

Computing for Medicine

Lecture 11: HL7 & FHIR

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

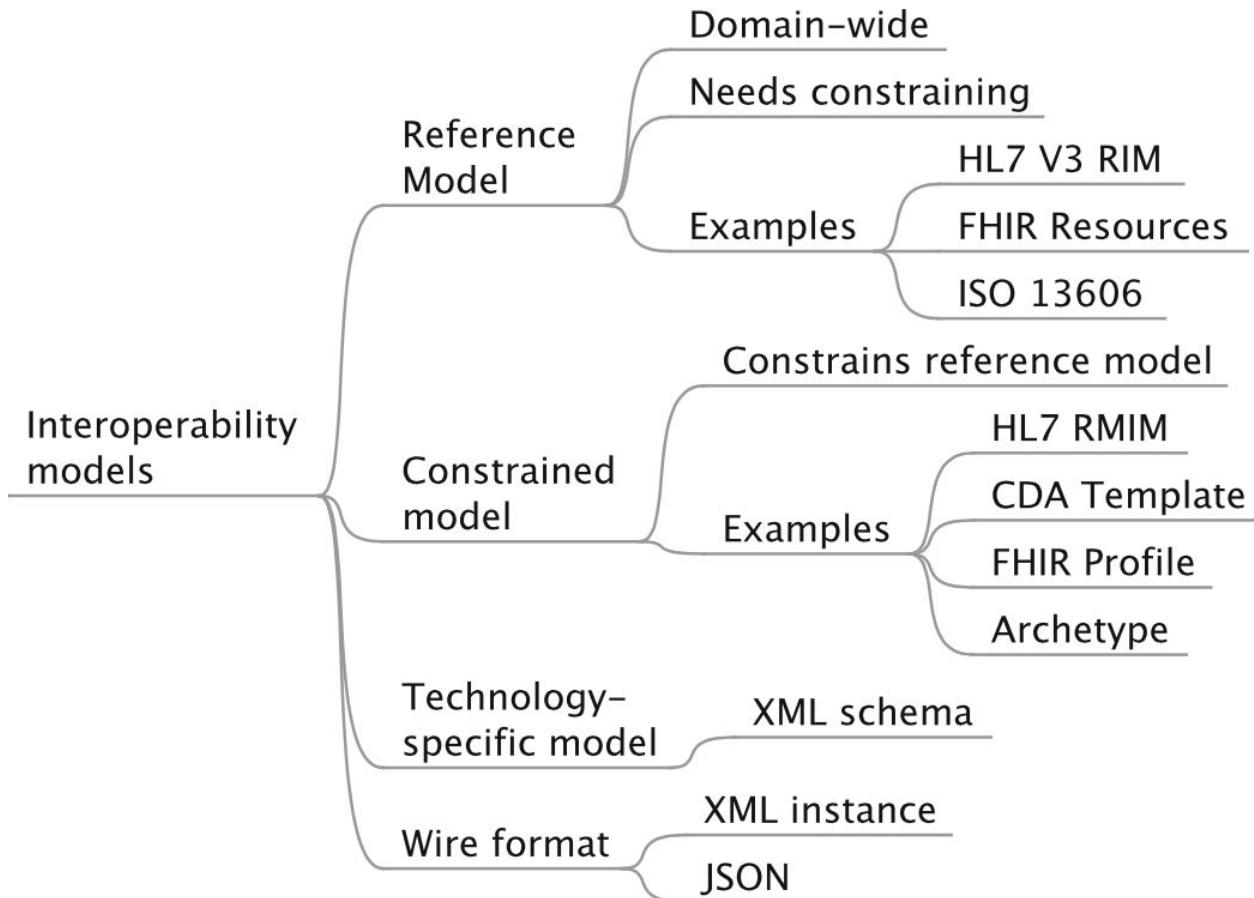
Requires the following sequential steps in Object Oriented Software Development

- 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
```



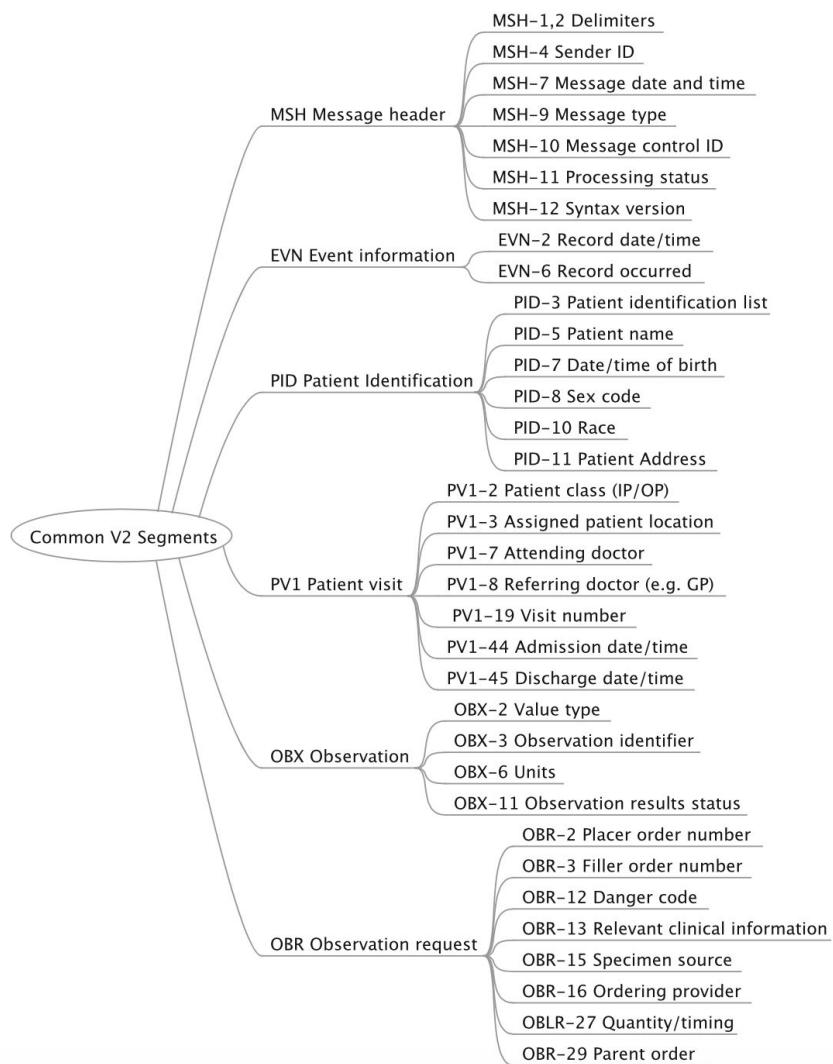
Segment Definitions, Segments, Reports

```

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



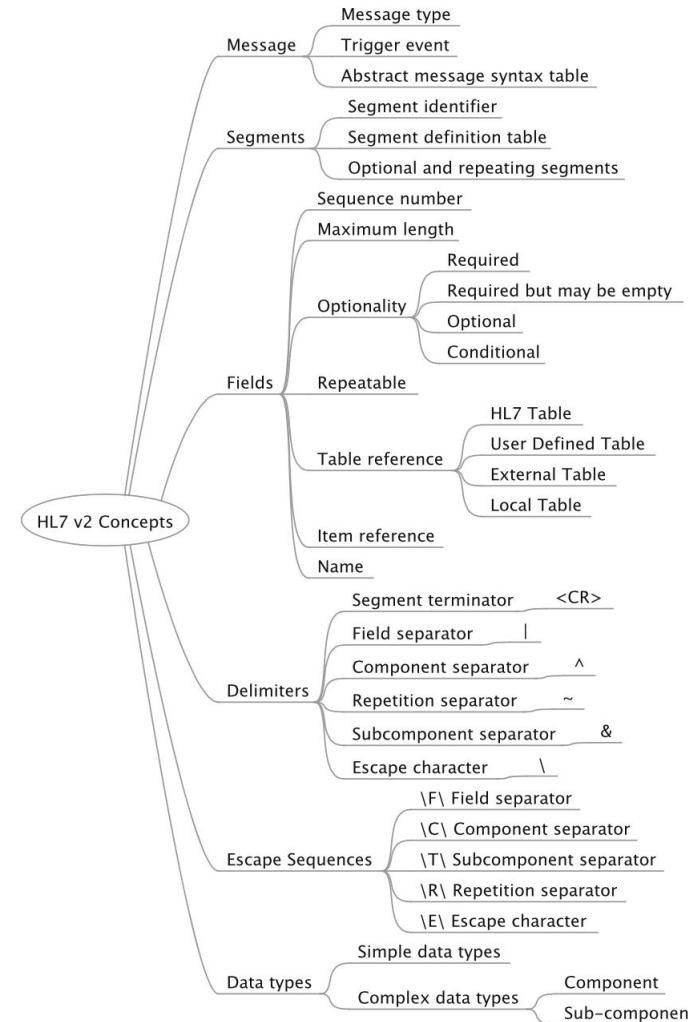
HL7 Messages

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"
 }
 }
 }
]
}
```

# 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.

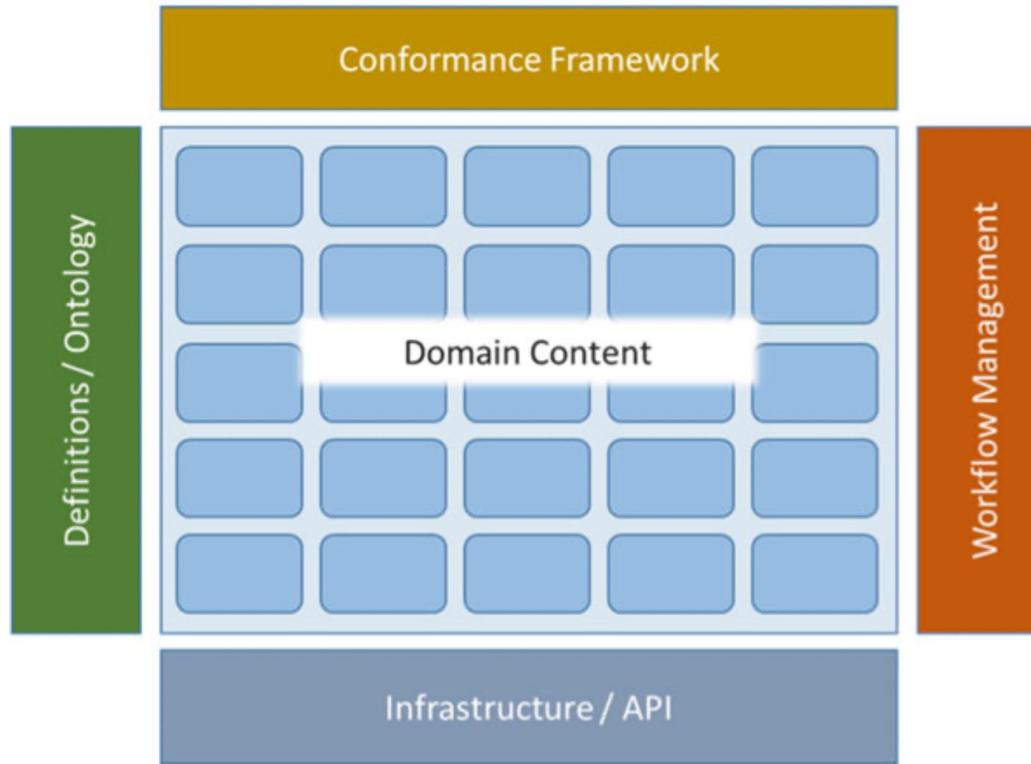
# Value Sets & Profiles

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



# 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 active) 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

# 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. At the top right is the HL7 FHIR logo. Below the title, a navigation bar includes links for "IG Home", "Table of Contents", "Background", "Specification", "Downloads", and "Artifact Index". A breadcrumb trail "Table of Contents > Home Page" is shown below the navigation bar. 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 starts with a section titled "1 Home Page" containing a table with metadata like Official URL, Version, Draft date, and Computable Name. Below this is a paragraph about the IG's purpose and two pathways for LIS to CCR. A yellow callout box lists Scope, Dependencies, Audience, and Acknowledgements. Further down, there's a paragraph about the publication's purpose and a note about eCP content. The footer states the guide is sponsored by HL7 O&O and Public Health Work Groups, defines 8 FHIR profiles, and is version 1.1.1.

**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:

# Openly Available FHIR Servers: 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>

# 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)	<a href="#">Hay on FHIR</a>
STU-3 Specification	<a href="#">FHIR Chat</a>
STU-2 Specification	<a href="#">FHIR.org</a>
FHIR wiki	<a href="#">Clinicians Workshop</a>

clinFHIR Videos (open in new tab)

Scenario Builder	<a href="#">Other links</a>
Adding structured data	<a href="#">SNOMED browser</a>
Logical Modeler	<a href="#">SHRIMP (Terminology browser)</a>
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.

# 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

# Summary of the resource

Section	Purpose	Key Elements
Resource Identity & Metadata	Tracks and manages the version and identity of this patient resource.	<code>id, meta.lastUpdated</code>
Human Readable Summary	Ensures clinicians can read an intelligible summary of the patient's data.	<code>text, div, p</code>
Extension	Adds non-core data while keeping the structure valid.	<code>extension, url, valueCode</code>
Identifier	Holds formal IDs such as MRN.	<code>identifier, system, value</code>
Standard Demographics	Core patient attributes and provider linkage.	<code>name, gender, birthDate, careProvider</code>

# Example JSON for the Patient Resource

```
json

{
 "resourceType": "Patient",
 "id": "glossy",
 "meta": {
 "lastUpdated": "2014-11-13T11:41:00+11:00"
 },
 "text": {
 "status": "generated",
 "div": "<div xmlns=\"http://www.w3.org/1999/xhtml\"><p>Henry Levin the
 },
 "extension": [
 {
 "url": "http://example.org/StructureDefinition/trials",
 "valueCode": "renal"
 }
],
 "identifier": [
 {
 "value": "1234567890"
 }
]
}
```

# 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)
```

# India on FHIR

MAY 23, 2022 • 8 MIN READ

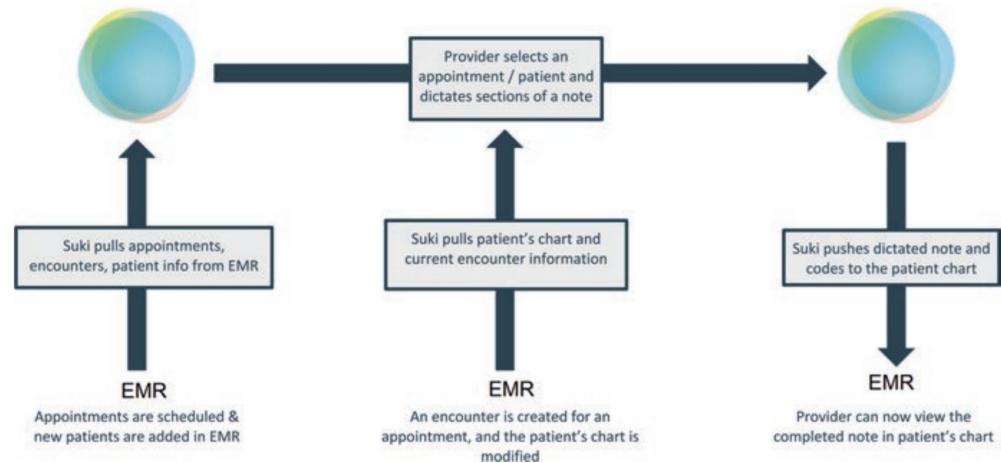
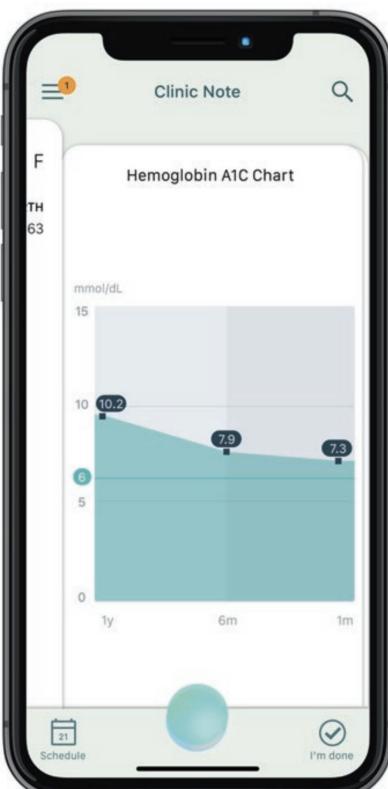
## Ayushman Bharat Digital Mission: Ushering in the UPI moment of healthcare

The illustration shows a large smartphone displaying a female doctor in a white coat and stethoscope. The doctor is gesturing towards the screen. To the right, a male patient in a green t-shirt is shown with a speech bubble above him. Various icons representing healthcare, such as a green cross, a heart with a pulse line, and a speech bubble, are floating around the phone. The background is white with some green leaf-like shapes at the bottom.

 **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

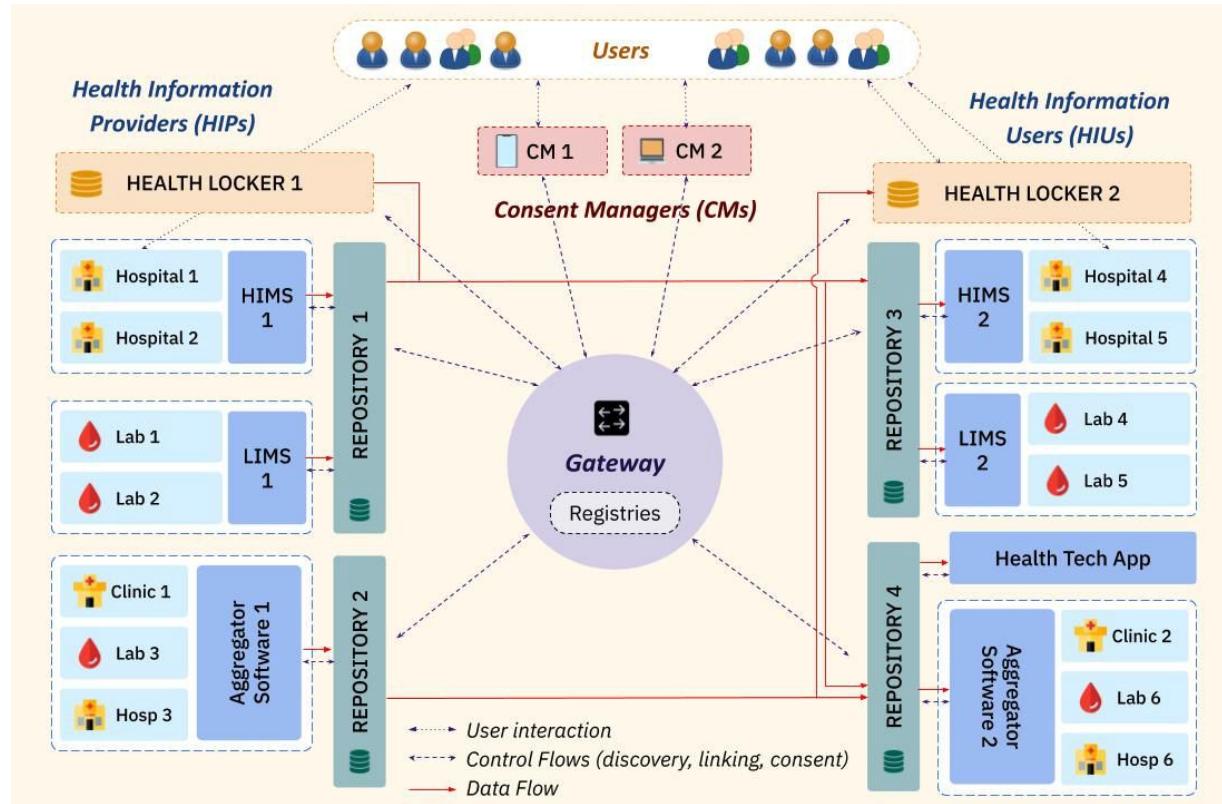
## ABDM digital health architecture

### 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

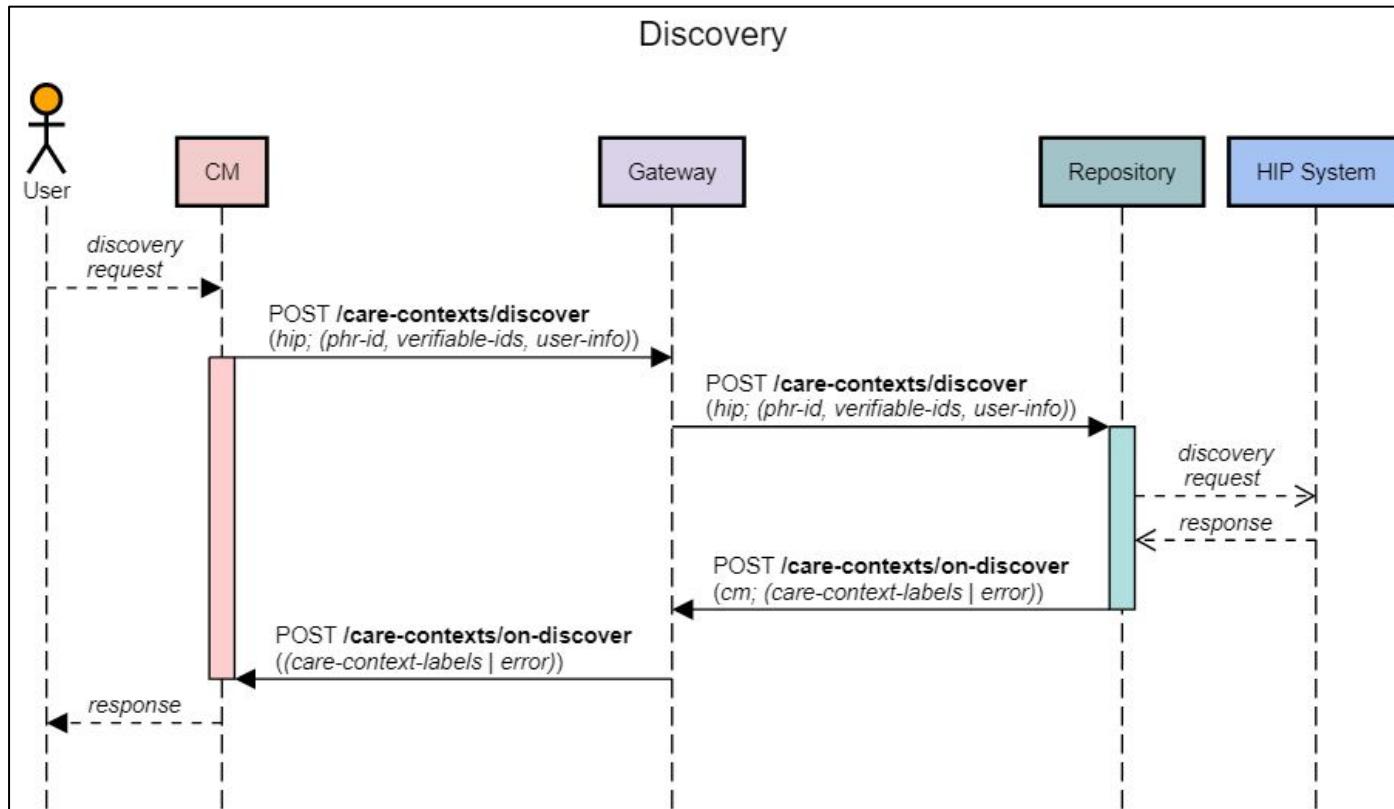
## Definitions for the StructureDefinition-PrescriptionRecord Profile.

### 1. Composition

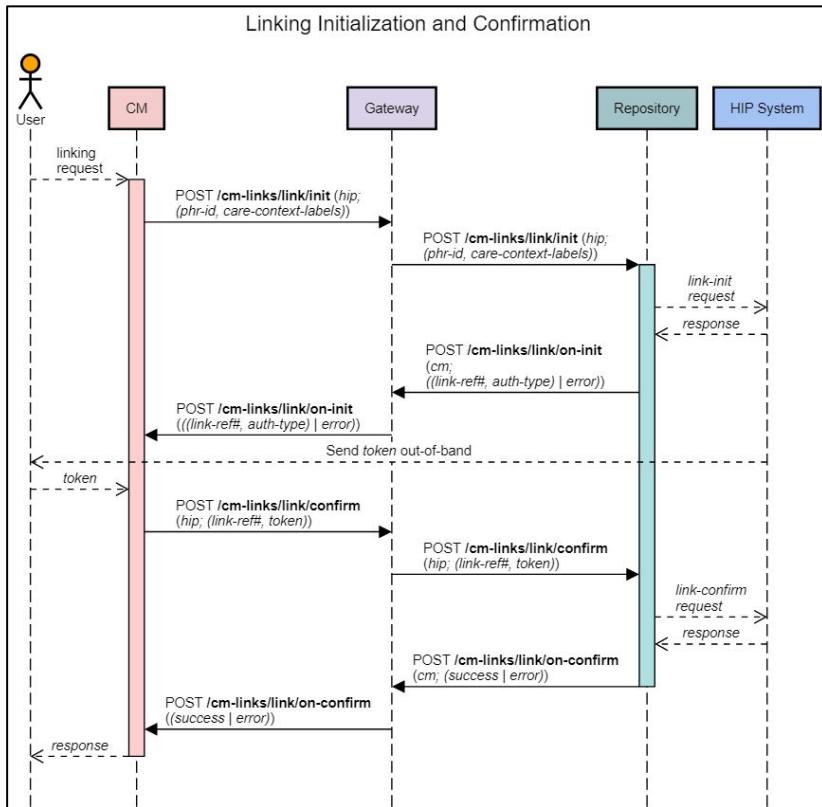
**Definition** A set of healthcare-related information that is assembled together into a single logical package that provides a single coherent statement of meaning, establishes its own context and that has clinical attestation with regard to who is making the statement. A Composition defines the structure 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 dates like "3rd Oct, 2019 - Max Health Care" and "5th Aug, 2019 - Max Health Care". At the bottom are tabs for "RECORDS", "PROVIDERS", and "REQUESTS".
- Middle Screenshot:** A detailed view of an "Immunization" record. It shows a date of "05 Aug 2019, 12:00am" and a section for "Tetanus Toxoid". It lists details such as Lot Number (Not Available), Route (Intravenous route), Reason (Dog Bite), Occurrence Date (05 Aug 2019, 01:00am), Dose Number (3), and Manufacturer (Max Super Speciality Hospital, Saket).
- Right Screenshot:** A detailed view of a "Discharge Summary - Bacillus..." record. It shows an "inpatient visit" from "01 Oct 2019, 03:32pm" with a "Diagnosis" of "Bacterial infection due to Bacillus". It includes sections for "Presenting Problems" (listing symptoms like Vomiting, Brief loss of consciousness, and Swinging fever) and "Prescribed medications during Admission".



- ▶ 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 **(( $dhsk(P)$ ,  $dhpk(P)$ )**

AUG 2, 2022 • 9 MIN READ

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



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/>

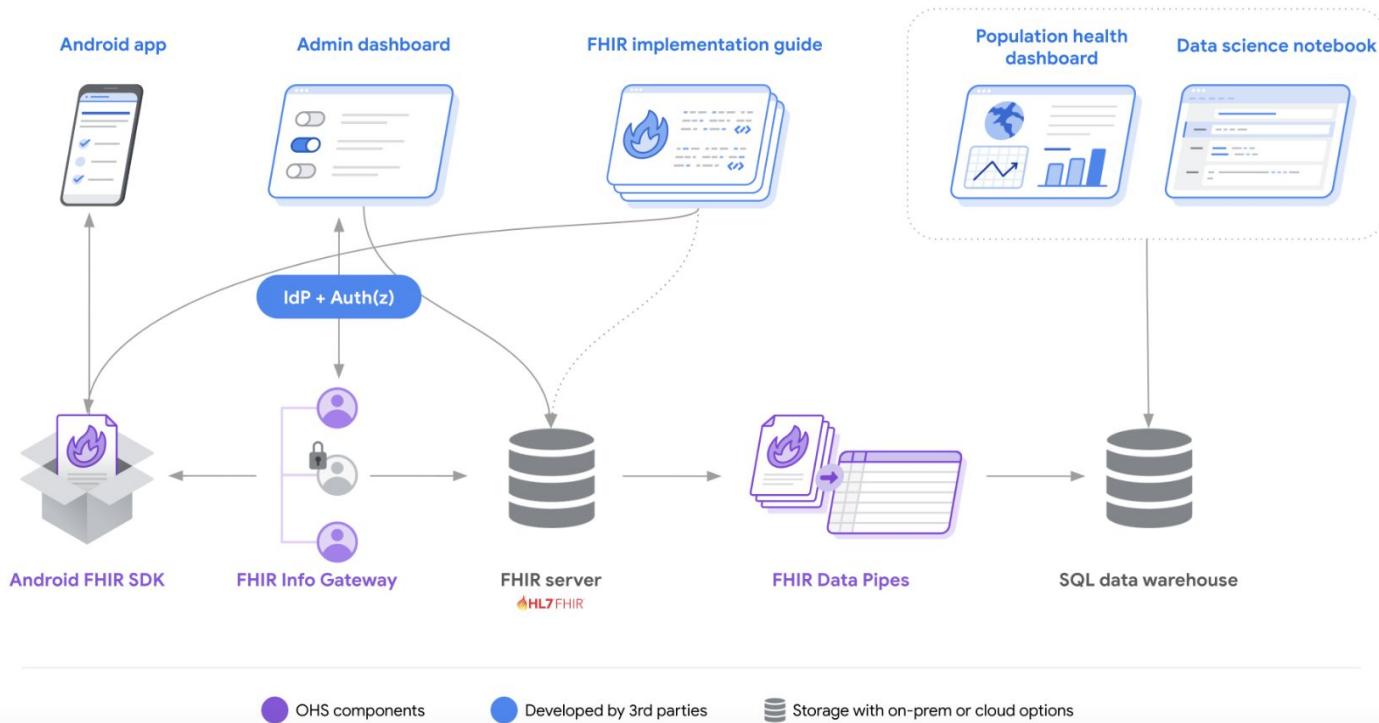
# Health ID



The screenshot illustrates the Ayushman Bharat Digital Mission (ABDM) ecosystem across three platforms:

- Web Interface (Top):** Shows the "Create" and "Verify" tabs for ABHA number generation. Fields include ABHA Address (n123@bx), Authentication Mode (Mobile OTP selected), and OTP (279224). A "Verified" button is shown.
- Recent Encounters (Middle):** A table listing recent encounters for "Nishtha Mahajan" (Age: 19, Female). The table columns are NAME, AGE, GENDER, STARTED, and ENCOUNTER ID. Actions like "Download ABHA Card" and "Link" are available for each entry.
- Mobile Application (Bottom):** Displays "My Linked Facilities" with a Medblocks entry (Patient ID: n123@bx). It shows a "Pull Records" button and a list of recent encounters for "Nishtha Mahajan" (ENC-00035, 2022-5-14 - OFD).

# Google on FHIR: Open OHS End to End FHIR



# Real World Implementations of FHIR Resources

# How UK is Building PHRs on FHIR

The screenshot shows a web page with a blue header bar. On the left, there's a logo for INTEROPen and a badge indicating support from NHS Digital. The main title is "Build | FHIR". A dropdown menu is open under the "Nav" button in the header, listing three items: "HL7 UK Care Connect Profiles", "NHS Digital Profiles", and "Care Connect Reference Implementation". At the bottom right, there's a red banner with the text "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

HL7 UK Care Connect Profiles

NHS Digital Profiles

Care Connect Reference Implementation

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

[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.

Shell

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.

Java

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 has tabs for History and Collections, with "Mitre" selected, showing 3 requests. The main request panel shows a GET request to "http://127.0.0.1:8183/STU3/metadata". 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 "Send" button is highlighted in blue. The bottom right of the panel says: "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 and highlighted in orange), '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 highlighted in orange), and 'binary'. Below these buttons is a dropdown menu set to 'Text'. The main body area contains an FHIR XML payload for creating a patient resource. The XML starts with a root element <Patient> and includes various fields like id, meta, extension, identifier, and system values.

```
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!**