, Ref 123456789

Patient: MICKEY MOUSE, DoB: 14-Jan-1962, M

Address: 14 Disney Rd, Disneyland, MM1 9DL

Specimen: Swab, FOOT, Right, Requested By: C987654

Location: 5 N

Patients GP: Dr Smith (G123456)

Organism: STAU

Susceptibility: AMP R

SXT S

CIP S

What it looks like at the backend

```
MSH|^~\&||^123457^Labs|||200808141530||ORU^R01|12345678  
9|P|2.4  
PID|||123456^^^SMH^PI||MOUSE^MICKEY||19620114|M|||14  
Disney Rd^Disneyland^^^MM1 9DL  
PV1|||5 N|||||G123456^DR SMITH  
OBR|||54321|666777^CULTURE^LN|||20080802|||||||SW^^^FOO  
T^RT|C987654  
OBX||CE|0^ORG|01|STAU|||||F  
OBX||CE|500152^AMP|01||||R|||F  
OBX||CE|500155^SXT|01||||S|||F  
OBX||CE|500162^CIP|01||||S|||F
```

Technical Interoperability: The Technology Layer

This is the technology layer

- Moves data from system A to system B, neutralizing the effects of distance
- Domain independent
- Does not know or care about the meaning of what is exchanged
- Information theory is the foundation stone of technical interoperability

Health Level 7 International (HL7)

- Is a Standards Development Organization
- Is now the lingua franca to pass health messages across systems
- At least two translations required during information interchange

Internal format ---> Wire Format ---> Internal Format
(computer) (connection) (computer)

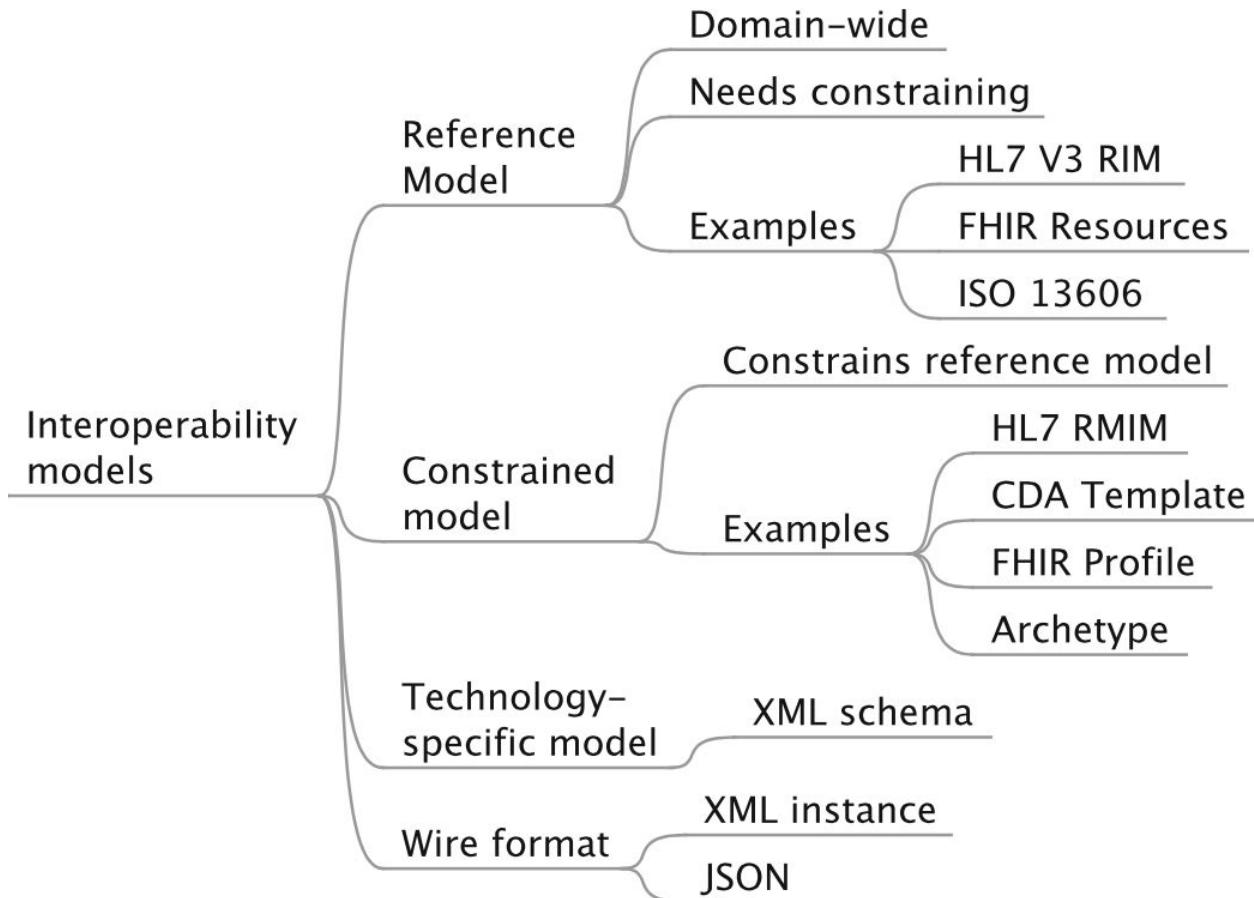
Requires the following sequential steps in Object Oriented Software Development

- i. Computational-Independent Model (CIM).
- ii. Platform-Independent Model (PIM) - the conceptual design of a system.
- iii. Platform-Specific Model (PSM)- the implementable design.
- iv. Code, the actual software code, also referred to as wire-format.

Another Example of Syntactic Interoperability: HL7 Standard

```
##### Translate this function from HL7 V2.8 ADT_A01 to HL7 V2.4 ADT_A05
### HL7 V2.8 ADT_A01
```

```
MSH|^~\&|ADT1|GOOD HEALTH HOSPITAL|GHH LAB, INC.|GOOD HEALTH
HOSPITAL|198808181126|SECURITY|ADT^A01^ADT_A01|MSG00001|P|2.8|||
EVN|A01|200708181123|||
PID|1||PATID1234^5^M11^ADT1^MR^GOOD HEALTH
HOSPITAL~123456789^^^USSA^SS|EVERYMAN^ADAM^A^III||19610615|M||C|222
2 HOME STREET^GREENSBORO^NC^27401-1020|GL|(555) 555-2004|(555)555-
2004||S||PATID12345001^2^M10^ADT1^AN^A|44433333|987654^NC|
NK1|1|NUCLEAR^NELDA^W|SPO^SPOUSE|||NK^NEXT OF KIN
PV1|1|I|2000^2012^01|||004777^ATTEND^AARON^A||SUR|||ADM|A0|
### HL7 V2.4 ADT_A05
```



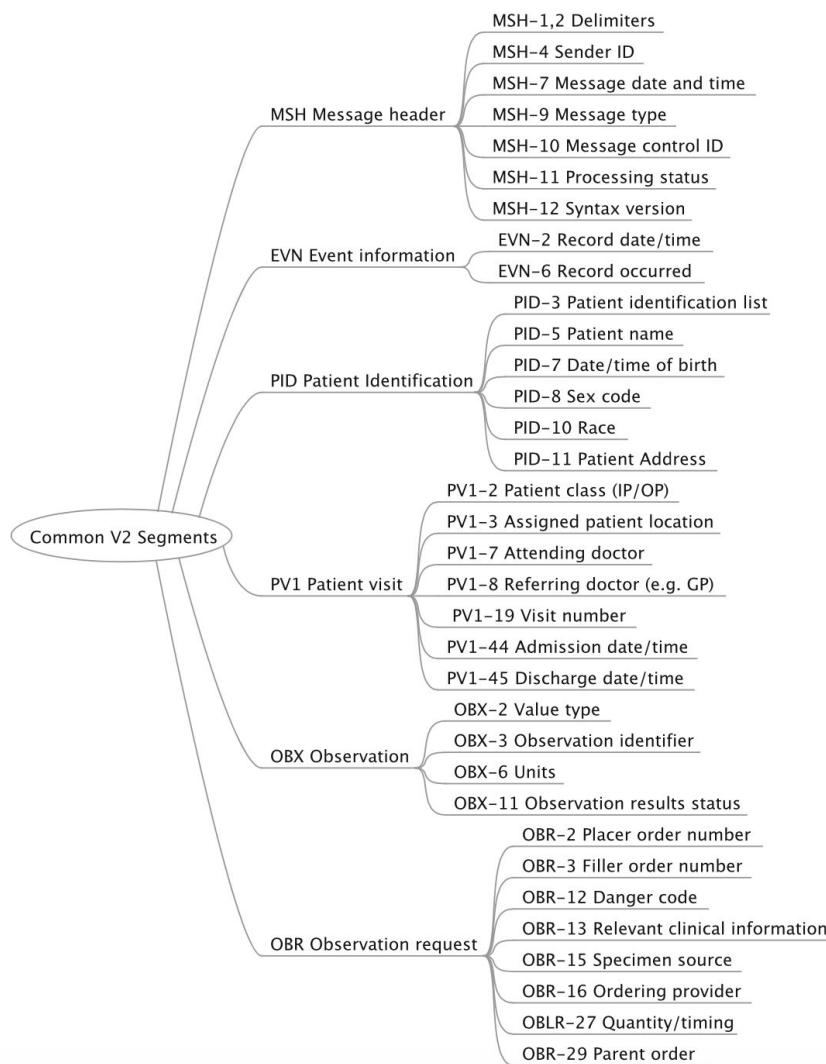
Segment Definitions, Segments, Reports

```

MSH|^~\&||^123457^Labs|||200808141530||ORU^R01|12345678
9|P|2.4
PID|||123456^^SMH^PI||MOUSE^MICKEY||19620114|M|||14
Disney Rd^Disneyland^^MM1 9DL
PV1|||5 N||||G123456^DR SMITH
OBR|||54321|666777^CULTURE^LN|||20080802||||||SW^^^FOO
T^RT|C987654
OBX||CE|0^ORG|01|STAU|||||F
OBX||CE|500152^AMP|01||||R|||F
OBX||CE|500155^SXT|01||||S|||F
OBX||CE|500162^CIP|01||||S|||F

```

Report from Lab123457, 15:30 14-Aug-2008, Ref 123456789
Patient: MICKEY MOUSE, DoB: 14-Jan-1962, M
Address: 14 Disney Rd, Disneyland, MM1 9DL
Specimen: Swab, FOOT, Right, Requested By: C987654
Location: 5 N
Patients GP: Dr Smith (G123456)
Organism: STAU
Susceptibility: AMP R
SXT S
CIP S



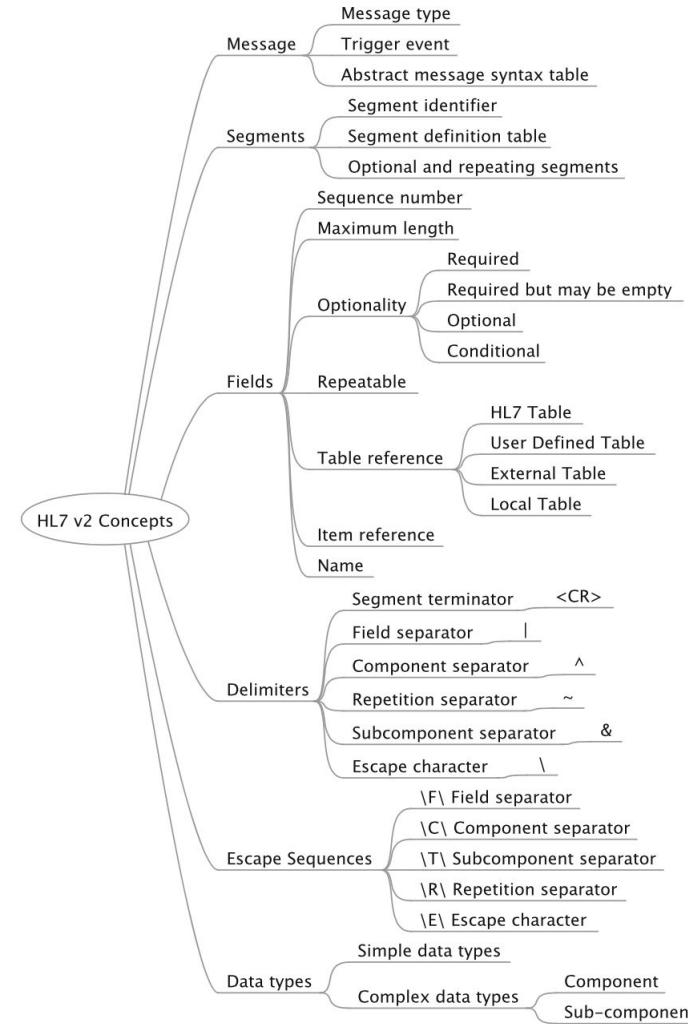
HL7 Messages

Value	Description
ACK	General acknowledgment message
ADT	ADT message
ORM	Order message
ORU	Observation result unsolicited

Value	Description
A01	Admit/visit notification
A02	Transfer a patient
A03	Discharge/end visit
A04	Register a patient

MSH	Message Header
EVN	Event Type
PID	Patient Identification
PV1	Patient Visit

Symbol	Usage
	Field separator
^	Component separator
~	Repetition separator
\	Escape character
&	Subcomponent separator
<CR>	Segment terminator



How do you create something like this?

- *public clouds*
- *private clouds*
- *hybrid clouds*



Core Idea: REST

- Representational State Transfer (RESTful) APIs
- Built to copy the web
- Organised around the concept of "Resources"
- All resources have references to other resources, extensions, and a human readable XHTML display
- Augmentation by Messages and Document paradigm also possible
- Open license, a focus on implementation, and a formal maturity process linked to implementation outcome.



Standard REST APIs



FHIR APIs

FHIR Standard

```
```json
{
 "resourceType": "Bundle",
 "type": "message",
 "entry": [
 {
 "resource": {
 "resourceType": "MessageHeader",
 "eventCoding": {
 "system": "http://hl7.org/fhir/message-events",
 "code": "ADT_A01"
 },
 "destination": [
 {
 "endpoint": "http://localhost:8080/fhir/baseDstu3"
 }
],
 "source": {
 "name": "ADT1",
 "software": "GOOD HEALTH HOSPITAL",
 "endpoint": "http://localhost:8080/fhir/baseDstu3"
 }
 }
 }
]
}
```

# Follow the page link for understanding resources

The screenshot shows the homepage of the HL7 Cancer Pathology Data Sharing Implementation Guide (IG). At the top left is the HL7 International logo. In the center, the title "Cancer Pathology Data Sharing" is displayed with a subtitle "1.0.0 - STU1" and the American flag icon. To the right is the HL7 FHIR logo. A navigation bar below the title includes links for "IG Home", "Table of Contents", "Background", "Specification", "Downloads", and "Artifact Index". Below the navigation bar, a breadcrumb trail shows "Table of Contents > Home Page". A yellow callout box contains a note about the publication being a continuous build for version 1.0.0, based on GitHub content, and noting it changes regularly. The main content area features a section titled "1 Home Page" with a table of metadata. This table includes rows for "Official URL", "Version", "Draft as of", "Computable Name", and "Copyright/Legal". Below this, a paragraph describes the purpose of the IG, mentioning LIS and CCR pathways. A yellow callout box highlights sections for "Scope", "Dependencies", "Audience", and "Acknowledgements". Further down, a paragraph details the publication's scope and compliance with FHIR Release 4. A final note at the bottom states that the guide is sponsored by HL7 Orders and Observations (O&O) and Public Health Work Groups.

**Cancer Pathology Data Sharing**  
1.0.0 - STU1

IG Home Table of Contents Background Specification Downloads Artifact Index

Table of Contents > Home Page

Cancer Pathology Data Sharing, published by HL7 Orders and Observations Work Group. This is not an authorized publication; it is the continuous build for version 1.0.0). This version is based on the current content of <https://github.com/HL7/cancer-reporting/> and changes regularly. See the [Directory of published versions](#).

## 1 Home Page

Official URL: <a href="http://hl7.org/fhir/us/cancer-reporting/ImplementationGuide/hl7.fhir.us.cancer-reporting">http://hl7.org/fhir/us/cancer-reporting/ImplementationGuide/hl7.fhir.us.cancer-reporting</a>	Version: 1.0.0
Draft as of 2023-08-18	Computable Name: usCancerPathologyData
Copyright/Legal:	

The Cancer Pathology Data Sharing implementation guide (IG) reporting process documents best practices for transmitting pathology data as FHIR resource bundles and distributing them to the Central Cancer Registry (CCR) via two pathways:

1. Laboratory Information Systems (LIS) to CCR via an electronic health record (EHR) intermediary
2. LIS to CCR directly

This publication promotes structured data collection and exchange of cancer pathology data, provides the data model, defined data items and their corresponding code and value sets. This guide specifies the collection and exchange of data specific to a cancer pathology synoptic report for public health reporting. This guide contains a library of FHIR profiles to create a cancer pathology message bundle and is compliant with FHIR Release 4.

Currently, the most successful implementation of the Cancer Pathology Data Sharing IG and Integrating the Healthcare Enterprise (IHE)/Structured Data Capture (SDC) on FHIR IG requires the integration of College of American Pathologists' (CAP) checklists into the LIS workflow. Future iterations of this IG may allow for more flexible incorporation of non-electronic Cancer Protocols (eCP) content (such as narrative pathology reports or others); however, that capability is currently not supported.

The Health Level Seven (HL7) Orders and Observations (O&O) and Public Health Work Groups sponsor this guide.

### 1.1 Scope

This guide defines 8 FHIR profiles:

# HAPI FHIR

Home Server: HAPI Test Server (R4 FHIR) Source Code About This Server

Options

Encoding (default) XML JSON

Pretty (default) On Off

Summary (none) true text data count

Server

**Server Home/Actions**

HFQL / SQL

Resources

Observation 4336934

Patient 4013050

Specimen 1876165

Composition 940493

Bundle 405630

Encounter 258353

Binary 225136

Location 220229

**HAPI FHIR**

You are accessing the public FHIR server **HAPI Test Server (R4 FHIR)**. This server is hosted elsewhere on the internet but is being accessed using the HAPI client implementation.

**This is not a production server!** Do not store any information here that contains personal health information or any other confidential information. This server will be regularly purged and reloaded with fixed test data.

Server	HAPI FHIR Test/Demo Server R4 Endpoint
Software	HAPI FHIR Server - 8.5.3-SNAPSHOT/e3a3c5f741/2025-08-28
FHIR Base	<a href="http://hapi.fhir.org/baseR4">http://hapi.fhir.org/baseR4</a>

**Server Actions**

Retrieve the server's **conformance** statement.

Conformance

Retrieve the update **history** across all resource types on the server.

History Since  Limit # (opt)

Post a bundle containing multiple resources to the server and store all resources within a single atomic transaction.

Transaction  Bundle\* (place transaction bundle body here)



<https://hapi.fhir.org/baseR4>

← 3.4 Client Configuration

3.5 Client Examples ▾

Powered by HAPI FHIR v8.5.6-SNAPSHOT

Showing documentation for 8.6.0

**WELCOME TO HAPI FHIR**

- Table of Contents 0.0
- Changelog: 2025 0.1
- Changelog: 2024 0.2
- Changelog: 2023 0.3
- Changelog: 2022 0.4
- Changelog: 2021 0.5
- Changelog: 2020 0.6
- Changelog: 2019 0.7
- Changelog: 2018 0.8
- Changelog: 2017 0.9
- Changelog: 2016 0.10
- Changelog: 2015 0.11
- Changelog: 2014 0.12

**GETTING STARTED**

- Introduction 1.0
- FHIR and HAPI FHIR Versions 1.1
- HAPI FHIR Modules 1.2
- Downloading and Importing 1.3
- FHIR R4B Support 1.4

**WORKING WITH THE FHIR MODEL**

- Working With Resources 2.0
- Parsing and Serializing 2.1
- Resource References 2.2

## 3.5.1 Client Examples

This page contains examples of how to use the client to perform complete tasks. If you have an example you could contribute, we'd love to hear from you!

## 3.5.2 Transaction With Conditional Create

The following example demonstrates a common scenario: How to create a new piece of data for a Patient (in this case, an Observation) where the identifier of the Patient is known, but the ID is not.

In this scenario, we want to look up the Patient record and reference it from the newly created Observation. In the event that no Patient record already exists with the given identifier, a new one will be created and the Observation will reference it. This is known in FHIR as a [Conditional Create](#).

**JSON:**

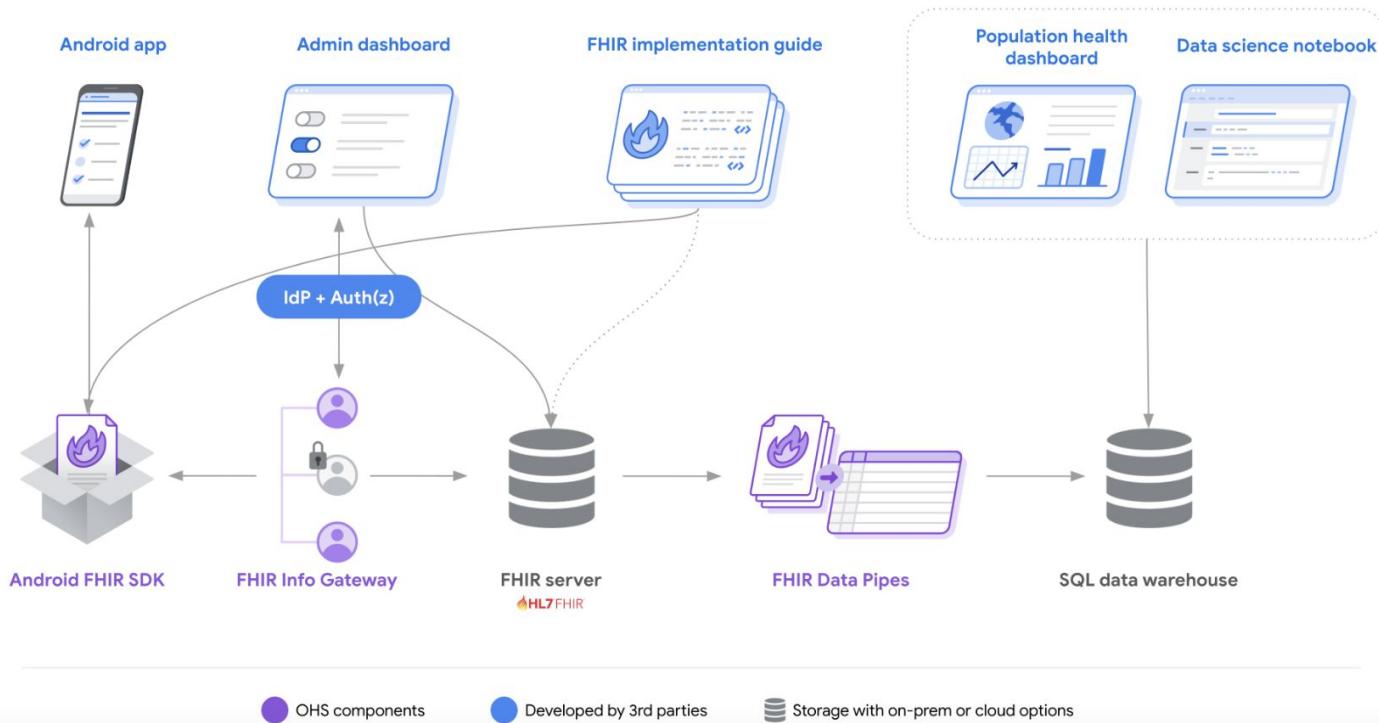
```
{
 "resourceType": "Bundle",
 "type": "transaction",
 "entry": [{
 "fullUrl": "urn:uuid:3bc44de3-069d-442d-829b-f3ef68cae371",
 "resource": {
 "resourceType": "Patient",
 "identifier": [{
 "system": "http://acme.org/mrns",
 "value": "12345"
 }],
 "name": {
 "given": "John",
 "family": "Doe",
 "prefix": "Dr.",
 "suffix": "MD"
 },
 "telecom": [{
 "system": "phone",
 "value": "+1 555-1234",
 "use": "home"
 }]
 }
 }]
```

<https://hapifhir.io/hapi-fhir/docs/client/examples.html>

On this page:

[Client Examples](#)[Transaction With Conditional Create](#)  
[Fetch all Pages of a Bundle](#)  
[Create Composition and Generate Document](#)

# Google on FHIR: Open OHS End to End FHIR



# FHIR Scope of Models: General to Specific

Scope: General Message Definitions to Implementable Message Specifications

- A single domain-wide model (reference model), e.g. HL7 v3/RIM, ISO 13606, FHIR Resource definitions
- Technology-independent specifications constraining the domain wide model, e.g. HL7 v3/RMIMs, CDA Templates, FHIR Profiles and archetypes.
- Implementable message specifications, mappings from technology-independent message specifications into the selected syntax, such as XML or JSON.

# Reference Information Model: General Scope

## HL7 v3/RIM (Reference Information Model):

- **RIM** is the core, abstract model used by HL7 v3. It provides a standardized, conceptual framework to represent healthcare data across different systems and domains.
- It defines the building blocks (like classes, attributes, and relationships) that are used to create healthcare-related messages, documents, and interactions.
- The RIM is highly abstract and not directly implementable. It serves as the foundation upon which more specific models and standards are built.
- Its purpose is to ensure consistency and a unified approach to handling healthcare information.

# Tying the RIM to the Storyboarding

Remember: The RIM contains abstract concepts.

Let's consider the following example of a patient encounter.

- **Entity:** A person (e.g., the patient or the healthcare provider).
- **Role:** The function of the entity in a particular context (e.g., "Patient" or "Doctor").
- **Act:** An action or event that happens (e.g., "Encounter", "Observation").
- **Participation:** The relationship between a role and an act (e.g., a patient participating in a doctor visit).

# Refined Message Information Model: Specific

- **RMIM** is a specialization or refinement of the RIM. It tailors the abstract concepts in the RIM to a particular use case or domain, such as lab results, patient records, or clinical encounters.
- RMIMs are more specific and closer to implementation. They define how data should be structured and exchanged in a given context based on the general principles of the RIM.
- Each RMIM refines the abstract RIM by selecting and constraining the appropriate classes, attributes, and relationships for the specific message or data exchange scenario.

# List out the objects at RIM level

## Entity (Person)

- Role: Patient
- Role: Healthcare Provider (Doctor)

## Act (Encounter)

- Participation: Patient (participates in Encounter)
- Participation: Doctor (participates in Encounter)

# List out the details at RMIM level

EncounterMessage (Message Header)

- Act: Encounter (type: Consultation)
- Participation: Patient (John Doe)
- Participation: Doctor (Dr. Smith)
- Observation: Blood Pressure (120/80 mmHg)

# Python code stub for RIM

```
HL7 v3 RIM Abstract Classes
```

```
class Entity:
```

```
 def __init__(self, name):
```

```
 self.name = name
```

```
class Role:
```

```
 def __init__(self, entity, role_type):
```

```
 self.entity = entity
```

```
 self.role_type = role_type
```

```
class Act:
```

```
 def __init__(self, act_type):
```

```
 self.act_type = act_type
```

```
 self.participations = []
```

# RMIM

```
class EncounterMessage:

 def __init__(self, encounter_type):

 self.encounter = Act(encounter_type)

 self.observations = []
```

# RMIM

```
def add_participant(self, entity_name, role_type):
 entity = Entity(entity_name)
 role = Role(entity, role_type)
 participation = Participation(role, self.encounter)
 self.encounter.add_participation(participation)
```

# Example: Patient Resource

```
<Patient xmlns="http://hl7.org/fhir">
 <id value="glossy"/>
 <meta>
 <lastUpdated value="2014-11-13T11:41:00+11:00"/>
 </meta>
 <text>
 <status value="generated"/>
 <div xmlns="http://www.w3.org/1999/xhtml">
 <p>Henry Levin the 7th</p>
 <p>MRN: 123456. Male, 24-Sept 1932</p>
 </div>
 </text>
 <extension url="http://example.org/StructureDefinition/trials">
 <valueCode value="renal"/>
 </extension>
 <identifier>
 <use value="usual"/>
 <type>
 <coding>
 <system value="http://hl7.org/fhir/v2/0203"/>
 <code value="MR"/>
 </coding>
 </type>
 <system value="http://www.goodhealth.org/identifiers/mrn"/>
 <value value="123456"/>
 </identifier>
 <active value="true"/>
 <name>
 <family value="Levin"/>
 <given value="Henry"/>
 <suffix value="The 7th"/>
 </name>
 <gender value="male"/>
 <birthDate value="1932-09-24"/>
 <careProvider>
 <reference value="Organization/2"/>
 <display value="Good Health Clinic"/>
 </careProvider>
</Patient>
```

Resource Identity & Metadata

Human Readable Summary

Extension with URL to definition

Standard Data:  
• MRN  
• Name  
• Gender  
• Birth Date  
• Provider

# Deep Dive

- **Level 1: Foundation**—The standard’s basic framework (**30 resources**). It is divided into Conformance, Terminology, Security, Documents and Other subcategories.
- **Level 2: Base**—Support for implementation and binding to external specifications (**26 resources**). It is divided into Individuals, Entities #1, Entities #2, Workflow and Management subcategories.
- **Level 3: Clinical**—Structural and process elements of real-world health care systems (**39 resources**). It is divided into Summary, Diagnostics, Medications, Care Provision and Request & Response subcategories.
- **Level 4: Financial**—Record-keeping and data exchange (**16 resources**). It is divided into Support, Billing, Payment and General subcategories.
- **Level 5: Specialized**—Providing the ability to reason about health care processes (**35 resources**). It is divided into Public Health & Research, Definitional Artifacts, Evidence-based Medicine, Quality Reporting & Testing and Medication Definition subcategories.

# Deep Dive into FHIR Resources

<b>Conformance</b>	Resources describe how a system does or should work	Conformance, StructureDefinition, ValueSet
<b>Infrastructure</b>	Resources defined as part of the API to provide API related services, or basic IT infrastructure	Bundle, List, AuditEvent
<b>Administration</b>	Resources to manage the administrative side of healthcare – who the participants are, where they are or should be, and managing workflow	Patient, Encounter, Appointment, Order / OrderResponse
<b>Clinical</b>	Clinical summaries, record keeping and planning	Observation, Condition, Care Plan, AllergyIntolerance
<b>Financial</b>	Resources that support the financial services associated with the provision of healthcare	Claim, Coverage, ExplanationOfBenefit

# Example of Conformance

## Due diligence with data: Data Quality Assessments

### Conformance

Value Conformance	Value Conformance (Do we have right list of values in "Gender" field ? Do we have correct range of values in "Temp" ? Do we have the right "UOM" ?
Schema and Relation Conformance	Is ORU R01 HL7V2 in expected message format ?)

### Accuracy

Are data values present ?	Discharge time is missed in data- last 24 hours.
Are data values good ?	Possible duplicate patients. Temp values out of range. Sex values agree with sex specific contexts (pregnancy, prostate cancer)  Data values and distributions (including subgroup distributions) agree with trusted reference standards

### Data Distribution in source systems

Data distribution/ Source Variations	Counts of unique patients by diagnosis code / procedure code /encounter type is as expected. Distribution of encounters per patient or medications per encounter are as expected. Types of patient population in source #1 vs. source #2.
Training / Serving Skew	If real time data look different from historical data, models will perform differently. Relationship between predictors to outcome may change over time - better treatment plan, new life saving device/procedure/drug and so on.

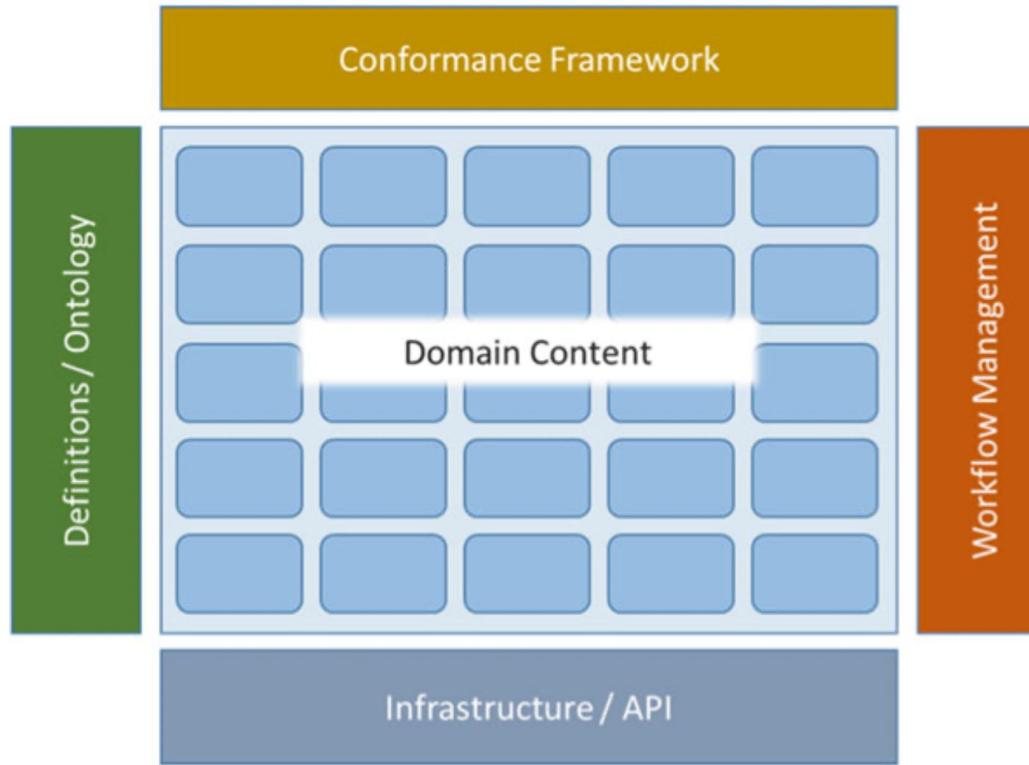
# Value Sets & Profiles

Code	Display	Definition
food	Food	Any substance consumed to provide nutritional support for the body.
medication	Medication	Substances administered to achieve a physiological effect.
environment	Environment	Any substances that are encountered in the environment, including any substance not already classified as food, medication, or
biologic	Biologic	A preparation that is synthesized from living organisms or their products, especially a human or animal protein, such as a hormone or antitoxin, that is used as a diagnostic, preventive, or therapeutic agent. Examples of biologic medications include: vaccines; allergenic extracts, which are used for both diagnosis and treatment (for example, allergy shots); gene therapies; cellular therapies. There are

```
{
 "resourceType": "ValueSet",
 "id": "example-gender",
 "status": "active",
 "description": "Example Value Set for Gender",
 "compose": {
 "include": [
 {
 "system": "http://hl7.org/fhir/administrative-gender",
 "concept": [
 { "code": "male", "display": "Male" },
 { "code": "female", "display": "Female" },
 { "code": "other", "display": "Other" },
 { "code": "unknown", "display": "Unknown" }
]
 }
]
 }
}
```

Note the Difference from Profiles which Provide a set of constraints on a resource for particular contexts of use.

# FHIR Spec



# Hands On: Explore ClinFHIR & HAPI FHIR

### Search for Patient

Enter name for patient search

Enter Id of patient on this server

Enter Identifier of patient

Cancel

clinFHIR Launcher

For Implementers  For developers

Patient Viewer

Graph Builder 2

Add new patient

<https://fhir.s37vcloskatz.static-test-account.isccloud.io/>

If the server is protected by OAuth2 / SMART enter the Access Token

Bundle Visualizer

Various displays for the contents of a bundle. Bundles can be pasted into the viewer and optionally saved in the data server.

Server Query

Supports ad hoc queries against any FHIR server. Includes a simple query builder. The response can be displayed as Json or a Tree view, and FHIRPath is supported.

Implementation Guide Browser

Display the contents of an Implementation Guide, and the relationships between the contents of the Guide.

Scenario Builder

The Scenario Builder is used to join together the resources needed to represent a specific clinical scenario. It can use Core Resource types, Profiles and Logical models as it does this. The intention is to help people understand how resources can tell a clinical story, and to validate that the resource types available (including profiles) are sufficient.

Note that the builder still has issues with more complex resource types - this is a work in progress

Resource Validator

Validate a resource, or bundle of resources, by calling one or more validation servers.

<http://clinfhir.com/>

supported by  InterSystems®  
Creative data technology

Current servers

Data Server	InterSystems IRIS R4
Conformance Server	Public HAPI R4 server
Terminology Server	OntoserverR4 (terminology)

Add Server

FHIR Links (open in new tab)

R4 Specification (current)	Hay on FHIR
STU-3 Specification	FHIR Chat
STU-2 Specification	FHIR.org
FHIR wiki	Clinicians Workshop

clinFHIR Videos (open in new tab)

Scenario Builder	Other links
Adding structured data	SNOMED browser
Logical Modeler	SHRIMP (Terminology browser)
Logical Modeler and Scenario Builder	
RESTful query tool	

*Note that some of these videos may describe earlier versions, so may not completely match the current functionality.*

Thanks to [InterSystems](#) for supporting the development of clinFHIR.

# India on FHIR

MAY 23, 2022 • 8 MIN READ

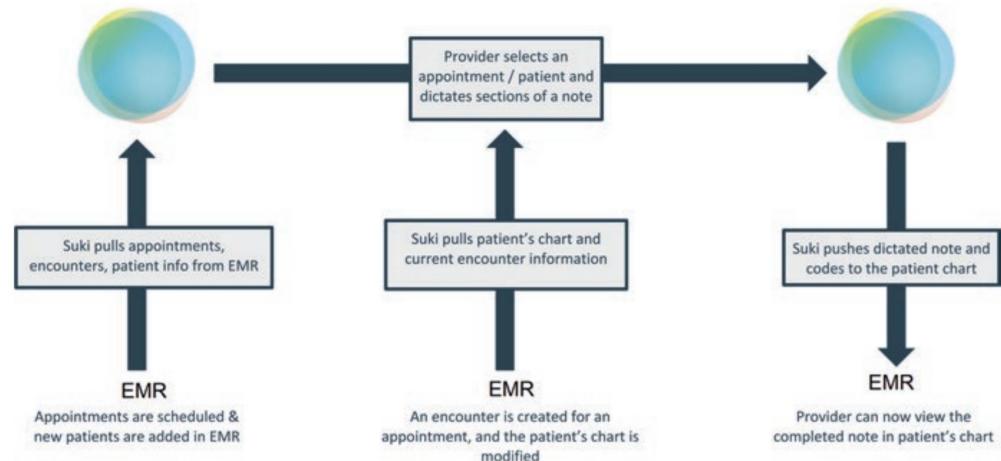
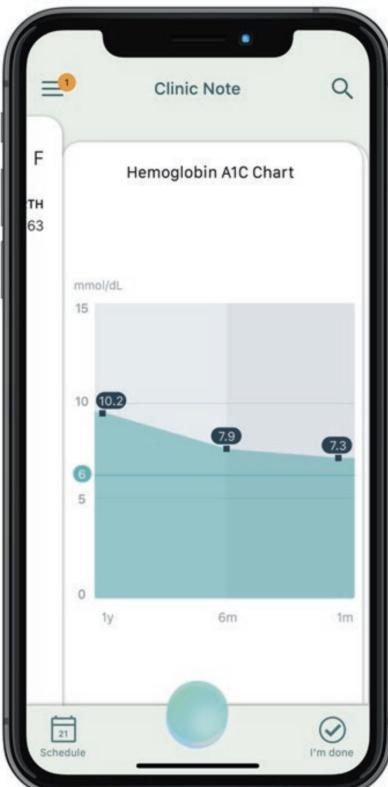
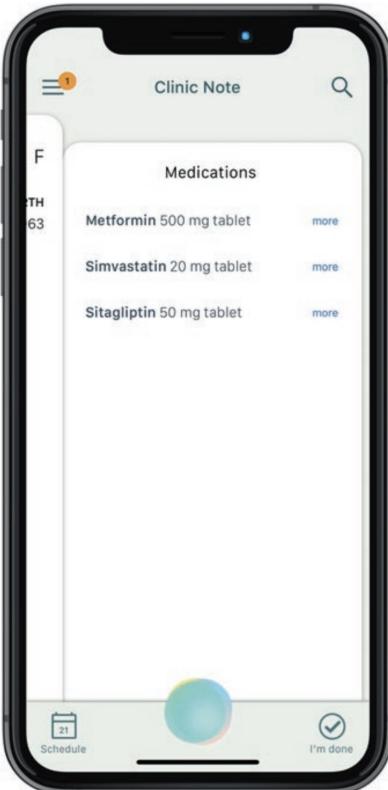
## Ayushman Bharat Digital Mission: Ushering in the UPI moment of healthcare

The illustration shows a large smartphone displaying a female doctor in a white coat and stethoscope. A green cross icon is positioned next to her. To the right, a male patient in a teal shirt is shown with a speech bubble above him. Various icons representing healthcare, such as a heart rate monitor and a message bubble, are floating around the phone and the patient.

 **AYUSHMAN BHARAT**  
**DIGITAL MISSION**

Building digital health ecosystem<sup>+</sup>

# Suki, show me the medications of Mr. Sinha



# India's FHIR Stack (ABDM)



- ▶ Building blocks
- ▼ Overview of FHIR framework

## Architecture

- FHIR components & roles
- FHIR flows
- APIs and Standards
- ▶ Implementer's guide
- ▶ Preparation of data and packaging
- ▶ How do I participate?
- ▶ Postman Collection

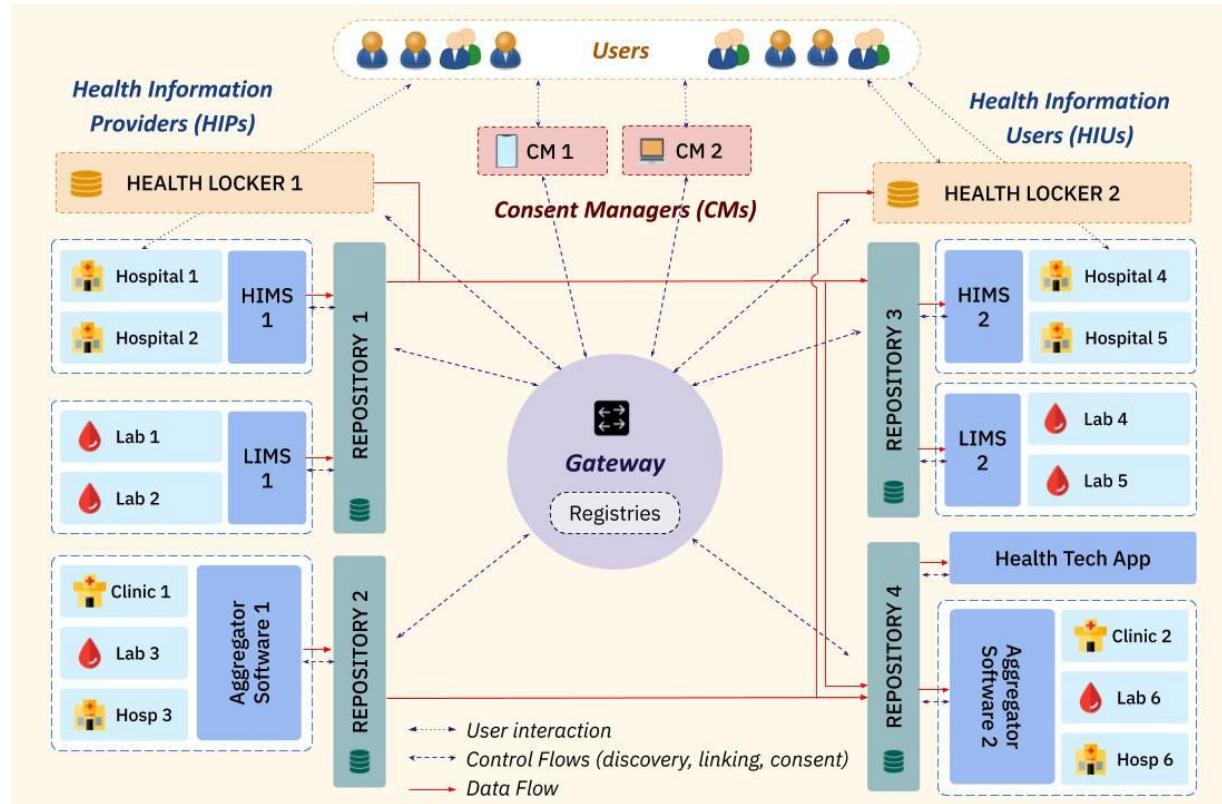
## ABDM digital health architecture

### Overview of architecture

The FHIR architecture is inline with the concepts described in the Niti Aayog National Health Stack (NHS) strategy and approach concept paper<sup>1</sup> published in July 2018.

As stated in the National Health Digital Mission (ABDM) operational strategy, the architecture is modelled as a Federated Architecture, where management and data access occurs in a 'federated' manner – where multiple entities will manage health data about users. The federated architecture will enable current and future health information flowing through the system, for example between providers and patients, wearables and EHR/EMRs, consumers and physicians, labs, institutions and payers. A centralized approach, where collation of data in National Repositories for democracy like ours with a 1.35 billion population will be prohibitively expensive and increase friction with the ecosystem, would be a single point of failure, with any security breach resulting in unimaginable compromise. A federated system allows data to sit at the source and be accessible on demand.

# India's FHIR Stack (ABDM)





# FHIR Implementation Guide for ABDM

CI Build v2.0.1



Home Profiles Terminology Examples Downloads



## FHIR Profiles for ABDM Health Data Interchange Specifications

### Table of Contents

This Implementation guide is published and maintained by NRCeS for NHA.

This version is based on the ABDM Health Data Interchange Specifications 1.0 and updated periodically.

Narrative Content

Detailed Descriptions

Mappings

XML

JSON

Turtle

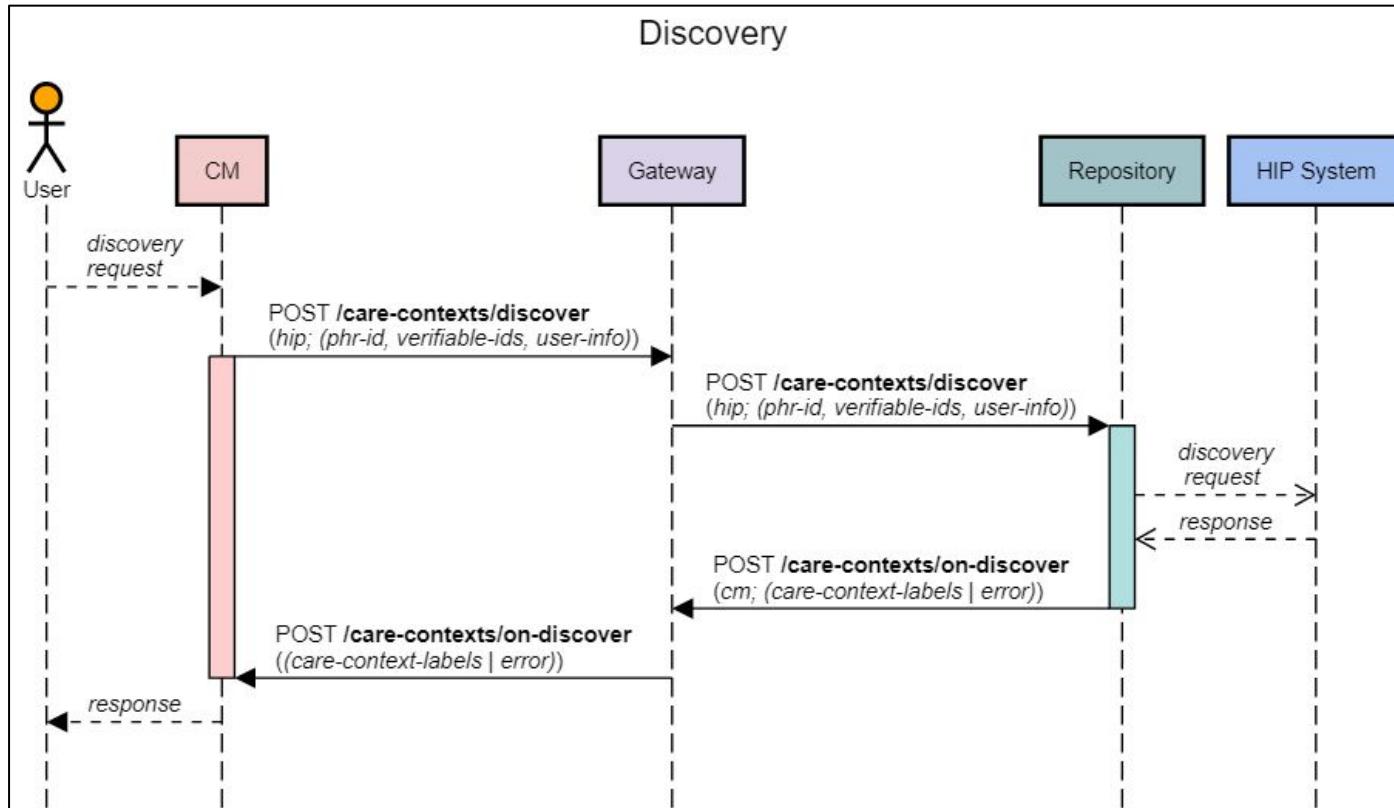
## Definitions for the StructureDefinition-PrescriptionRecord Profile.

### 1. Composition

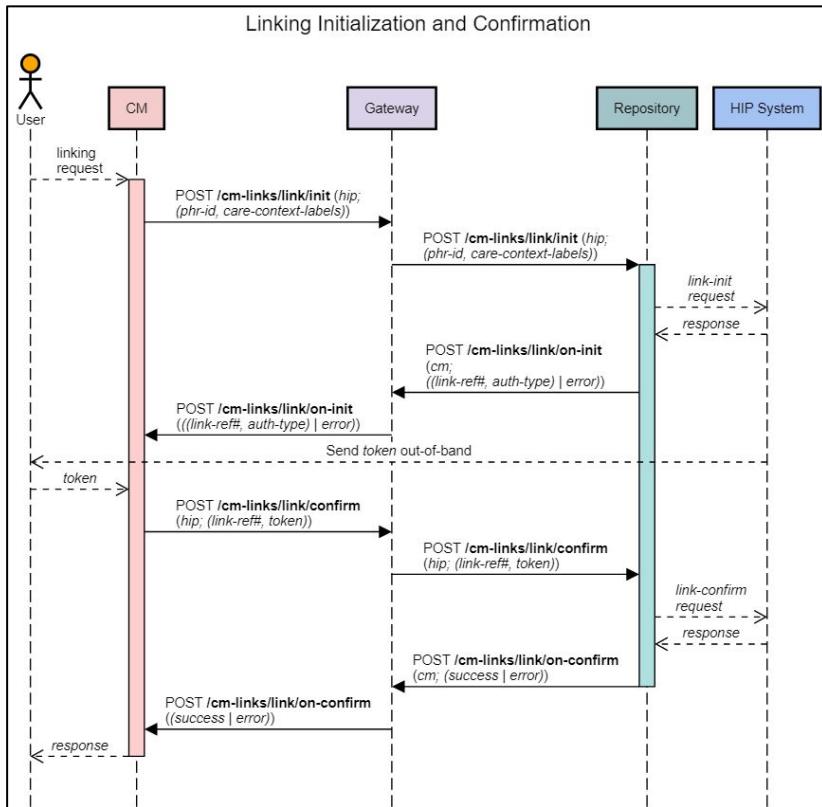
**Definition** A set of healthcare-related information that is assembled together into a single logical package that provides a single coherent statement of meaning, establishes its own context and that has clinical attestation with regard to who is making the statement. A Composition defines the structure and narrative content necessary for a document. However, a Composition alone does not constitute a document. Rather, the Composition must be the first entry in a Bundle where Bundle.type=document, and any other resources referenced from Composition must be included as subsequent entries in the Bundle (for example Patient, Practitioner, Encounter, etc.).

A set of healthcare-related information that is assembled together into a Composition to represent a physician's order for the preparation and administration of a drug or device for a patient. A Composition defines the structure, it does not actually contain the content: rather the full content of a document (for example Patient, Practitioner, Organization, MedicationRequest, etc.) is contained in a Bundle, of which the Composition is the first resource contained.

# Discovery of Patient Information



# Linking to Hospital (HIP)



# Health ID and Consent Management Framework

## Health data consent manager (HDCM)

HDCM plays the role of fiduciary or trustee with which a patient signs up to begin with. The HDCM does the following:

- Helps to create or discover existing ABDM ABHA Number
- Manages patient linkages to providers
- Manages consent for access to health information
- Helps discover patient information
- Monitors information exchange between HIP and HIU

All the above are done via a Patient App. In future, there will be other channels for patients to manage their health data.

## Health information gateway

Gateway is the hub that mediates and connects Consent Manager(s), Health Repository Providers and HIUs in the network. Its primary job is to allow for discovery, routing in the network. The gateway does the following:

- Connects and validates the HDCMs and health repositories (servicing HIUs and HIPs) to the network.
- Enables routing of information.
- Authenticates connected systems within the FHR Framework (provides a signed authentication token for FHR framework including the gateway communicates via asynchronous APIs over HTTPs channel.

## Registries

There are various National level Registries that are integrated with the network.

- Health Facility registry (HFR)
- Doctor or practitioner registry (DigiDoctor)
- HDCM and Health Repository Provider (HPR) Registry

The HDCM and HRP registries are currently maintained by the ABDM Gateway.

## Health repository

A health repository is the connector or bridge through which any HIU or HIP can connect to the network. The health repository allows HIPs and HIUs to access patient data for a specific period of time. The sandbox environment provides a basic HIU system, representing a doctor's interface. The sandbox environment also provides a mock HIP system using which you can test linkages and access to health information from multiple sources.

# Health ID and Consent Management Framework

## Registering as a patient using the Patient App

The following sections explain how a patient can register via consent manager app. Once you've registered as a patient, you will be able to search hospitals and choose to link your patient care contexts for the selected one. This will enable access to medical records for a HIU or for the patient herself.

### Mobile number verification

To register via the patient app, the first step is to register using a digitally verifiable identifier. As of now, Aadhaar and mobile numbers are such identifiers. In future, more digital identifiers would be supported.

Perform the following tasks to begin your registration process on the Consent Manager app:

1. Install the consent manager application on your phone.  
[Download .apk file ↴](#).
2. Open the Consent Manager app and click on the **Register** button to register as a patient.
3. You will be asked to enter your mobile phone number, in order to verify your identity. Make sure that you enter the mobile number which you generally provide at the hospitals that you visit.
4. Enter your mobile number. Take care to enter valid phone number.
5. Click the **Verify** button to authenticate your mobile number.
6. You will receive an SMS from the ABDM Consent Manager, along with an OTP (One Time Password).
7. Enter the OTP in the Consent Manager app.
8. If your OTP is validated, you will be directed to a Registration screen. If your OTP is not validated, you will be prompted to enter a valid OTP

## HIP services

The following responsibilities are expected to be carried out by HIP services in the FHIR Framework context:

- Ability to discover and link patient's care contexts within an organization's system.
- Allow for consented means of exchange of patient's health information in a machine readable format (FHIR), conforming to standards setup by ABDM.
- Provide a secure and safe means of data transfer from organization-specific HIS (Health Information System) instance to a validated and consented requester HIU, through the ABDM Gateway.

## HIU services

The following capabilities are expected of HIU services in the FHR context:

- Ability to search for and identify a patient using her ABHA Number. HIU systems can search for patients linked within the ABDM Gateway network, and across diverse Gateway networks in future.
- Ability to request and receive patient data in a safe and secure manner, manage data lifecycle, and enable secure data storage and access.

## Health locker services

Health locker provides a personal digital storage for users/patients. The following capabilities are expected of Health locker services in the FHR context:

- Sign up users/patients in their system.
- Allow users to upload their health documents to their locker.
- Ability to fetch users health documents from the HIPs based on patient consent.
- Ability to Provide Health Documents, both self uploaded and fetched from HIPs, to a valid requestor.
- Allow user/patient access to their health documents (through their locker apps or other channels).
- Provide secure means for health document access and storage.

### What is a Patient App?

While building and testing your health repository in integration with the sandbox's network components, you'll need to test patient flows as well. For example:

- Signup of patient with Consent Manager (CM)
- Linking patient's CM account with HIP's patient reference and health care contexts
- Granting or revoking consents

You can do all of the above using APIs as well, but the easiest way would be to use the reference patient Android App. [Download .apk file ↗](#).



ABHA Number Service

Health Facility Registry

DigiDoctor

Consent Manager and Gateway

ABHA Mobile Application

HIU Application

HIP Application

UHI Apps

HCX Integrators

▼ Overview of FHR framework

Architecture

FHR components & roles

FHR flows

APIs and Standards

▼ Implementer's guide

What is already available

What resources can I use

ABDM Sandbox integration & exit process

Building HIP

Facility share profile

Building HIU

Building Health Locker

Building ABHA Mobile Application

▼ Building UHI Applications

UHI Protocol

Terminology

UHI Architecture Overview

Registering your UHI App

Sandbox Gateway, EUA & HSPA

## Building UHI EUA App

This details out the steps to build your own EUA app including

- Sign up / Sign in with PHR Address
- Select a UHI service
  - Teleconsultations
    - Search HSPAs for Doctor
    - Display search results
    - Book selected Doctor/Facility
    - Collect Payment if required
    - Confirm Booking
    - Exchange Messages with Doctor
    - Share health records
    - Setup WebRTC (teleconsults)
    - Initiate Call (teleconsults)
    - Get final prescription
  - Appointment booking
    - Search HSPAs for Facility/Doctor
    - Display search results
    - Book selected Facility/Doctor
    - Collect Payment if required
    - Confirm Booking
  - Ambulance booking
    - Search HSPAs for Facility/Doctor
    - Display search results
    - Book selected Facility/Doctor
    - Collect Payment if required
    - Confirm Booking

[Link for UHI APIs](#)

# Example Apps

Citizen/Patient Services
Single, Secure Health id to all citizens
Personal Health Record
Singel (National) Health Portal
App Store
Specialized Services for Remote Areas/ Disadvantaged Groups
NDHM Call Centre
Digital Referrals & Consultations
Online Appointments
e-Prescription Service
Digital Child Health
National "Opt-out" (for privacy)
Services by / for Healthcare Providers/ Professionals
Summary Care Record
Open Platform to access Emergency Services
Technology for Practitioner (GP) Transformation
Digital Referrals, Case Transfers
Clinical Decision Support (CDS)
Digital Pharmacy & pharmacy Supply Chain
Hospital Digitization (HIS)
Digital Diagnostics
Technical Services
Architecture & Interoperability
Health Information Exchange
Standards
Health Network
Data & Cyber Security
Information Governance

The image displays three screenshots of a mobile health application interface, likely from the NDHM app, showing various patient records and medical histories.

- Left Screenshot:** Shows a list of "My Health Records" under "ndhm". It includes sections for "Discharge Summary...", "Immunization", and "Prescription". Below these are records for "3rd Oct, 2019 - Max Health Care" and "5th Aug, 2019 - Max Health Care". Each record shows details like date, location, and specific medical information (e.g., Tetanus Toxoid, Tuberculosis - Live Attenuated).
- Middle Screenshot:** A detailed view of an "Immunization" record. It shows a summary table with columns for Lot Number, Route, Reason, Occurrence Date, Dose Number, and Manufacturer. Below this is a section for "Tuberculosis - Live Attenuated" with similar detailed information.
- Right Screenshot:** A detailed view of a "Discharge Summary - Bacillus..." record. It includes sections for "Max Health Care" (inpatient visit), "Admitted On" (01 Oct 2019, 03:32pm), "Diagnosis" (Bacterial infection due to Bacillus), and "Presenting Problems" (Vomiting, Brief loss of consciousness, Swinging fever). It also shows "Prescribed medications during Admission" and "Procedures Performed".



- ▶ Building blocks
- ▶ Overview of FHIR framework
- ▶ Implementer's guide
- ▼ Preparation of data and packaging
  - The main envelope
  - Diagnostic reports as FHIR
  - DiagnosticReport
- Data encryption and decryption**
  - How to start testing the health repositories
- ▶ How do I participate?
- ▶ Postman Collection

## Data encryption and decryption as requester HIU

The following abbreviations are used in this section:

- ECDH: Elliptic-curve Diffie–Hellman Key Exchange
- AES-GCM: Advanced Encryption Standard–Galois/Counter Mode
- DHPK: Elliptic-curve Diffie–Hellman public key
- DHSK: Elliptic-curve Diffie–Hellman secret/private key
- P and U is annotation for system
- DHK(U,P): Elliptic-curve Diffie–Hellman Key
- Rand: Random String

Information shared as part of the data flow will be secured using an encryption mechanism that ensures perfect forward secrecy. This means that even if any of the key materials stored at HIPs, HIUs or HDCM clients (either long-term private keys or session keys) are compromised, it would not be possible to decipher data that was previously exchanged. The encryption mechanism uses Elliptic-curve Diffie–Hellman Key Exchange (ECDH), which is used in many Internet protocols such as SSH and TLS for establishing shared secret keys between remote parties.

### Data encryption for HDCM client

The following points detail the process behind data encryption for HDCM client:

1. When creating a data request, the HIU does the following:
  - a. Creates a set of Elliptic-curve Diffie–Hellman (ECDH) parameters
  - b. Generates a **ECDH key pair ( $dhsk(U)$ ,  $dhpk(U)$ )** (which is a short-term public-private key pair)
  - c. Generates a **32-byte random value**,  $rand(U)$  which is also called **nonce**.
2. The HIU sends these values to HDCM, along with the data request via a digitally-signed API call.
3. HDCM forwards the request to the HIP, again via a digitally-signed API call.
4. HIP checks whether the consent artefact is valid, and whether the data being requested is in keeping with the terms of the artefact. If the artefact is valid, the HIP does the following:
  - Generates a fresh ECDH public-private key pair in the same group as specified by the HIU **(( $dhsk(P)$ ,  $dhpk(P)$ )**

# Profiling a FHIR Resource

The screenshot shows the HL7 FHIR Release 4 website. The header features the HL7 FHIR logo and navigation links for Home, Getting Started, Documentation, Resources, Profiles, Extensions, Operations, and Terminologies. A search icon and a user profile icon are also present. The main content area is titled "Conformance > Profiling FHIR". A red banner at the top of the content area states: "This page is part of the FHIR Specification (v4.0.1: R4 - Mixed Normative and STU) in its permanent home (it will always be available at this URL). The current version which supercedes this version is 5.0.0. For a full list of available versions, see the [Directory of published versions](#). Page versions: R5 R4B R4 R3 R2". Below the banner, there are two tabs: "Profiling FHIR" (which is selected) and "Examples". The main section is titled "5.1.0 Profiling FHIR". It includes a table with three rows: "FHIR Infrastructure Work Group", "Maturity Level: Normative", and "Standards Status: Normative". A green box contains the text: "ANSI This page has been approved as part of an ANSI standard. See the Infrastructure Package for further details." Below this, a paragraph explains the nature of the FHIR specification and the need for adaptation. A bulleted list details the types of adaptations. Finally, a note about vendor/implementation variations is provided.

This page is part of the FHIR Specification (v4.0.1: R4 - Mixed Normative and STU) in its permanent home (it will always be available at this URL). The current version which supercedes this version is 5.0.0. For a full list of available versions, see the [Directory of published versions](#). Page versions: R5 R4B R4 R3 R2

FHIR Infrastructure Work Group    Maturity Level: Normative    Standards Status: Normative

ANSI This page has been approved as part of an ANSI standard. See the Infrastructure Package for further details.

The base FHIR specification (this specification) describes a set of base resources, frameworks and APIs that are used in many different contexts in healthcare. However, there is wide variability between jurisdictions and across the healthcare ecosystem around practices, requirements, regulations, education and what actions are feasible and/or beneficial.

For this reason, the FHIR specification is a "platform specification" - it creates a common platform or foundation on which a variety of different solutions are implemented. As a consequence, this specification usually requires further adaptation to particular contexts of use. Typically, these adaptations specify:

- Rules about which resource elements are or are not used, and what additional elements are added that are not part of the base specification
- Rules about which API features are used, and how
- Rules about which terminologies are used in particular elements
- Descriptions of how the Resource elements and API features map to local requirements and/or implementations

Note that because of the nature of the healthcare ecosystem, there may be multiple overlapping sets of adaptations - by healthcare domain, by country, by institution, and/or by vendor/implementation.

5.1.0.1 Glossary

AUG 2, 2022 • 9 MIN READ

## Case Study - Implementing ABDM for the Government of Andhra Pradesh



IMPLEMENTING  
**ABDM**  
FOR THE ANDHRA PRADESH GOVERNMENT

CASE STUDY

The Ministry of Health and Welfare, Andhra Pradesh approached us to help with implementing all the 3 milestones for [Ayushman Bharat Digital Mission](#). Most of the ABDM APIs were built on top of FHIR, and they found out about Medblocks through our content.

<https://medblocks.org/abdm-for-the-ap-government-a-honest-review/>

# Health ID



The image displays two screenshots of the Ayushman Bharat Digital Mission (ABDM) system. The left screenshot shows the 'ABHA number' creation page with fields for ABHA Address (n123@bx), Authentication Mode (Mobile OTP selected), and OTP (279224). A 'Verified' button is highlighted. The right screenshot shows the 'Recent Encounters' section for a user named Nishtha Mahajan, listing several encounters with encounter IDs ENC-00036 through ENC-00029. The bottom part of this screenshot shows a mobile application interface with tabs for 'My Records', 'Linked Facility', 'Consents', and 'Nearby', and a patient summary for 'ENC-00035 2022-5-14 - OFD'.

# Real World Implementations of FHIR Resources

# How UK is Building PHRs on FHIR

The screenshot shows a blue header bar with the text "Care Connect API | FHIR®". Below the header, there's a logo for INTEROPen and a "Supported by NHS Digital" badge. A navigation bar includes "Nav", "Care Connect", "FHIR", and "Feedback". A dropdown menu is open under "Care Connect", listing "HL7 UK Care Connect Profiles", "NHS Digital Profiles", and "Care Connect Reference Implementation". At the bottom, a red banner contains the text "Build | FHIR Patient Server" and "Summary: How to create a basic FHIR Patient server using open source tools".

Home Care Connect API | FHIR®

INTEROPen

Supported by **NHS**  
Digital

Build | FHIR Patient Server

Summary: How to create a basic FHIR Patient server using open source tools

- HL7 UK Care Connect Profiles
- NHS Digital Profiles
- Care Connect Reference Implementation

[Overview](#)[Repositories 198](#)[Projects](#)[Packages](#)[People 4](#) Find a repository...[Type ▾](#)[Language ▾](#)[Sort ▾](#)

## STU3-FHIR-Assets

[Public](#)

Repository for development of NHS Digital STU3 FHIR assets.



10

8

1

0

Updated 19 minutes ago

## prm-repo-pds-adaptor

[Public](#)

The PDS-Adaptor is a web service that will communicate with the PDS using the FHIR API to maintain patient details.



0

0

0

0

Updated 13 hours ago

[nhsconnect / careconnect-examples](#)

Public

Notifications

[Code](#)[Issues](#)[Pull requests](#)

3

[Actions](#)[Projects](#)[Security](#)[Insights](#)[master](#) ▾

4 branches

0 tags

[Go to file](#)[Code](#) ▾

KevinMayfield Merge remote-tracking branch 'origin/master' ...

e82bddb on 25 Jun 2019 ⏲ 273 commits

[UHSDiagnosticReports](#)

Github warning

3 years ago

[ccri-edms-server](#)

Copied over EDMS (alfresco) example from ccri-document

4 years ago

[ccri-eolc](#)

Changes for DWP

3 years ago

[ccri-interopen-examples](#)

Combined all doc uploads into one module

3 years ago

# Step 1: Building a FHIR Server

If you followed the pre-requisites and whether you have chosen IntelliJ or Eclipse, you should have a basic FHIR server. To test and confirm, start POSTMan and enter this URL

GET http://127.0.0.1:8183/STU3/metadata

You should see a FHIR **ConformanceStatement** returned from the server.

The screenshot shows the Postman application window. The top navigation bar includes File, Edit, View, Help, New, Import, Runner, and a workspace dropdown set to "My Workspace". The status bar indicates "IN SYNC". The left sidebar shows a "History" tab with three collections: "Mitre" (3 requests), "Postman Ec..." (37 requests), and "FHIR Message" (6 requests). The main workspace displays a GET request to "http://127.0.0.1:8183/STU3/metadata". The request details panel shows the method as "GET", the URL as "http://127.0.0.1:8183/STU3/metadata", and a "Send" button. Below the URL, the "Authorization" tab is selected, showing "Inherit auth from parent". A note states: "The authorization header will be automatically generated when you send the request. [Learn more about authorization](#)". The right side of the workspace shows a message: "This request is not inheriting any authorization helper at the moment. Save it in a collection to use the parent's authorization helper."

[https://nhsconnect.github.io/CareConnectAPI/build\\_patient\\_server.html](https://nhsconnect.github.io/CareConnectAPI/build_patient_server.html)

# Step 2: Adding a Patient

The screenshot shows the Postman application interface. At the top, there is a header bar with 'POST' dropdown, URL 'http://127.0.0.1:8183/STU3/Patient', 'Params' button, 'Send' button, and 'Save' button. Below the header, there are tabs for 'Authorization', 'Headers (1)', 'Body' (which is selected), 'Pre-request Script', and 'Tests'. On the far right, there are 'Cookies' and 'Code' buttons. Under the 'Body' tab, there are four radio buttons: 'form-data', 'x-www-form-urlencoded', 'raw' (which is selected), and 'binary'. Below these buttons is a large code editor area containing FHIR XML. The XML defines a patient resource with an ID of '1', a last updated timestamp of '2018-04-03T13:59:40.080+00:00', and a profile of 'CareConnect-Patient-1'. It includes two extensions: one for ethnicity ('British, Mixed British') and one for NHS number verification status ('Number present and verified'). Both extensions use the 'CareConnect' code system and have a value of 'A'.

```
1 <Patient xmlns="http://hl7.org/fhir">
2 <id value="1"/>
3 <meta>
4 <lastUpdated value="2018-04-03T13:59:40.080+00:00"/>
5 <profile value="https://fhir.hl7.org.uk/STU3/StructureDefinition/CareConnect-Patient-1"/>
6 </meta>
7 <extension url="https://fhir.hl7.org.uk/STU3/StructureDefinition/Extension-CareConnect-EthnicCategory-1">
8 <valueCodeableConcept>
9 <coding>
10 <system value="https://fhir.hl7.org.uk/STU3/CodeSystem/CareConnect-EthnicCategory-1"/>
11 <code value="A"/>
12 <display value="British, Mixed British"/>
13 </coding>
14 </valueCodeableConcept>
15 </extension>
16 <identifier>
17 <extension url="https://fhir.hl7.org.uk/STU3/StructureDefinition/Extension-CareConnect-NHSNumberVerificationStatus-1">
18 <valueCodeableConcept>
19 <coding>
20 <system value="https://fhir.hl7.org.uk/STU3/CodeSystem/CareConnect-NHSNumberVerificationStatus-1"/>
21 <code value="01"/>
22 <display value="Number present and verified"/>
23 </coding>
24 </valueCodeableConcept>
25 </extension>
26 <system value="https://fhir.nhs.uk/Td/nhs-number"/>
```

# Storing in a Database

The screenshot shows the MongoDB Compass interface connected to a standalone MongoDB instance at localhost:27017. The database is 'ccri-fhirStarter' and the collection is 'idxPatient'. There is one document in the collection.

**Document Details:**

```
_id: ObjectId("5ac47fd723598f6af80ff1fe")
_class: "uk.nhs.careconnect.fhirstarter.entities.PatientEntity"
dateOfBirth: 1998-03-13 00:00:00.000
gender: "FEMALE"
identifiers: Array
 0: Object
 system: "https://fhir.nhs.uk/Id/nhs-number"
 value: "9876543210"
 1: Object
 system: "https://fhir.leedsth.nhs.uk/Id/pas-number"
 value: "ABC8650149"
 2: Object
 system: "https://fhir.leedsth.nhs.uk/Id/PPMIIdentifier"
 value: "1"
telecoms: Array
names: Array
 0: Object
addresses: Array
 0: Object
 city: "Nottingham"
 county: "Derbyshire"
 use: "WORK"
 postcode: "NG10 1ZZ"
 lines: Array
 0: "Field Jardin"
 1: "Long Eaton"
```

**Thanks for  
attending the class!**