Brief Introduction to FHIR & Walkthrough to FHIR Implementation Guide for ABDM
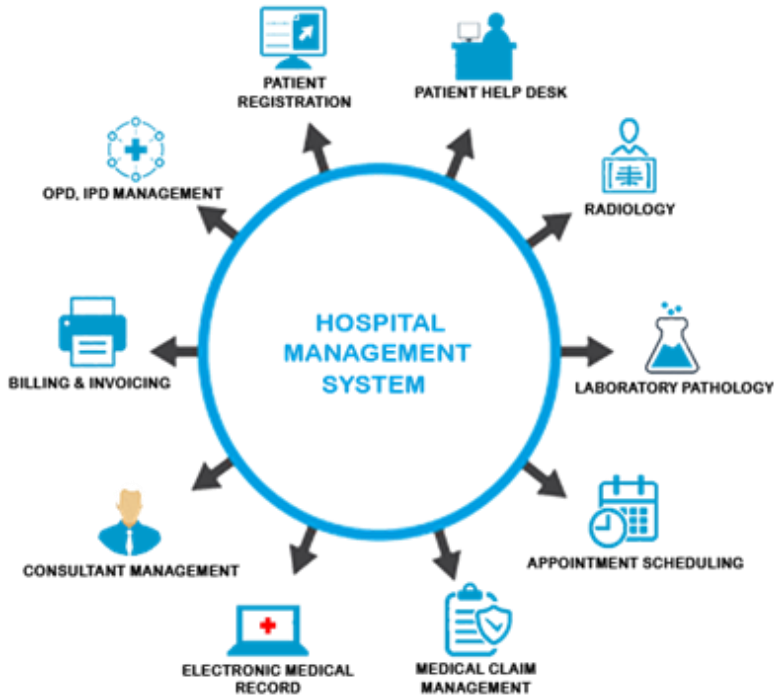
National Resource Centre for EHR Standards (NRCeS)

C-DAC Pune

Agenda

- Background
- Introduction to Fast Healthcare Interoperability Resource (FHIR)
- Key Concepts of FHIR: Resources, Data Types, Bundle
- FHIR Interoperability Paradigm
- Available Reference Implementations
- Profiles & Extensions
- FHIR Implementation Guide
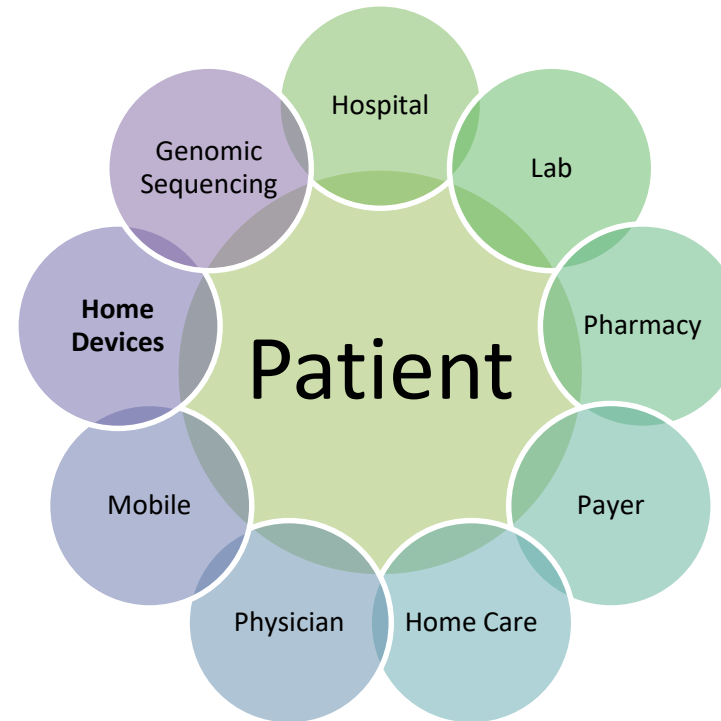- Adoption of FHIR in India (FHIR Profiles & Implementation Guide for ABDM & walkthrough)
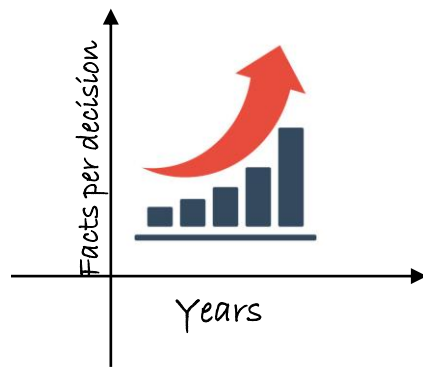
The necessity of a modern approach & goals
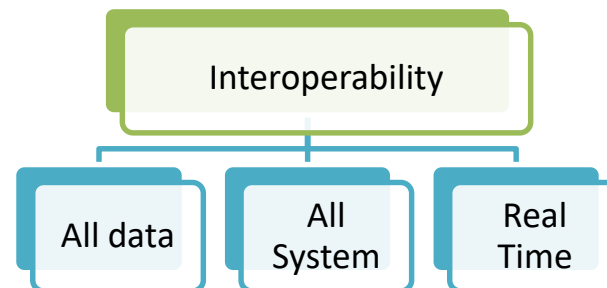
Data Exchange Scenario

More data is available

Data not limited to Hospital

Patient

- Hospital
- Lab
- Pharmacy
- Payer
- Home Care
- Physician
- Mobile
- Home Devices
- Genomic Sequencing

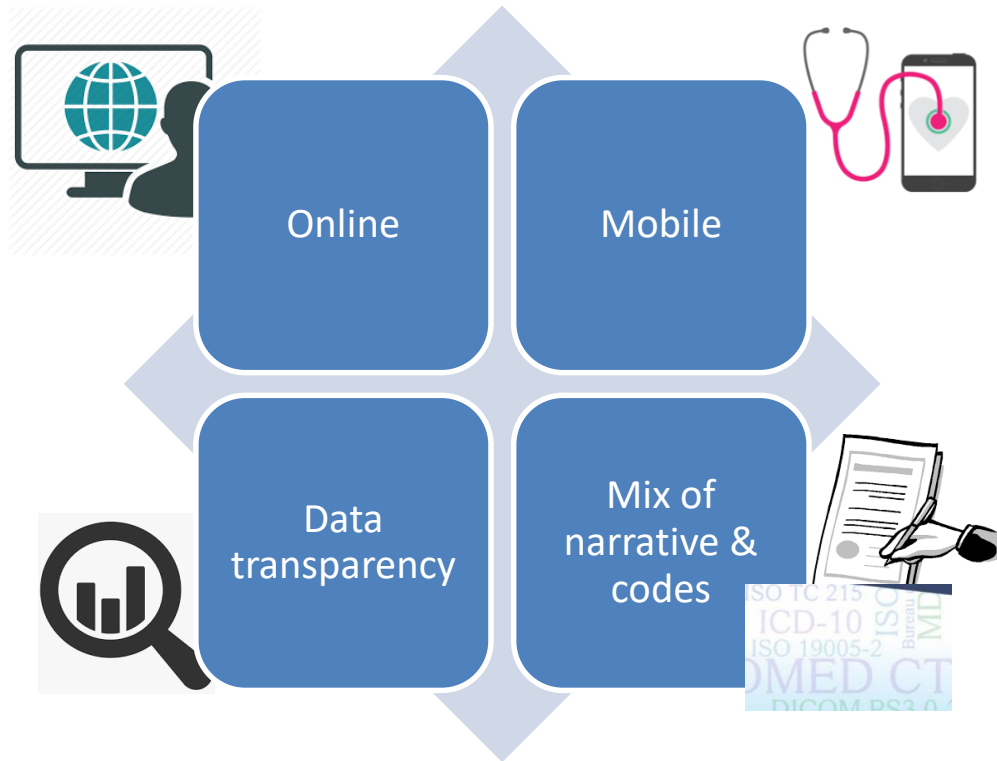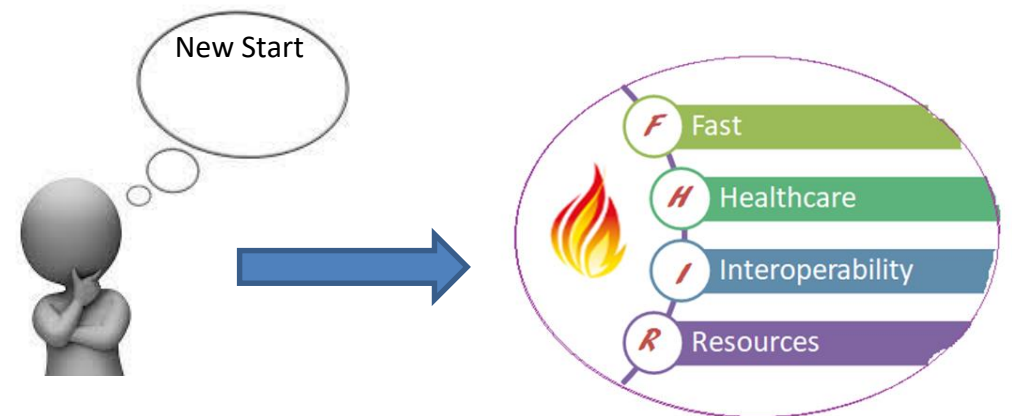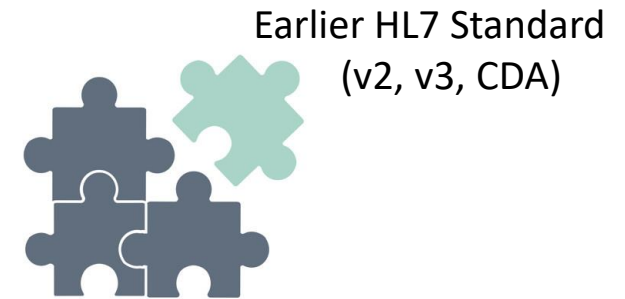Interoperability
- All data
- All System
- Real Time

Goal:

- **Easy to develop**: shallow learning curve and minimal custom tooling requirements
- **Easy to implement**
- **Semantically Robust**: can be mapped back to other standards
- **Implementer friendly**: uses common tools and formats, and web-based technologies for the specification
- The artifacts should be able to be **validated electronicall**y - as far as that is possible
- Integrates well with and leverages **modern web-based communication** technologies (HTTP, XML, JSON, etc.).

Evolution of FHIR

Online

Mobile

Data transparency

Mix of narrative & codes

ICD-10
ISO TC 215
ISO 19005-2
SNOMED CT
DICOM PS3.0

Current Data Scenarios

Earlier HL7 Standard (v2, v3, CDA)

New Start

F Fast
H Healthcare
I Interoperability
R Resources

Fast Healthcare Interoperability Resources (FHIR)

Fast Healthcare Interoperability Resource (FHIR)

- Health Data exchange standard developed and nurtured by HL7 International

- Internet-based approach to connecting different discrete elements

- Aims to build a base set of resources that, either by themselves or when combined, satisfy the majority of common use cases

- FHIR has around 150 resource types covering several categories including Entities, Clinical, and Financial types

- Representable in XML, JSON, or RDF formats

- Provides Restful CRUD specifications for common operations

- Extensible by design - allows usecase specific customization

- Terminology binding to popular code sets

Healthcare-related interoperability

Administration

Clinical Care

Research

Other

Scope

Why FHIR?

- Implementation focused standard with implementation libraries and examples for reference

- Support human-readable serialization formats

- Specification is free for use with no restrictions

- Uses web standards: XML, JSON, HTTP, OAuth, etc.

- Multiple Exchange Paradigms: REST, Messaging, Documents, Services

- Extensible by design - allows use case specific customization
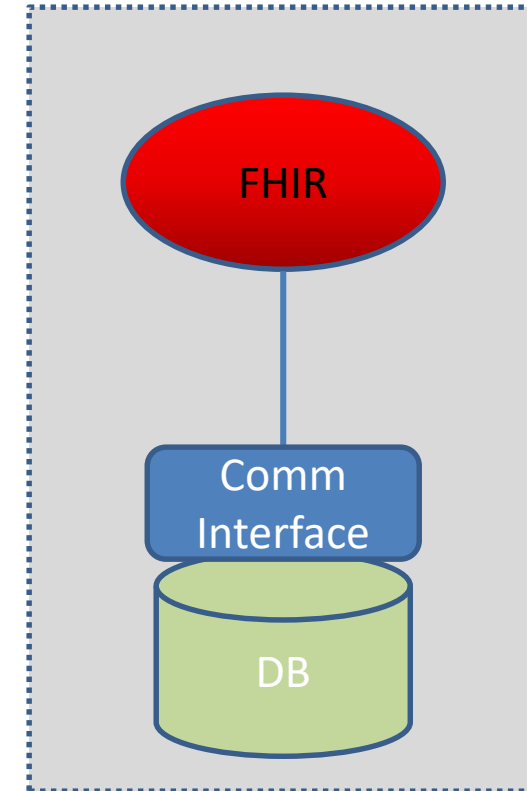
- Terminology binding to popular code sets

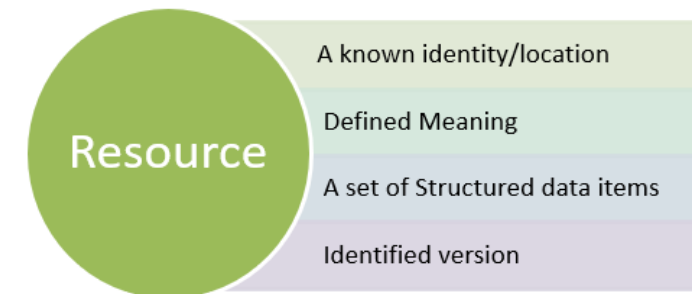# FHIR Usage Scenarios
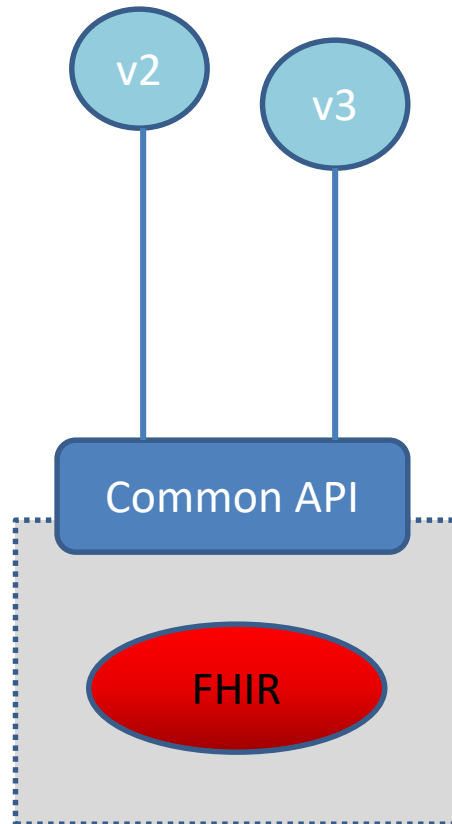
Message broker +
FHIR engine
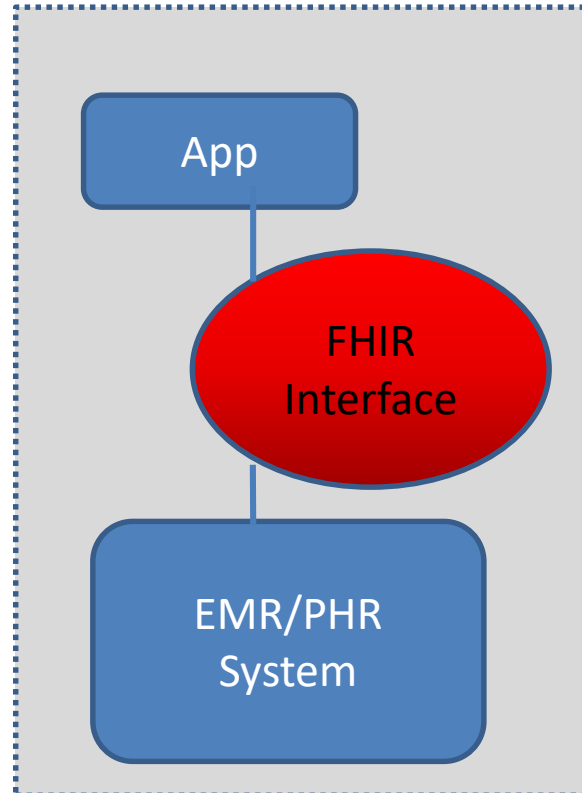
FHIR server with
existing back end

FHIR server and FHIR
back end
(FHIR objects storage)

FHIR Resource

- <u>Resources</u> represent a unit of exchange of data that can be justifiable in interoperability
- A resource is made up of elements, each of which is a particular data type
- A resource has a known identity (a URL) by which it can be addressed
- Resources combine both computer processable and human-understandable data
  - Metadata to aid in searches and cataloging
  - Structural specification
  - Defined value sets for any enumerators
  - A display element for direct print or display of simplified text
  - Links to other resources
- Example of resources: <u>Patient</u>; <u>Practitioner</u>; <u>Observation</u>; <u>Organization</u>

Resource

A known identity/location

Defined Meaning

A set of Structured data items

Identified version

Key Parts of a Resource

```xml
<Patient xmlns="http://hl7.org/fhir">
    <id value="example-01"/>
    <meta>
        <versionId value="1"/>
        <lastUpdated value="2020-07-09T14:58:58.181+05:30"/>
        <profile value="http://nrces.in/ndhm/fhir/r4/StructureDefinition/Patient"/>
    </meta>
    <text>
        <status value="generated"/>
        <div xmlns="http://www.w3.org/1999/xhtml">Patient name - ABC, Age- 41 year,Gender- Male</div>
    </text>
    <extension url="https://nrces.in/ndhm/fhir/r4/StructureDefinition/someExtension">
        <valueCode value="someValue"/>
    </extension>
    <identifier>
        <type>
            <coding>
                <system value="http://terminology.hl7.org/CodeSystem/v2-0203"/>
                <code value="MR"/>
                <display value="Medical record number"/>
            </coding>
        </type>
        <system value="https://healthid.ndhm.gov.in"/>
        <value value="22-7225-4829-5255"/>
    </identifier>
    <name>
        <text value="ABC"/>
    </name>
    <telecom>
        <system value="phone"/>
        <value value="+919818512600"/>
        <use value="home"/>
    </telecom>
    <gender value="male"/>
    <birthDate value="1981-01-12"/>
</Patient>
```

Resource Identity & Metadata

Human Readable Text

Extension with URL to Definition

Standard & Structured Data:
- Identifier
- Name
- Telecom
- Gender
- DOB

Resource list in FHIR

Resource FHIR R 4.0.1 List : http://hl7.org/fhir/R4/resourcelist.html

Data Types

Bundles

- A lab report in FHIR can be represented as a set of related resources: patient, requesting physician, observations, report in PDF format, order.
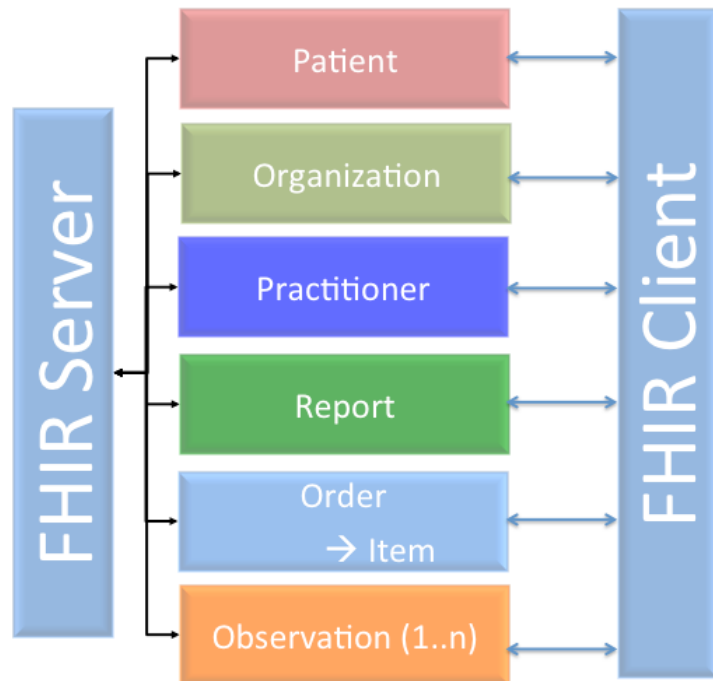
Individual resources can be transmitted as multiple transactions

Multiple resources bundled for a logical purpose as a transaction

FHIR Interoperability Paradigms

FHIR supports interoperability via 4 paradigms

Rest

Documents

Messaging

Services

FHIR Interoperability Paradigms

- REST:
  - Simple, out-of-the-box interoperability
  - Leverage HTTP: GET, POST, etc.
  - Pre-defined operations
    - Create, Read, Update, Delete
    - Also: Read Version, Search (resource/type/server), History (resource/type/server), Capabilities, Patch, Batch & Transaction
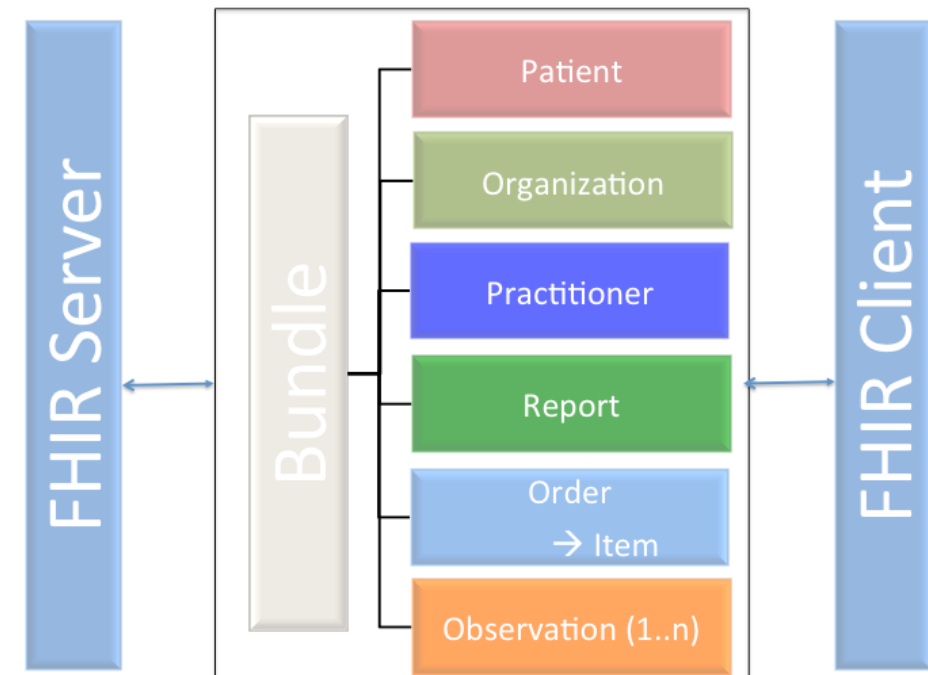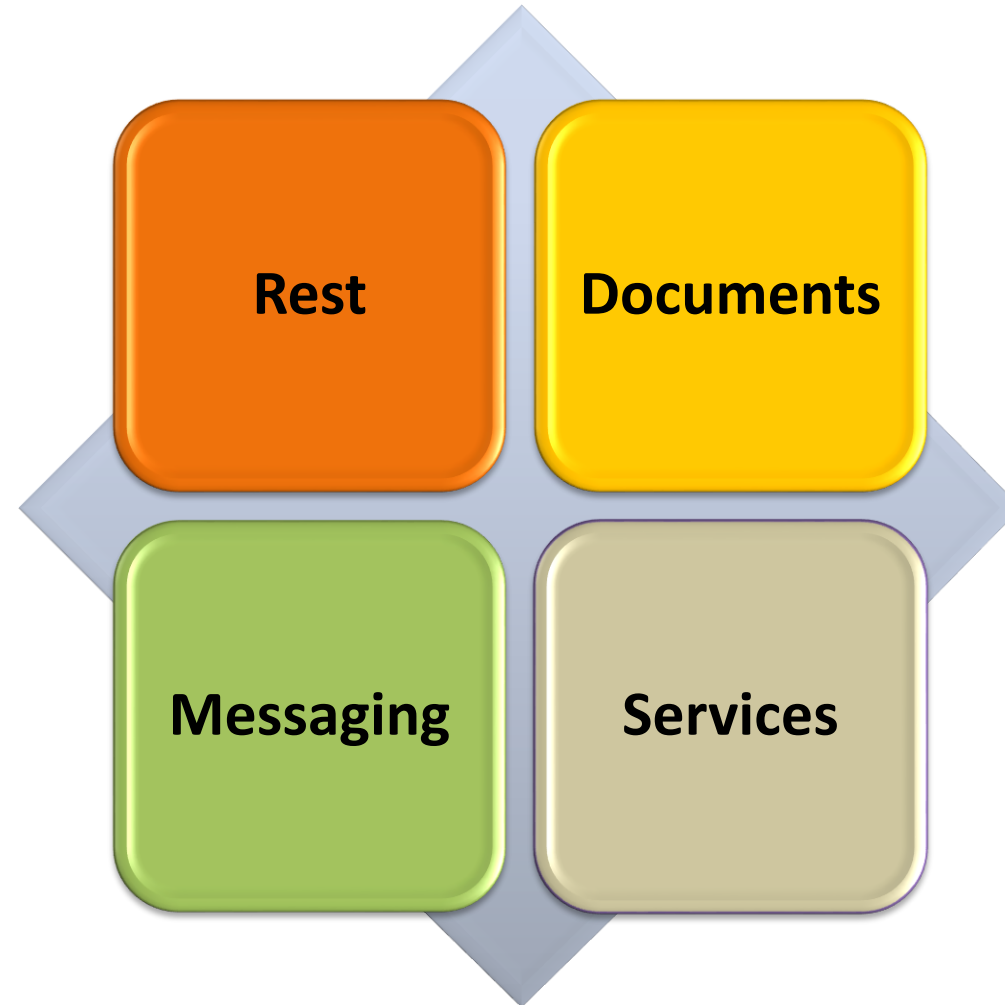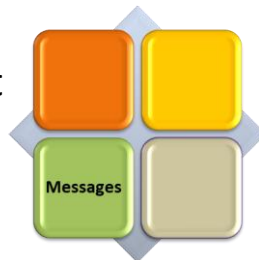
- Messages:
  - Similar to v2 and v3 messaging
  - Also a collection of resources as a Bundle resource
  - Allows request/response behaviour with bundles for both request and response
  - Event-driven
    - E.g. Send lab order, get back the result
  - Can be asynchronous and/or indirect

- Documents:
  - Similar to CDA
  - Collection of resources bound together
    - Root is a "Composition" resource
    - Just like CDA header
  - Sent as a Bundle resource
  - One context
  - Can be signed, authenticated, etc.
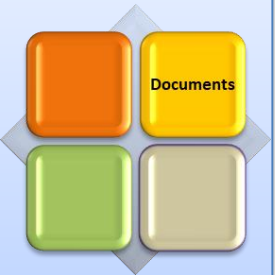
- Service:
  - Do whatever you like
  - Based on SOA principles
  - Ultra complex/simple workflows
  - Individual resources or collections (in Bundles or other formats)
  - Use HTTP or use something else
  - Only constraint is that you're passing around FHIR resources in some shape or manner

Available Reference Implementations

Java   HAPI-FHIR : Object Models, Parsers, Client + Server Framework, FHIR Validator, & Utilities. The specification is built with this Java code

C#   HL7.FHIR : Object models, Parsers/Serializers, Utilities, and a Client. Source code on GitHub at http://github.com/ewoutkramer/fhir-net-api

Pascal   FhirServer : Object models, Parsers/Serializers, Validator, Utilities, Client, and the FHIR Reference server. Requires Delphi (Unicode versions)

XML   XML Tools: Document Rendering Stylesheet, supplementary implementation schemas and transforms

Javascript See the HL7 wiki for Javascript libraries (Clients and Utilities for both servers and clients)

Swift   Swift-FHIR : Object Model, Client and Utilities

Downloads - Schemas, Code, Tools: http://hl7.org/fhir/R4/downloads.html
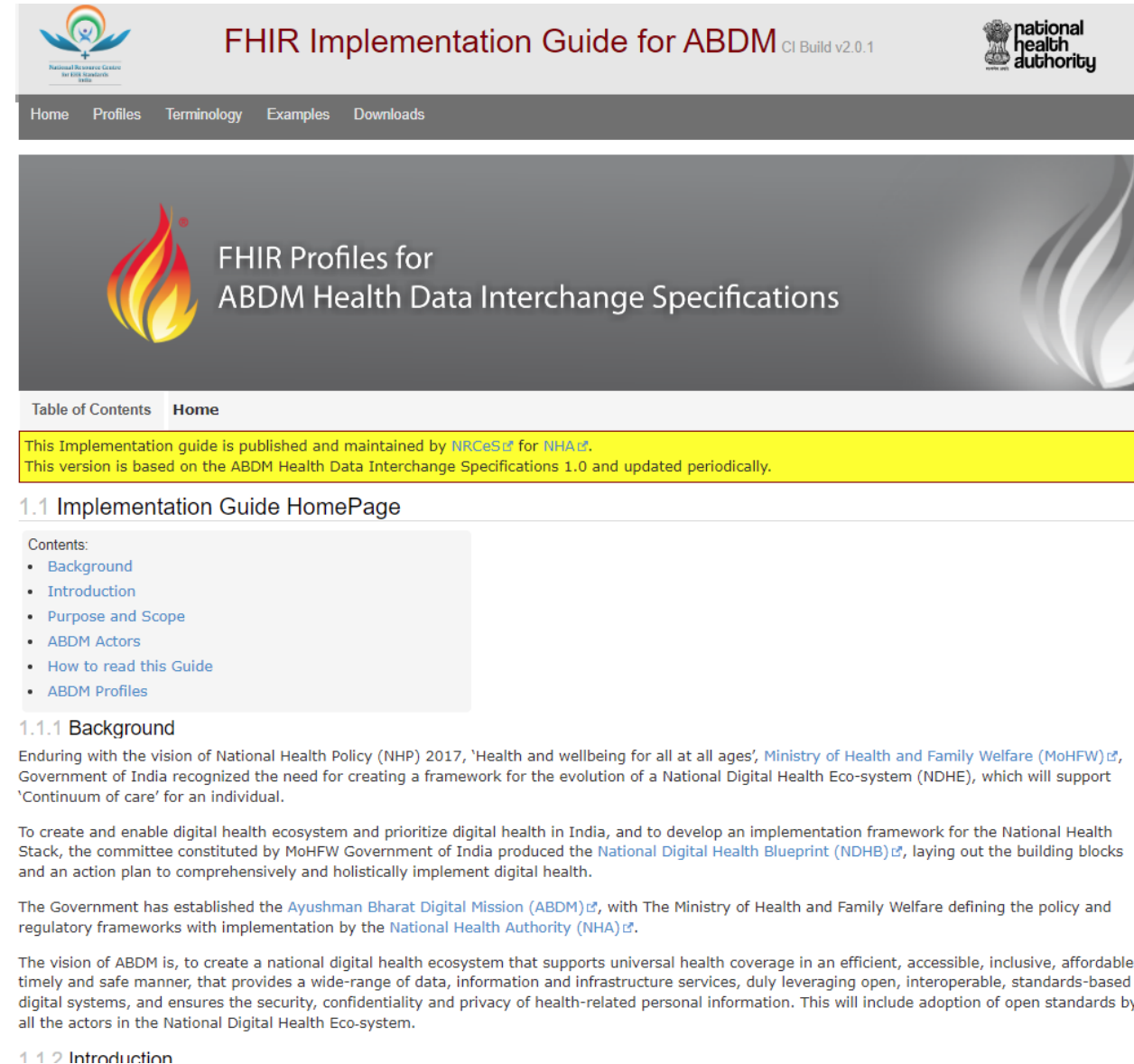
Profiles & Extensions

- FHIR specification satisfies the majority of common use cases
  - Provides flexibility to extend and adapt it according to local needs
  - Almost every element in the base FHIR specification is optional
- Resources can be modified for:
  - Constraining existing elements and fixing value sets for coded elements
  - Addition of new data elements/datatypes to existing resources (called **Extensions**)
- Such definitions are called **Profiles.**
- FHIR profiles describe **a set of rules** about how a resource is **used to meet a general use case**, so that the rules can be shared and published, compared with each other, and **used as the basis for implementation**.
- Profiling allows:
  - Defining required and optional resource elements
  - Defining additional resource elements
  - Binding terminology and value sets to be used
  - Deciding which API features are used, and how
- Extensions and Profiles require a formal published definition

FHIR Implementation Guide

- An implementation guide (IG) defines how a particular interoperability or standards problem is solved - typically through the use of FHIR resources.

- It is a set of rules about how FHIR resources are used (or should be used)

- Covers associated documentation to support and clarify the usage

- FHIR implementation guides are published on the web after they are generated

Adoption of FHIR in India & Implementation Guide for ABDM

- Clinical Artifacts considered for continuity of care scenario:
  - Diagnostic Report Record
  - Discharge Summary Record
  - OP Consult Record
  - Prescription Record
  - Wellness Record
  - Health Document Record
  - Immunization Record

FHIR Profiles for
ABDM Health Data Interchange Specifications

- Aims to cover most of the health record document sharing in a care setting
- Total 07 Clinical Artifacts, 31 Resource Profiles, 19 Terminology ValueSets, and 35 examples.
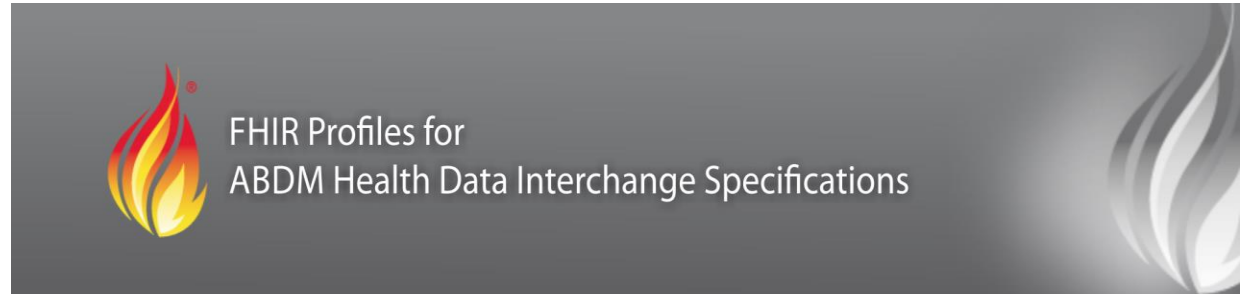
ABDM HI Types

Diagnostic Report Record	Discharge Summary Record	OP Consult Record	Prescription Record
Header (Patient Demographics, Care Provider Details, Encounter Details)	Header (Patient Demographics, Care Provider Details, Encounter Details)	Header (Patient Demographics, Care Provider Details, Encounter Details)	Header (Patient Demographics, Care Provider Details, Encounter Details)
Diagnostic Laboratory Report (Specimen, Collection related information, Results, Conclusion)	Chief Complaints	Chief Complaints (Condition)	Medications
Diagnostic Imaging Report (Imaging Details, Results, Interpretations)	Physical Examination	Physical Examination (Observation)	Binary
DocumentReference (DocumentReference)	Allergies	Allergies (Allergy Intolerance)	
	Medical History	Medical History (Condition | Procedure)	
	Family History	Family History	
	Investigations (Laboratory | Imaging)	Investigation Advice (ServiceRequest)	
	Medications	Medications (MedicationStatement |MedicationRequest)	
	Procedures	Procedures	
	Care Plan	Follow Up (Appointment)	
		DocumentReference (DocumentReference)	

ABDM HI Types

Immunization Record

- Header (Patient Demographics, Care Provider Details, Encounter Details)

- Immunization Details (Vaccine name, Manufacturer, lot number, date)

- Immunization Recommendation

Wellness Record

- Header (Patient Demographics, Care Provider Details, Encounter Details)
- Vital Signs (Heart rate, Respiratory rate, SPO2, temperature, blood pressure, etc.)
- Body Measurement (Weight, Height, etc.)
- Physical Activity (steps count, sleep duration, calories burned, etc.)
- General Assessment (blood glucose, fluid intake, general well being, mental status, etc.)
- Women Health (LMP, menopause, menarche, etc.)
- Life Style (diet type, alcohol drinking, smoking, etc.)
- Any other observations

Health Document Record

- Header (Patient Demographics, Care Provider Details, Encounter Details)

- DocumentReference

FHIR Implementation Guide for ABDM

- An implementation guide (IG) is a set of rules about how FHIR resources are used (or should be used) to solve a particular problem, with associated documentation to support and clarify the usage.

- Defines the scope of usage

- Describes requirements for FHIR implementation

- Provide structured access to profiles and examples

- IG for ABDM: https://nrces.in/ndhm

- **Text Summary**: provides human-readable summary of changes that we have made. **It refers to the Differential View of a profile**.

- **Differential View**: mentions the elements that are changed while profiling

- **Mandatory Element**: Element with cardinality 1..1, 1..*

-   : element that must be supported.

- **MUST Support**: implementations that produce or consume resources SHALL provide "support" for the element in some meaningful way

- **MUST Support for ABDM**: The Receiver (HIU) MUST have the capacity to read the element though it is optional. The Sender (HIP) may opt not to fill the element while sending (when data is not available)

IG and Profiles walkthrough

Summary

Mandatory: 7 elements (30 nested mandatory elements)
Must-Support: 38 elements
Fixed Value: 33 elements

Structures

This structure refers to these other structures:

- Patient (https://nrces.in/ndhm/fhir/r4/StructureDefinition/Patient)
- Encounter (https://nrces.in/ndhm/fhir/r4/StructureDefinition/Enco...)
- Practitioner (https://nrces.in/ndhm/fhir/r4/StructureDefinition/Pra...)
- PractitionerRole (https://nrces.in/ndhm/fhir/r4/StructureDefinit...)
- Organization (https://nrces.in/ndhm/fhir/r4/StructureDefinition/C...)
- Condition (https://nrces.in/ndhm/fhir/r4/StructureDefinition/Condit...)
- Observation (https://nrces.in/ndhm/fhir/r4/StructureDefinition/Ol...)
- AllergyIntolerance (https://nrces.in/ndhm/fhir/r4/StructureD...)
- Procedure (https://nrces.in/ndhm/fhir/r4/StructureDefinition/Proce...)

Name	Flags	Card.	Type	Description & Constraints
Composition		0..*	Composition	A set of resources composed into a single coherent clinical statement with clinical attestation
status	S	1..1	code	preliminary | final | amended | entered-in-error
type	S	1..1	CodeableConcept	Kind of composition (SNOMED CT if possible)
coding		1..1	Coding	Code defined by a terminology system
system		0..1	uri	Identity of the terminology system **Fixed Value:** http://snomed.info/sct
code		1..1	code	Symbol in syntax defined by the system **Fixed Value:** 373942005
display		1..1	string	Representation defined by the system **Fixed Value:** Discharge summary
text	S	0..1	string	Plain text representation of the concept
subject	S	1..1	Reference(Patient)	Who and/or what the composition is about
reference		1..1	string	Literal reference, Relative, internal or absolute URL
encounter	S	1..1	Reference(Encounter)	Context of the Composition
author	S	1..*	Reference(Device | RelatedPerson | Patient | Practitioner | PractitionerRole | Organization)	Who and/or what authored the composition
attester	S	0..*	BackboneElement	Attests to accuracy of composition
party		0..1	Reference(RelatedPerson | Practitioner | PractitionerRole | Patient | Organization)	Who attested the composition
custodian		0..1	Reference(Organization)	Organization which maintains the composition
Slices for section	S	1..*	BackboneElement	Composition is broken into sections **Slice:** Unordered, Open At End by value:code.coding.code
section:ChiefComplaints		0..*	BackboneElement	Composition is broken into sections
code				

https://nrces.in/ndhm

Approach used for Data sharing

FHIR standard based data sharing for all HI Types, supporting data in 03 formats:

- Scanned Documents
  - Helps uploading historic data
  - Allows quick on-boarding
- Structured data without standard terminology
  - Structured data sharing with flexibility to include free text
  - Better understanding of context
  - Tools like Natural Language Processing can be used for analytics in future
- Fully structured data with Coding / Terminology
  - Better understanding of data (interoperable and processable data)
  - Data accuracy is guaranteed to the maximum
  - Data ready for analytics which can help in real time decision support

```
    ],
    "text" : "Abdominal pain"
},
"subject" : {
    "reference" : "Patient/1"
}
}
```

```
"code" : {
    "coding" : [
    {
        "system" : "http://snomed.info/sct",
        "code" : "36969009",
        "display" : "Placement of stent in coronary artery"
    }
    ],
    "text" : "Placement of stent in coronary artery"
```

Walkthrough

[FHIR Implementation Guide for ABDM](#)

ABDM FHIR R4 Usage Samples

- Sample Codes that Demonstrate:
  - Creating clinical artifacts against ABDM profiles
  - Validating the created/received objects against ABDM profiles
  - Reading and Writing ABDM clinical artifacts programmatically
- Helps in quick onboarding of implementors

https://www.nrces.in/services/tools-and-technologies

Thank You!

nrc-help@cdac.in

www.nrces.in