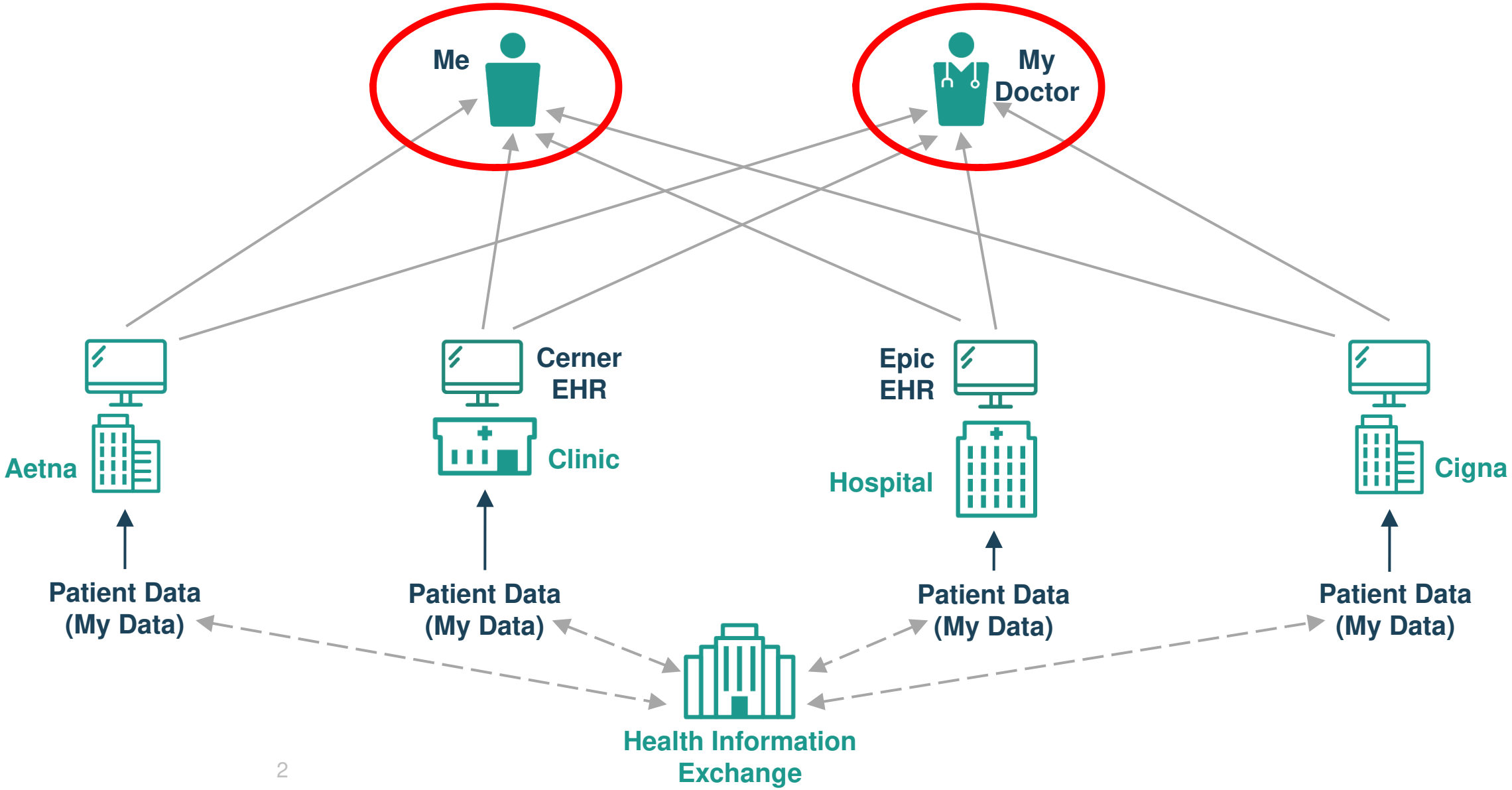
FHIR:
EHR Data Sharing

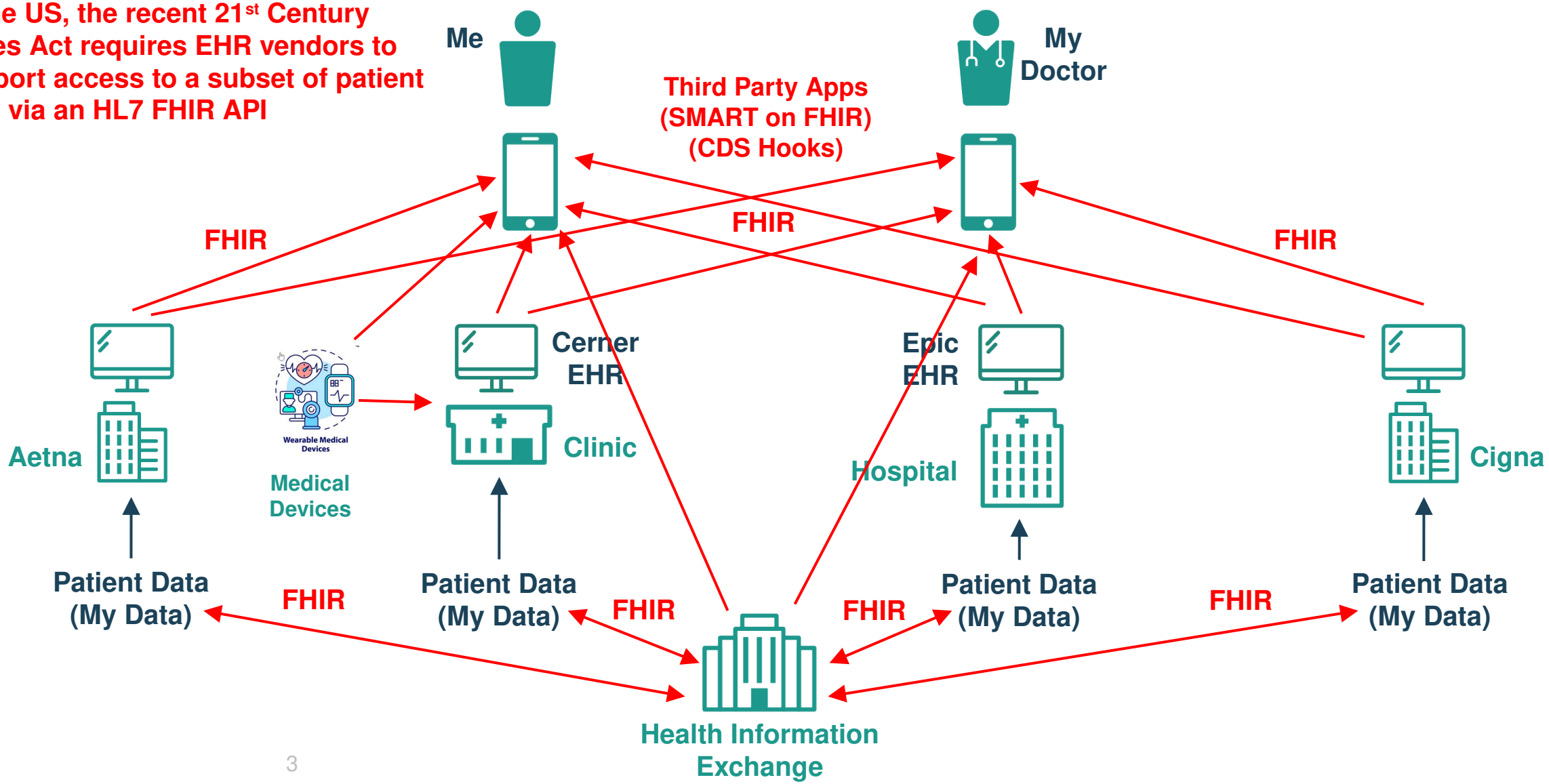
Courtesy: Dr. Darrell Woelk from Greenwood Technologies

Problem: Limited Healthcare Data Interoperability

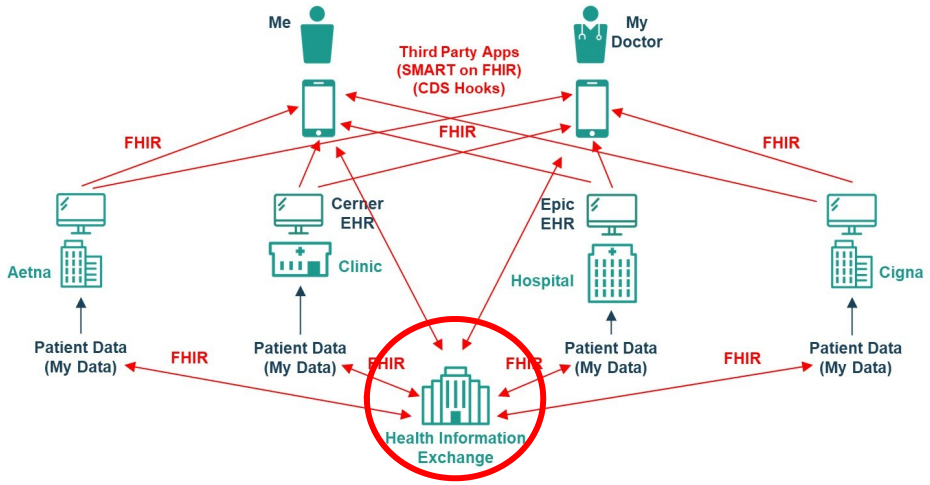


Solution: FHIR Enabled Healthcare Data Interoperability

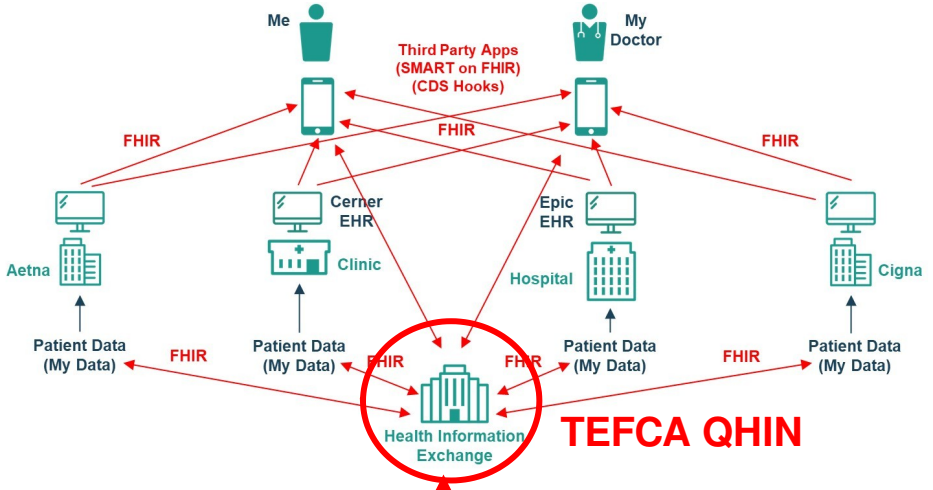
In the US, the recent 21st Century Cures Act requires EHR vendors to support access to a subset of patient data via an HL7 FHIR API



TEFCA Data Exchange Using FHIR

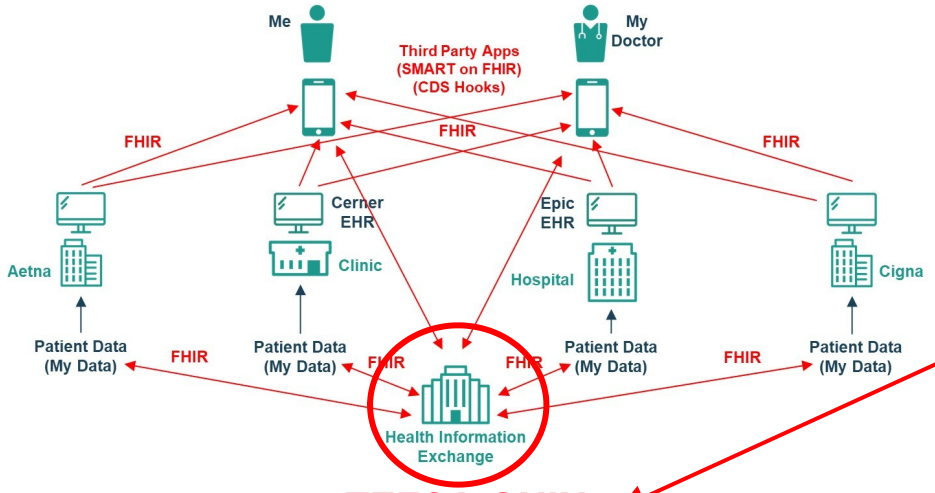


TEFCA QHIN



TEFCA QHIN

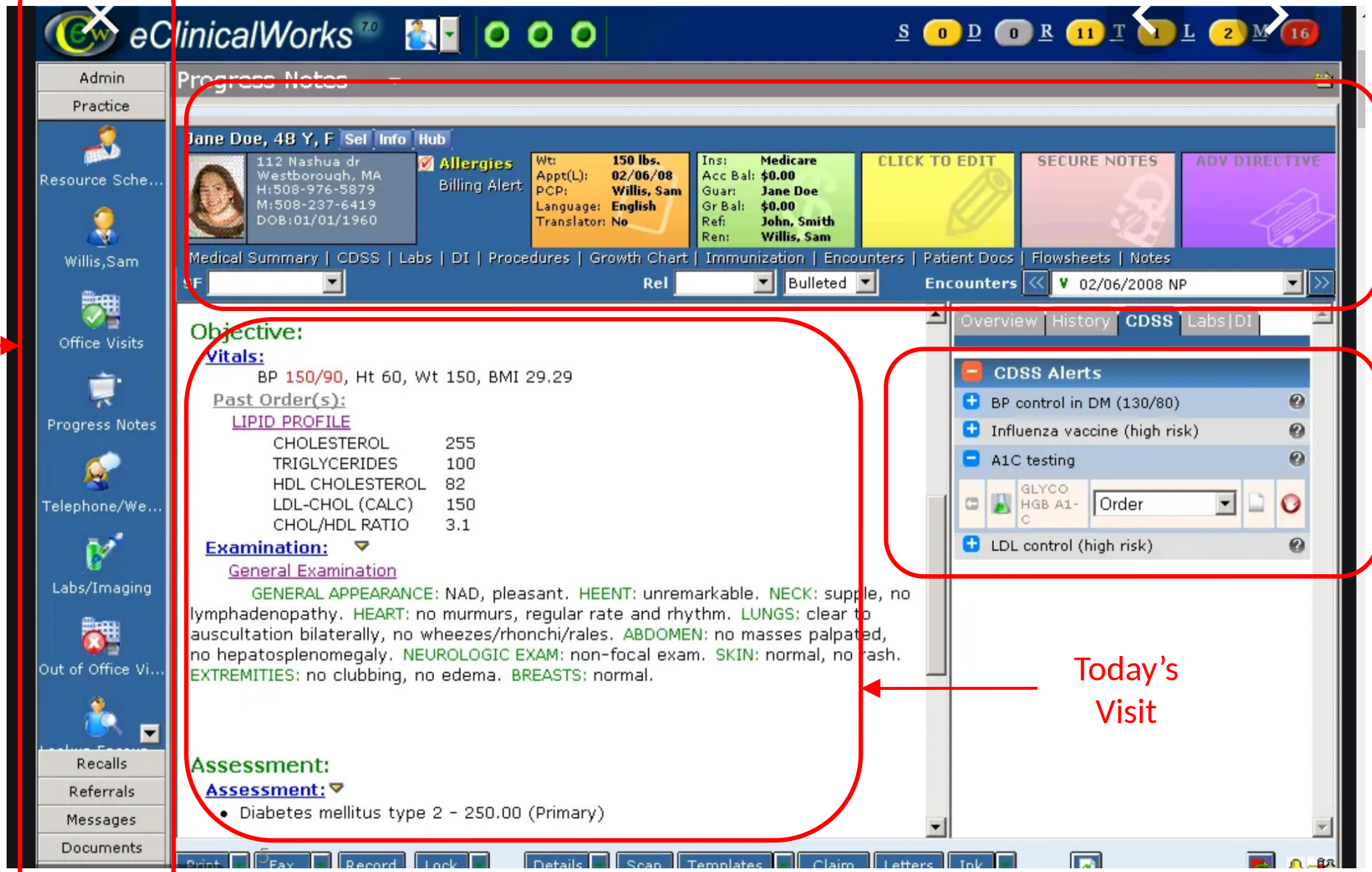
TEFCA Broker



TEFCA QHIN

ONC Trusted Exchange Framework and Common Agreement (TEFCA) includes a FHIR® Roadmap for TEFCA Exchange that defines Stages for network-facilitated and network-brokered exchange of FHIR data https://rce.sequoiaproject.org/wp-content/uploads/2022/01/FHIR-Roadmap-v1.0_updated.pdf

Sample EHR Screen



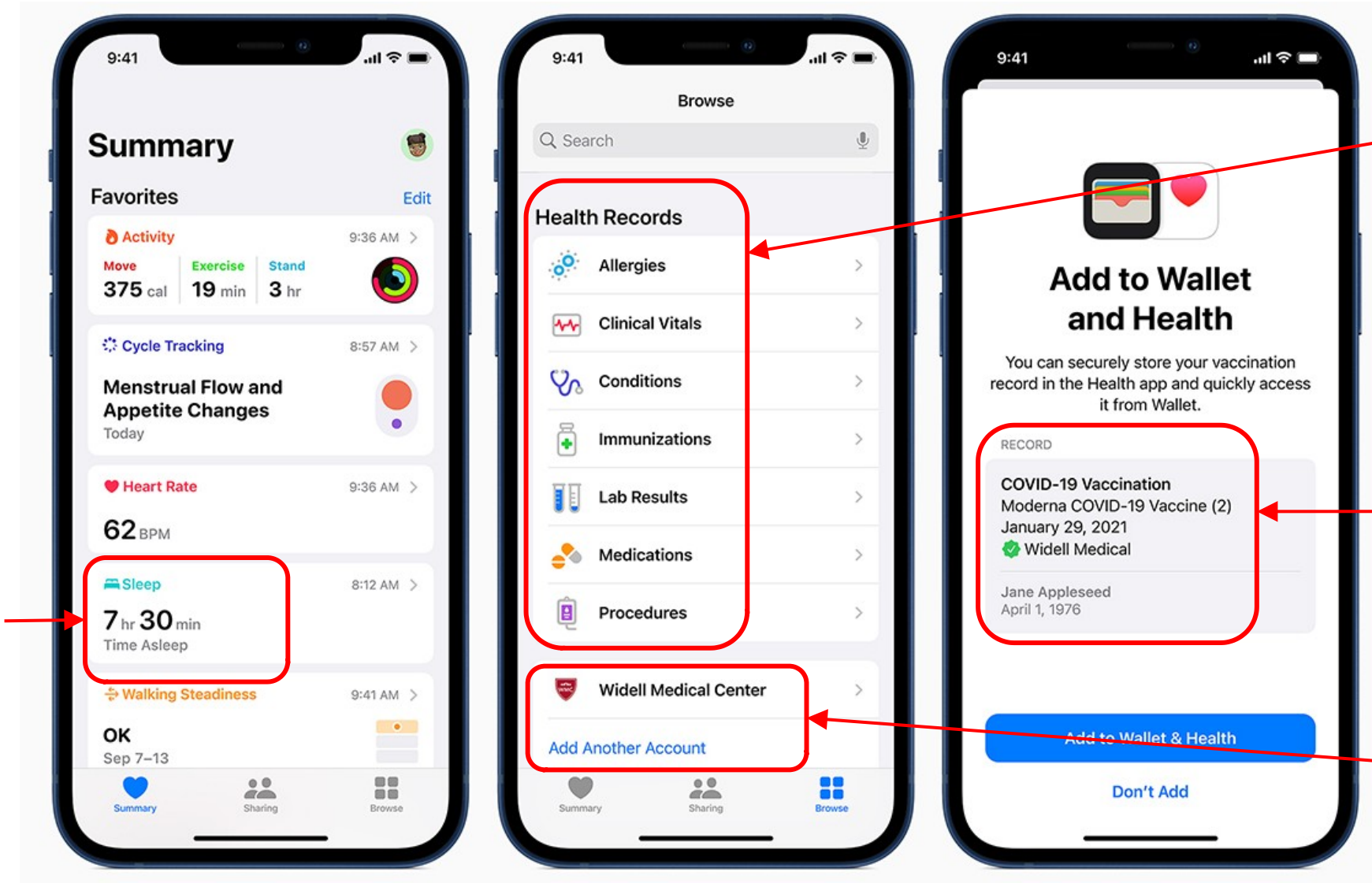
EHR Functions

Demographics & History

SMART on FHIR App Can Display Here

Today's Visit

Sample iPhone Health Screens



Sleep Monitor

FHIR Data from Widell Medical Center

Verified FHIR Vaccination Report from Widell Medical Center

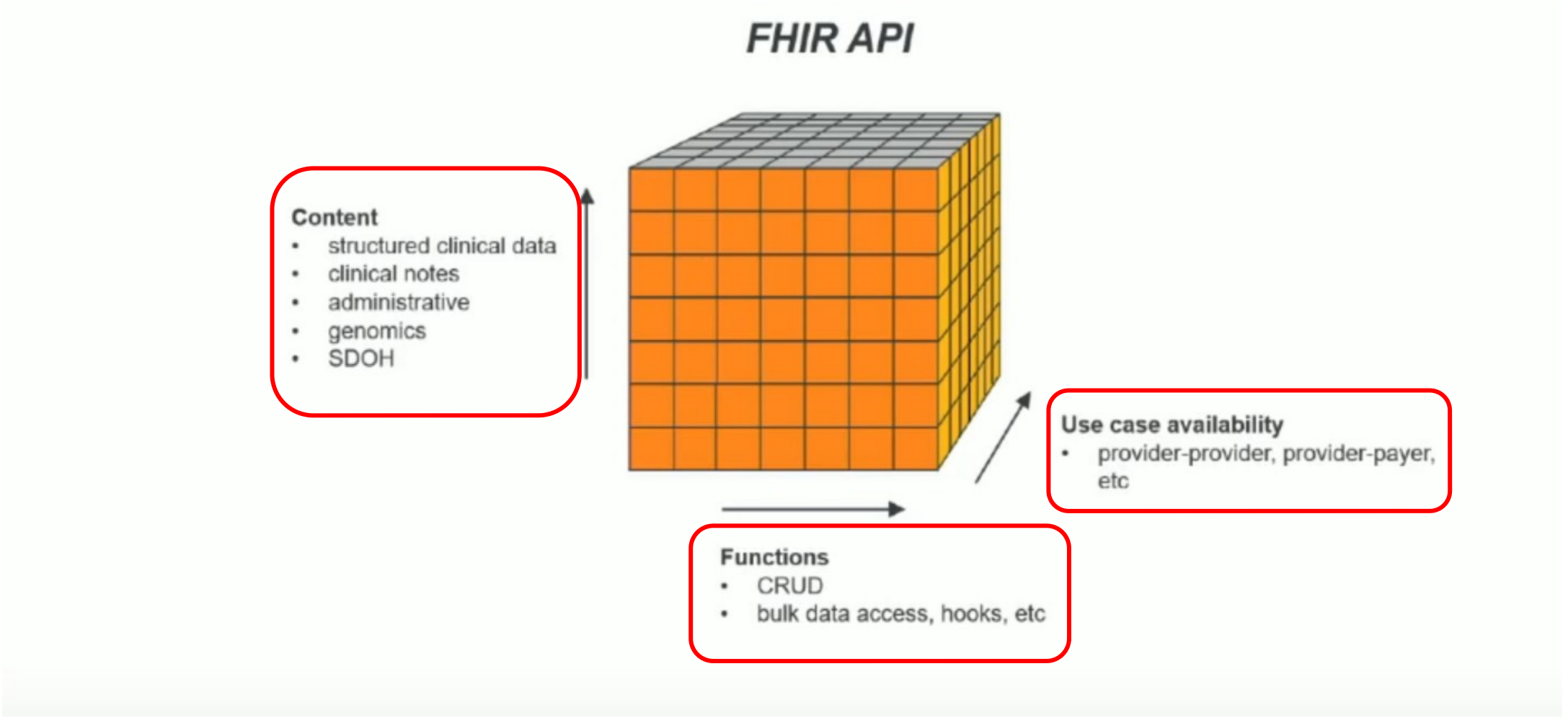
Add FHIR Data From Another Provider

https://www.apple.com/ca/healthcare/health-records

FHIR Interoperability Standards Ecosystem

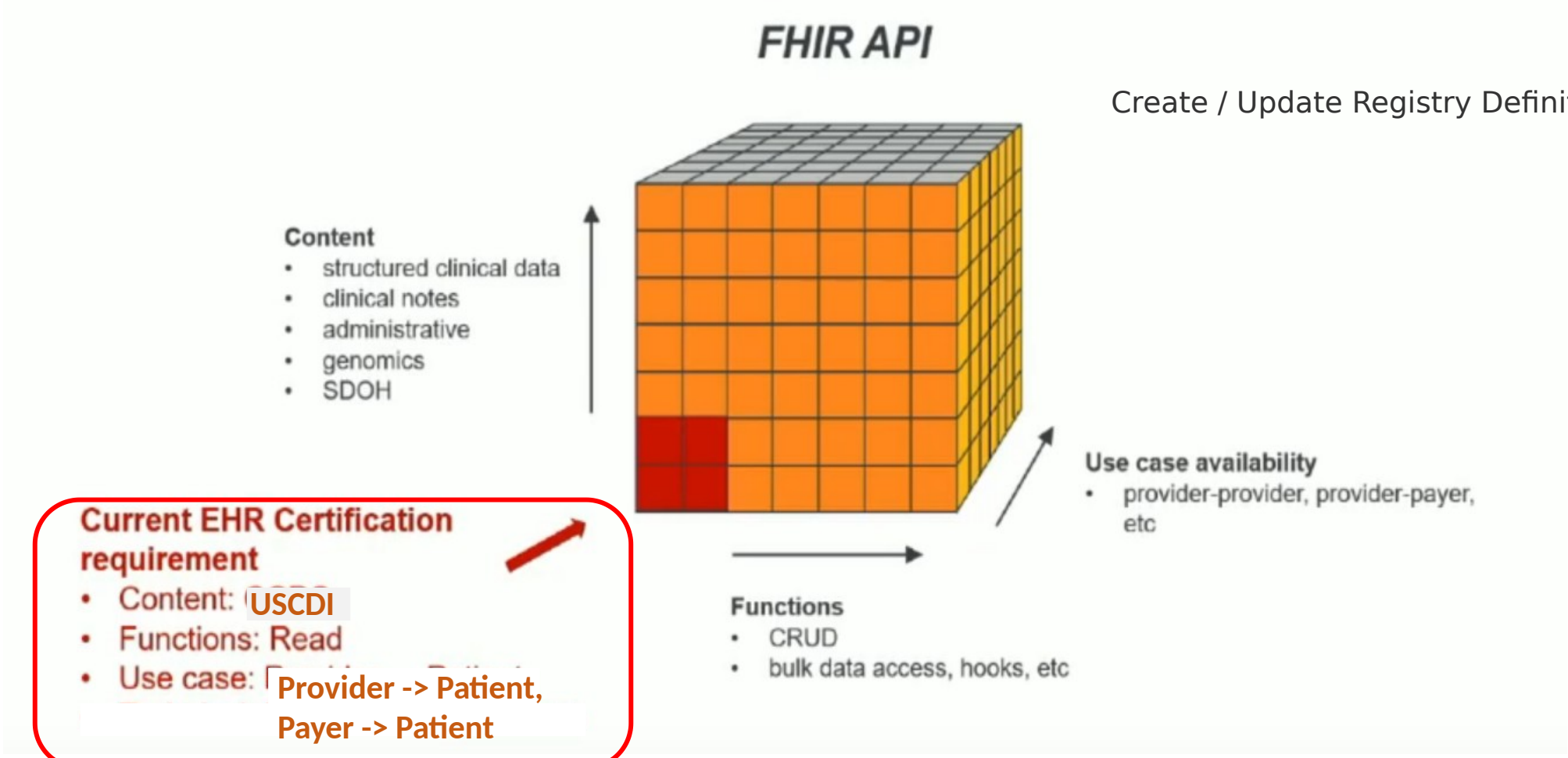
US Government Agencies	**ONC** Coordinate Exchange of Healthcare Data; **CMS** Administer Medicare, Medicaid CHIP, Insurance Marketplaces	Set Interoperability Rules
FHIR Taskforces	ONC FHIR at Scale Taskforce	Investigate Scalability of FHIR Deployment
FHIR Accelerator Projects	Argonaut, Da Vinci, CARIN, CodeX, Gravity, Vulcan, Helios	Create FHIR Implementation Guides for Use Cases
Industry Standards Organizations	HL7, IHE, IEEE, DICOM, OMG	Create Base Standards

Scope of the FHIR Standard



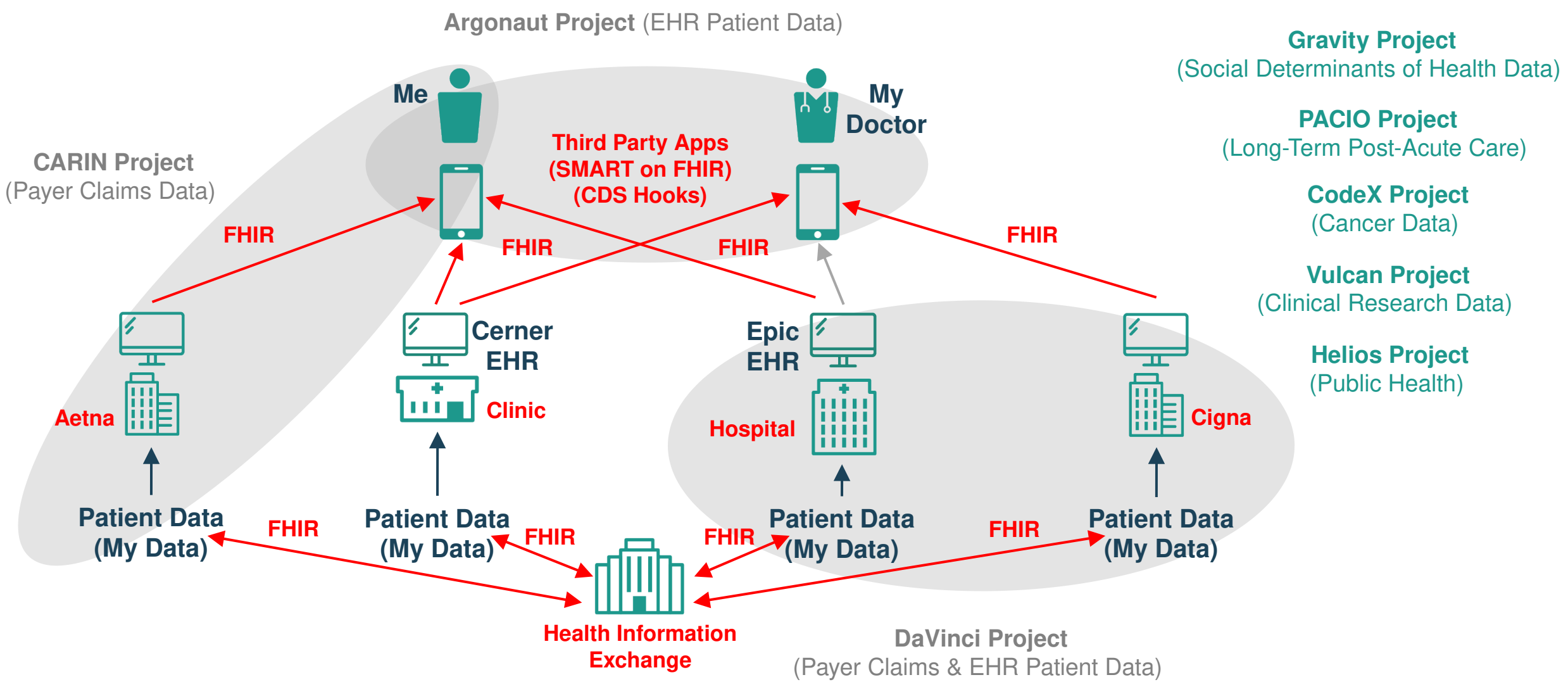
FHIR DevDays 2020 Keynote - Micky Tripathi: https://www.youtube.com/watch?v=vcJ03RxE84U

Scope of the ONC/CMS Rules



Adapted from FHIR DevDays 2020 Keynote - Micky Tripathi: https://www.youtube.com/watch?v=vcJ03RxE84U

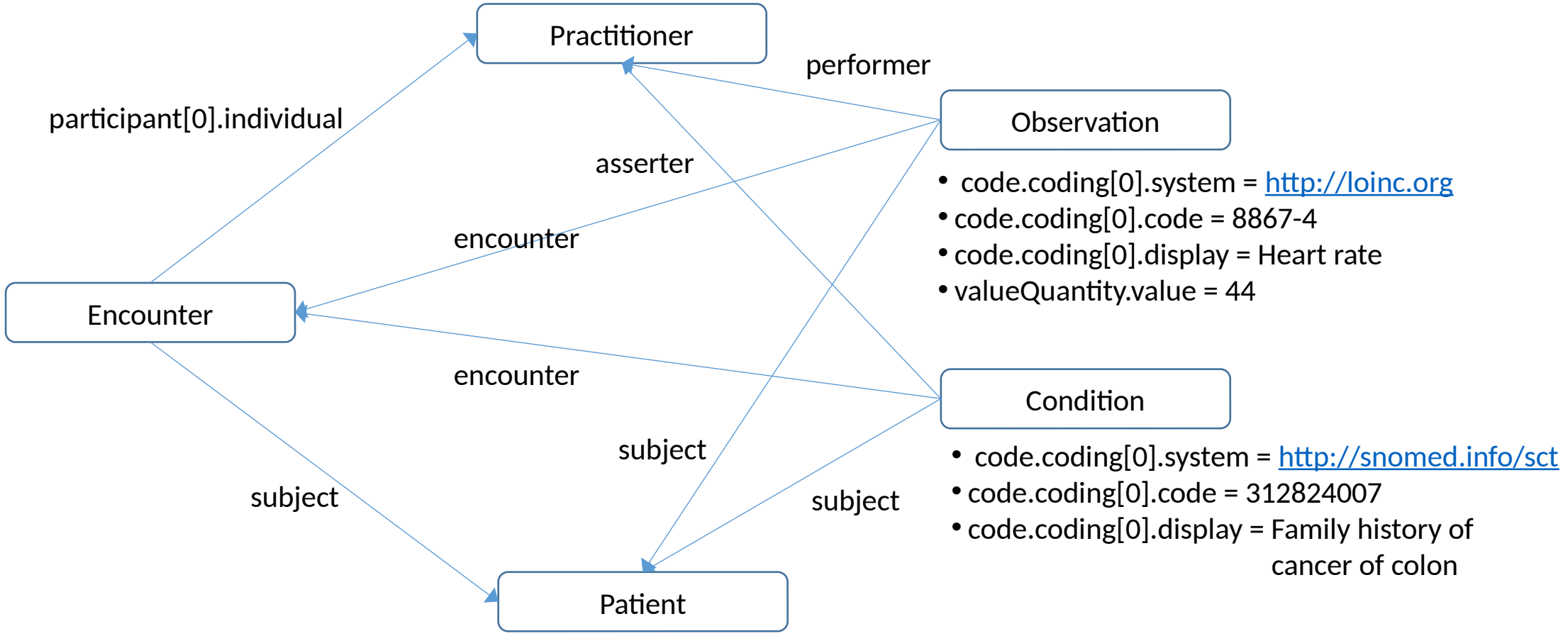
HL7 FHIR Accelerator Projects



So, What is FHIR?

- Fast Healthcare Interoperability Resources (FHIR) is an international standards framework for the exchange of healthcare data
- FHIR solutions are built from a set of modular components called "Resources".
- Resources can easily be assembled into working systems that solve real world clinical and administrative problems at a fraction of the price
- FHIR is suitable for use in a wide variety of contexts – mobile apps, cloud communications, HER data sharing, server communication in large institutional healthcare providers, and much more.
- Database servers have been developed that support creating, retrieving and searching for FHIR resources

Use Case: FHIR Resources for Patient Visit



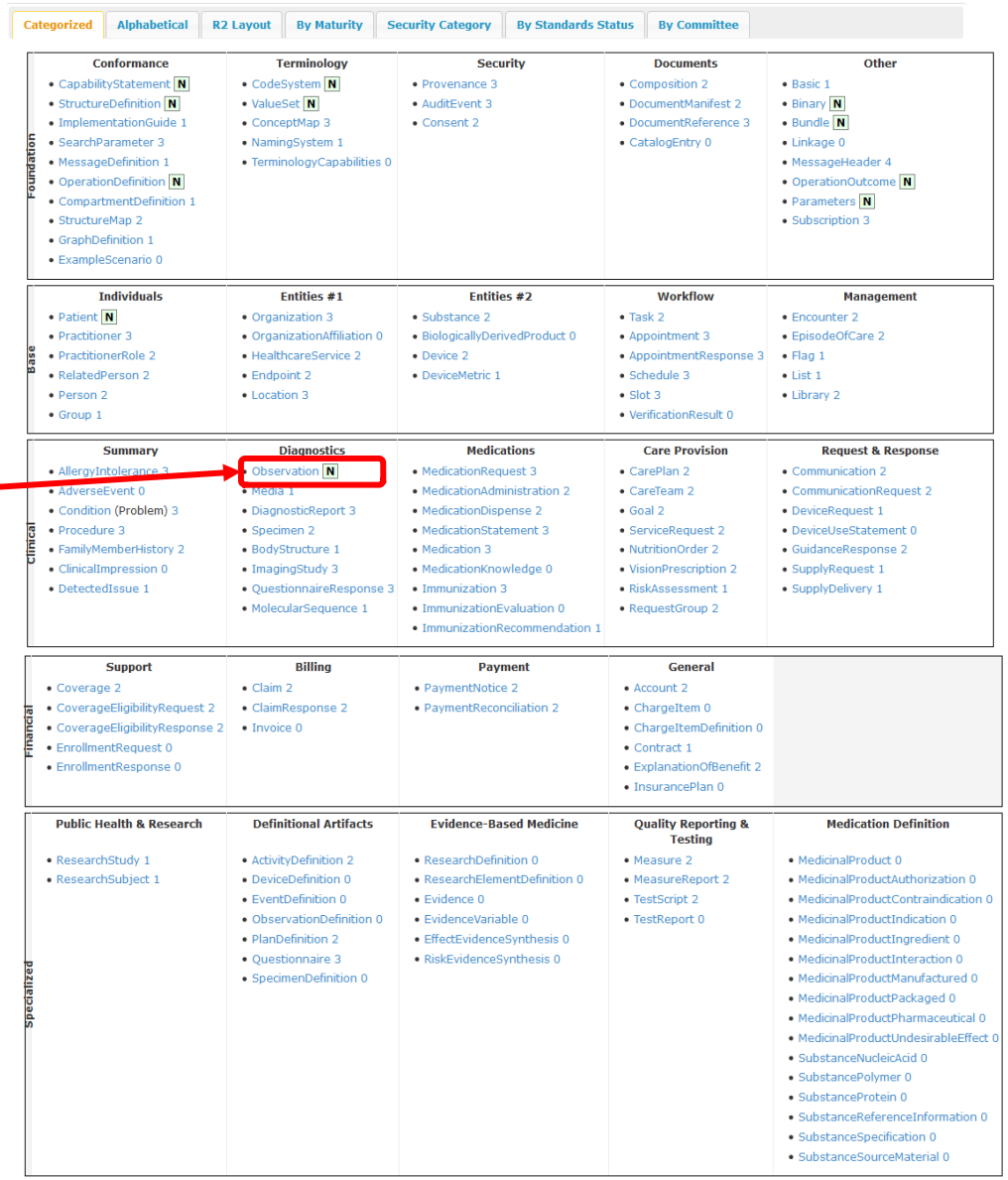
- code.coding[0].system = http://loinc.org
- code.coding[0].code = 8867-4
- code.coding[0].display = Heart rate
- valueQuantity.value = 44

- code.coding[0].system = http://snomed.info/sct
- code.coding[0].code = 312824007
- code.coding[0].display = Family history of cancer of colon

- id = example
- name.given = Tina
- name.family = Test

FHIR Resources

Observation Resource



https://www.hl7.org/FHIR/resourcelist.html

Categories of FHIR Resources

Foundation
- Conformance
- Terminology
- Security
- Documents
- Other

Base
- Individuals
- Entities #1
- Entities #2
- Workflow
- Management

Clinical
- Summary
- Diagnostics
- Medications
- Care Provision
- Request & Response

Financial
- Support
- Billing
- Payment
- General

Specialized
- Public Health & Research
- Definitional Artifacts
- Evidence-Based Medicine
- Quality Reporting & Testing
- Medication Definition

What's a Resource?

Examples

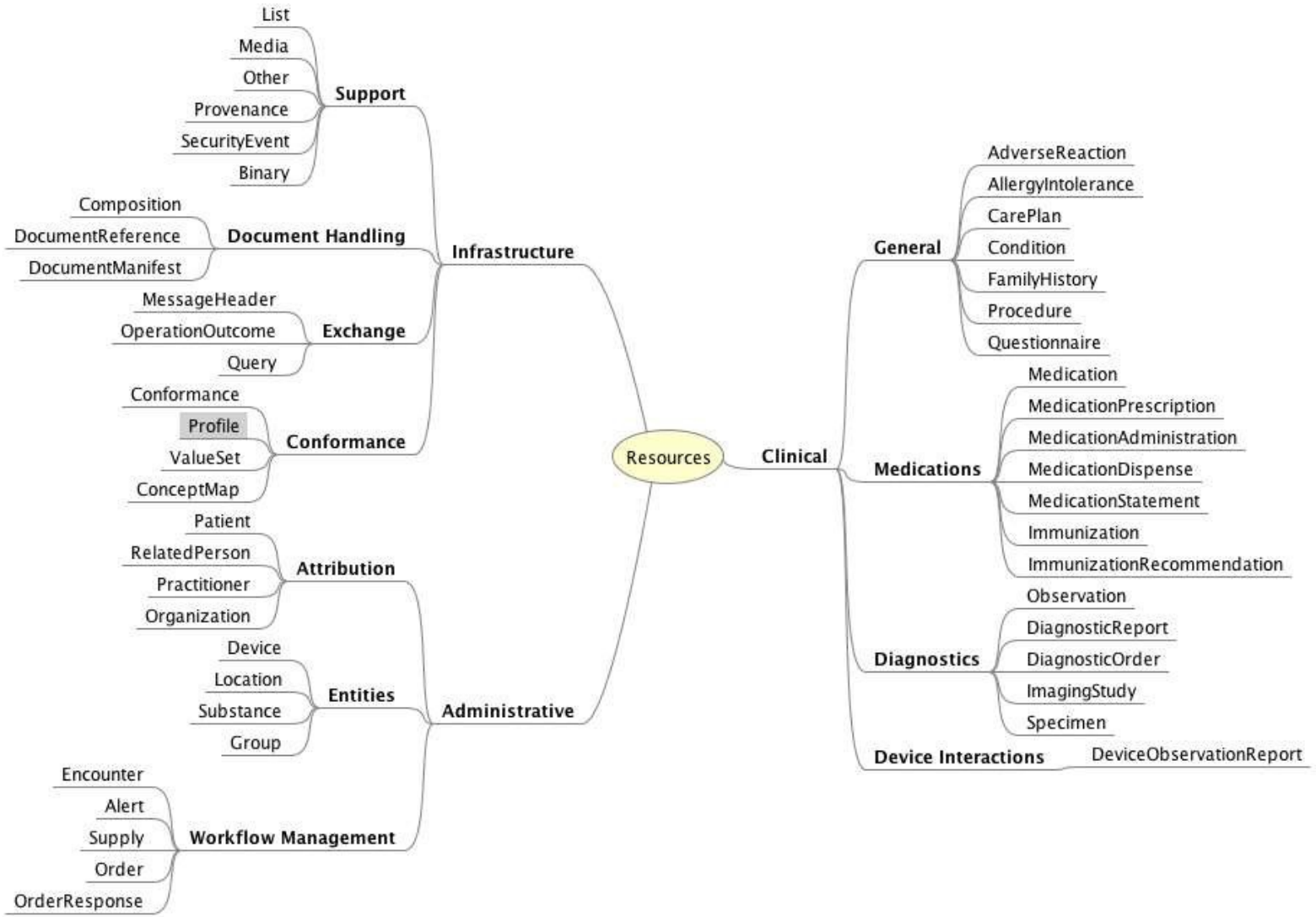
- **Administrative**
  - Patient, Practitioner, Organization, Location, Coverage, Invoice
- **Clinical Concepts**
  - Allergy, Condition, Family History, Care Plan
- **Infrastructure**
  - Document, Message, Profile, Conformance

Non-examples

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

100-150 total - ever

Resource List



Structure of the FHIR Observation Resource

Structure | UML | XML | JSON | Turtle | R4 Diff | All

Structure

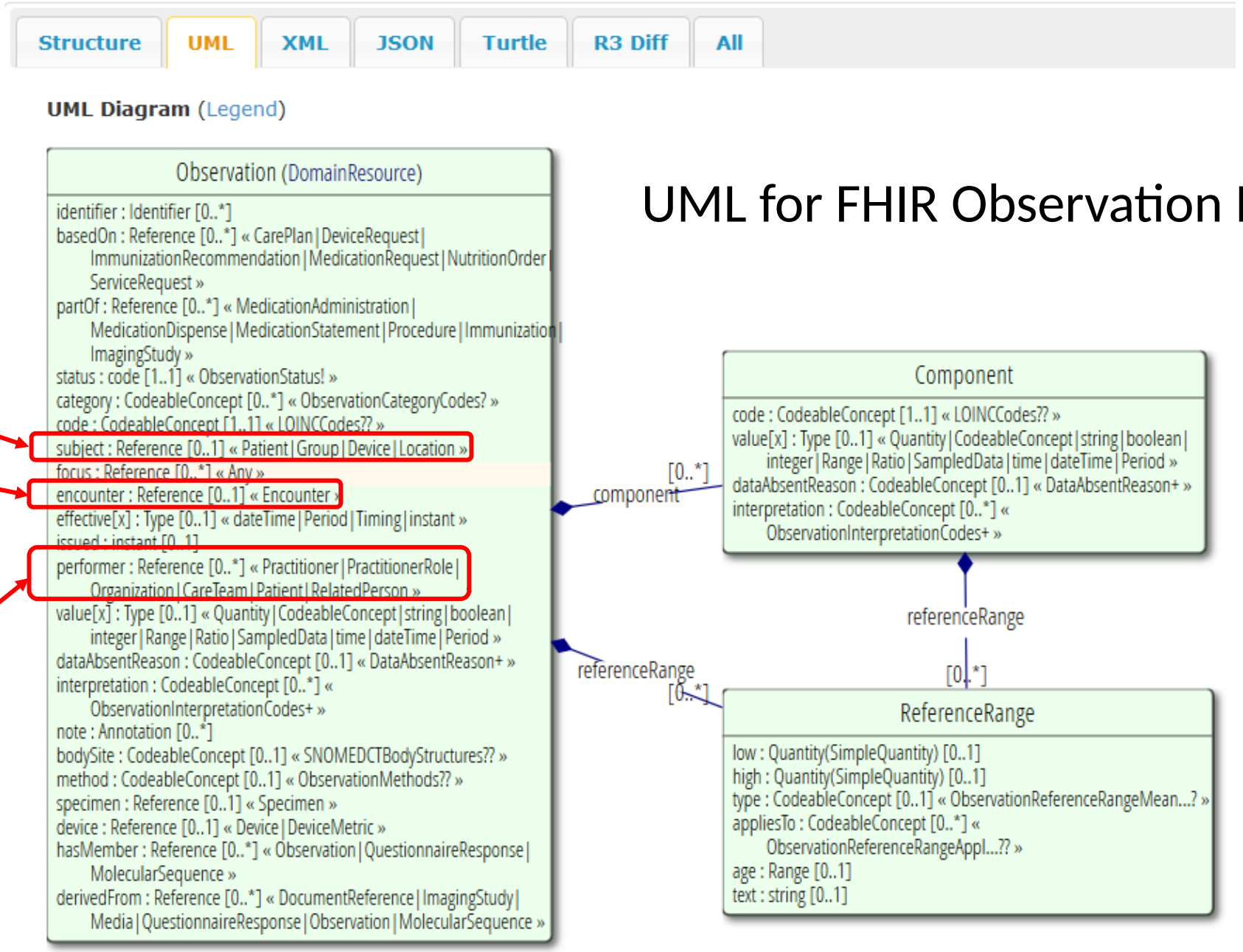
Name	Flags	Card.	Type	Description & Constraints
Observation	N		DomainResource	Measurements and simple assertions + *Rule: dataAbsentReason SHALL only be present if Observation.value[x] is not present* + *Rule: If Observation.code is the same as an Observation.component.code then the value element associated with the code SHALL NOT be present* Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
identifier	Σ	0..*	Identifier	Business Identifier for observation
basedOn	Σ	0..*	Reference(CarePlan | DeviceRequest | ImmunizationRecommendation | MedicationRequest | NutritionOrder | ServiceRequest)	Fulfills plan, proposal or order
partOf	Σ	0..*	Reference(MedicationAdministration | MedicationDispense | MedicationStatement | Procedure | Immunization | ImagingStudy)	Part of referenced event
status	?! Σ	1..1	code	registered | preliminary | final | amended + ObservationStatus (Required)
category		0..*	CodeableConcept	Classification of type of observation Observation Category Codes (Preferred)
code	Σ	1..1	CodeableConcept	Type of observation (code / type) LOINC Codes (Example)
subject	Σ	0..1	Reference(Patient | Group | Device | Location | Organization | Procedure | Practitioner | Medication | Substance)	Who and/or what the observation is about
focus	Σ TU	0..*	Reference(Any)	What the observation is about, when it is not about the subject of record
encounter	Σ	0..1	Reference(Encounter)	Healthcare event during which this observation is made
effective[x]	Σ	0..1		Clinically relevant time/time-period for observation
effectiveDateTime			dateTime	
effectivePeriod			Period	
effectiveTiming			Timing	
effectiveInstant			instant	
issued	Σ	0..1	instant	Date/Time this version was made available

UML for FHIR Observation Resource

Reference to Patient Resource

Reference to Encounter Resource

Reference to Practitioner Resource



https://www.hl7.org/FHIR/observation.html

mple of FHIR Observation Resource for Gluc
(JSON Format)


```
{
  "resourceType": "Observation",
  "id": "f001",
  "identifier": [
    {
      "use": "official",
      "system": "http://www.bmc.nl/zorgportal/identifiers/observa
      "value": "6323"
    }
  ],
  "status": "final",
  "code": {
    "coding": [
      {
        "system": "http://loinc.org",
        "code": "15074-8",
        "display": "Glucose [Moles/volume] in Blood"
      }
    ]
  },
  "subject": {
    "reference": "Patient/f001",
    "display": "P. van de Heuvel"
  },
  "effectivePeriod": {
    "start": "2013-04-02T09:30:10+01:00"
  },
  "issued": "2013-04-03T15:30:10+01:00",
  "performer": [
    {
      "reference": "Practitioner/f005",
      "display": "A. Langeveld"
    }
  ],
  "valueQuantity": {
    "value": 6.3,
    "unit": "mmol/l",
    "system": "http://unitsofmeasure.org",
    "code": "mmol/L"
  },
  "interpretation": [
    {
      "coding": [
        {
          "system": "http://terminology.hl7.org/CodeSystem/v3-ObservationInterpretation"
          "code": "H",
          "display": "High"
        }
      ]
    }
  ],
  "referenceRange": [
    {
      "low": {
        "value": 3.1,
        "unit": "mmol/l",
        "system": "http://unitsofmeasure.org",
        "code": "mmol/L"
      },
      "high": {
        "value": 6.2,
        "unit": "mmol/l",
        "system": "http://unitsofmeasure.org",
        "code": "mmol/L"
      }
    }
  ]
}
```


https://www.hl7.org/FHIR/observation-example-f001-glucose.html

FHIR Search Command

https://www.hl7.org/fhir/search.html

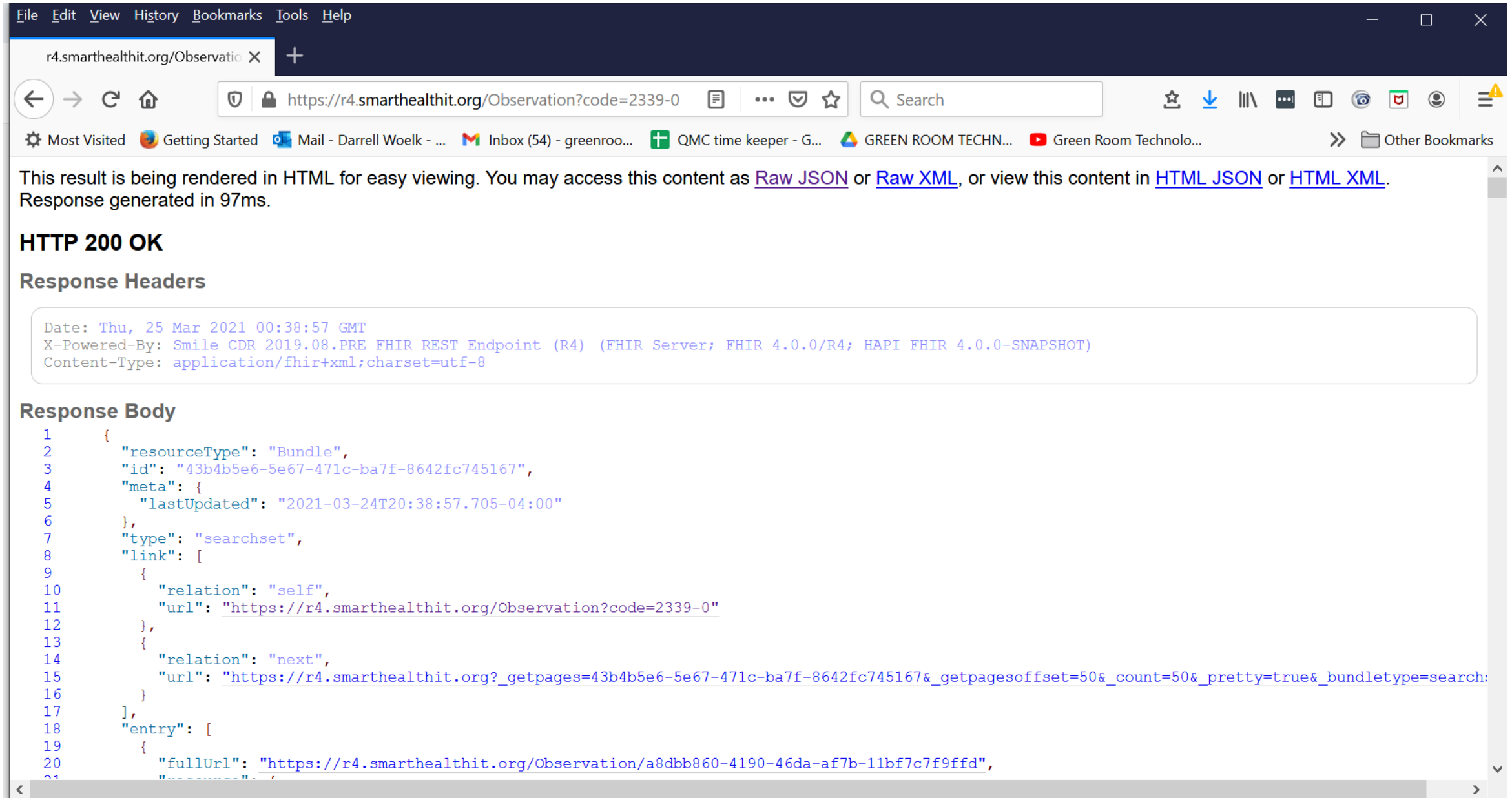
- Searching for resources is fundamental to the mechanics of FHIR. Search operations traverse through an existing set of resources filtering by parameters supplied to the search operation.
- FHIR Search Syntax
  - The client requests data using the following HTTP syntax:

    GET [baseUrl]/[resourceType]?[optional parameters]
  - The server then returns a FHIR Bundle resource, which is a container resource containing the matching search results
- Example:
  - https://r4.smarthealthit.org/Observation?code=2339-0

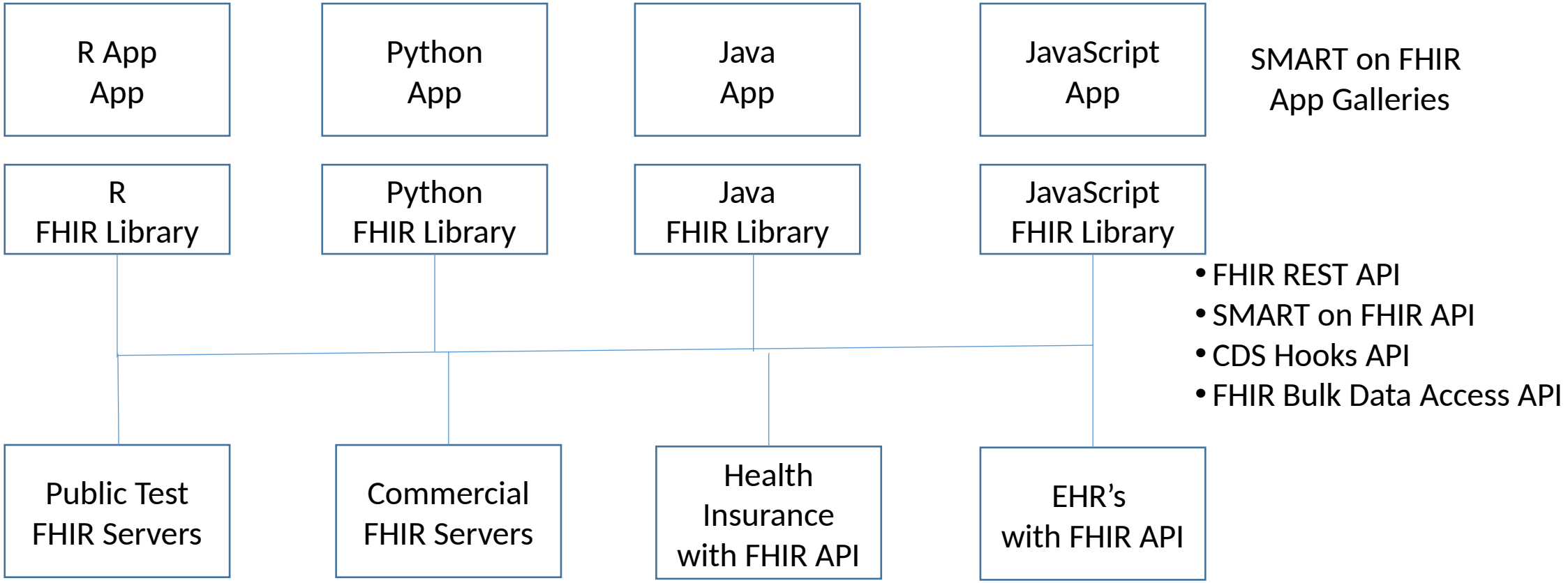
Search Using a Reference Between Resources

- Get the Observation resources with Triglycerides values for the Patient with id = 0e61c3ad-d11e-4080-a6aa-cac89cae4e37
  - https://r4.smarthealthit.org/Observation?subject=Patient/0e61c3ad-d11e-4080-a6aa-cac89cae4e37&code=2571-8
  - https://r4.smarthealthit.org/Observation?subject=Patient/0e61c3ad-d11e-4080-a6aa-cac89cae4e37&code=2571-8

Execute a FHIR API Call in a Browser: https://r4.smarthealthit.org/Observation?code=2339-0



Architecture for FHIR Applications



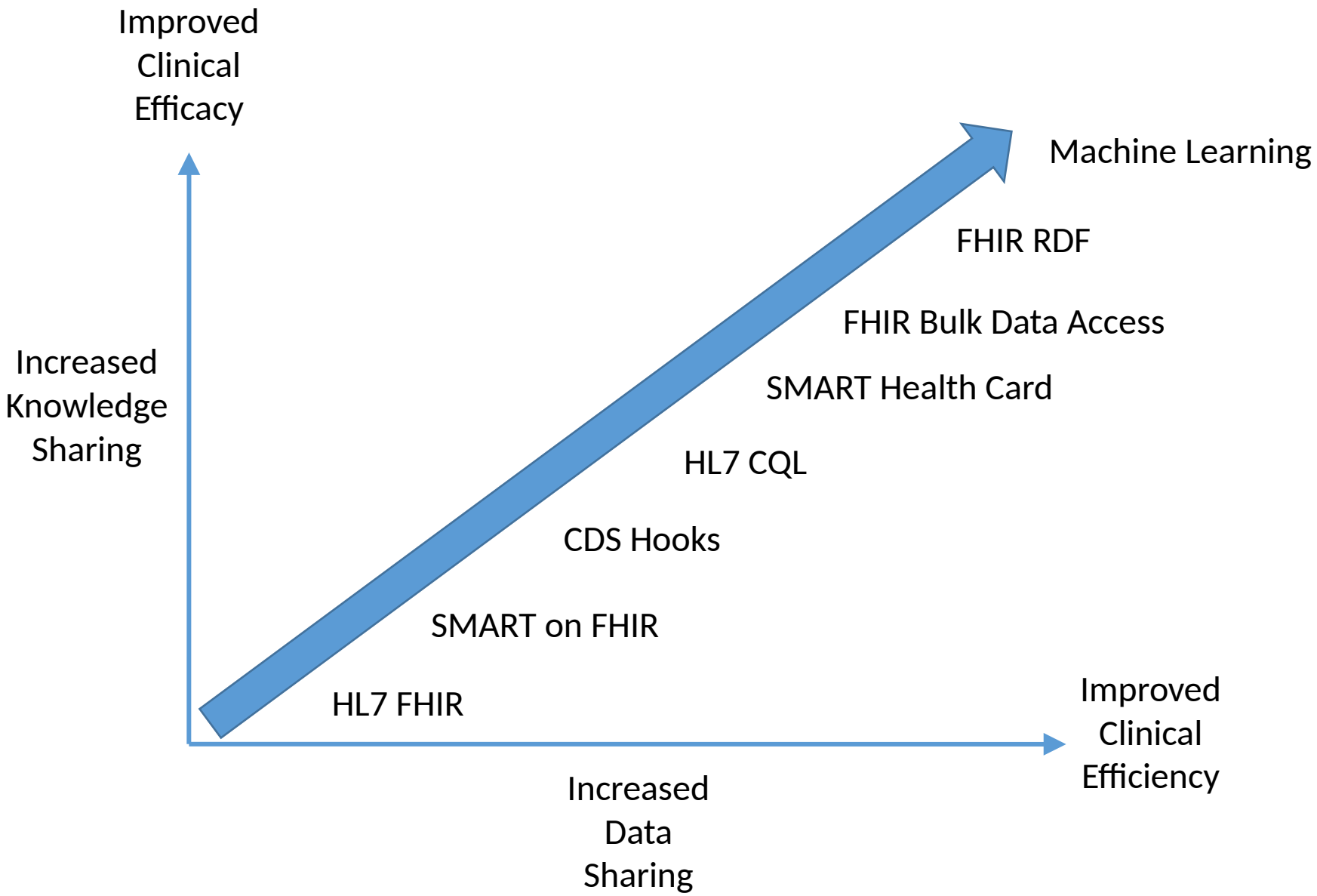
Open Source and Commercial FHIR Servers

- There are 29 public FHIR Test Servers online for use in application development and for testing at FHIR Connectathons
  - https://confluence.hl7.org/display/FHIR/Public+Test+Servers
- Logica Health provides a personal instance of a FHIR Server for testing FHIR applications
  - https://www.logicahealth.org/solutions/fhir-sandbox/
- There are a number of commercially supported FHIR Servers from small companies along with software tools for application development
  - 1UpHealth (https://1up.health/)
  - Health Samurai (https://www.health-samurai.io/)
  - Smile CDR (https://smilecdr.com/)
  - Vonk FHIR Server (https://vonk.fire.ly/)
  - and others .....

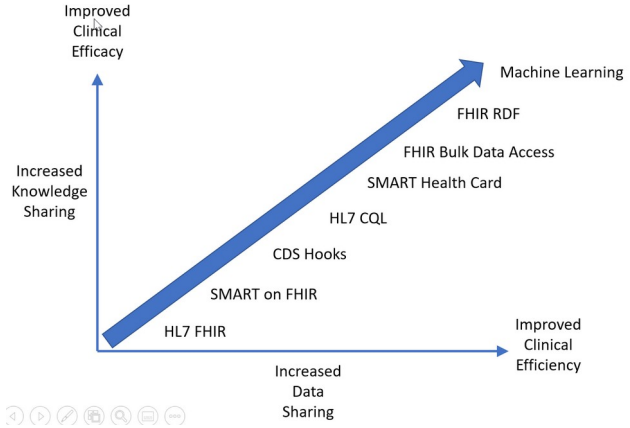
FHIR and the Major Technology Companies

- The Argonaut Project was formed by the major EHR vendors in 2014 to set priorities and write Implementation Guides for using FHIR
  - https://confluence.hl7.org/display/AP/Argonaut+Project+Home
- Apple Health Records iPhone app is able to access a user's selected medical records from provider organizations using the FHIR API
  - https://www.apple.com/healthcare/health-records/
- Microsoft has announced the Azure API for FHIR product that is a managed Platform-as-a Service (PaaS) cloud offering that is built on an open source FHIR server based on the Azure Cosmos DB
  - https://azure.microsoft.com/en-us/services/azure-api-for-fhir/
- Google has announced the Cloud Healthcare API PaaS which includes a FHIR database
  - https://cloud.google.com/healthcare/
- The IBM Watson for Health GxP PaaS includes a FHIR database and is able to import healthcare data from other sources
  - https://www.ibm.com/products/fhir-server

The Evolving FHIR Ecosystem

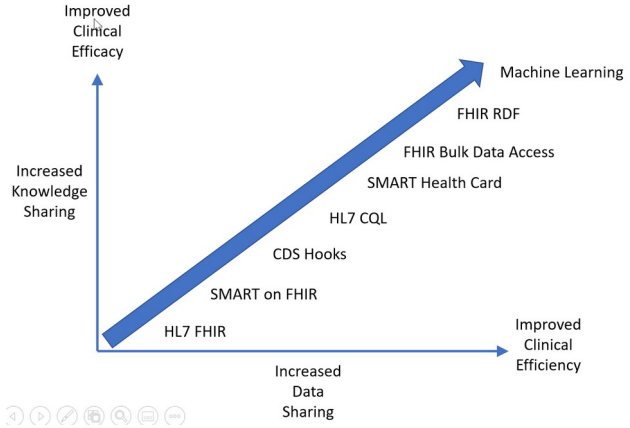


Improving Clinical Efficacy with FHIR



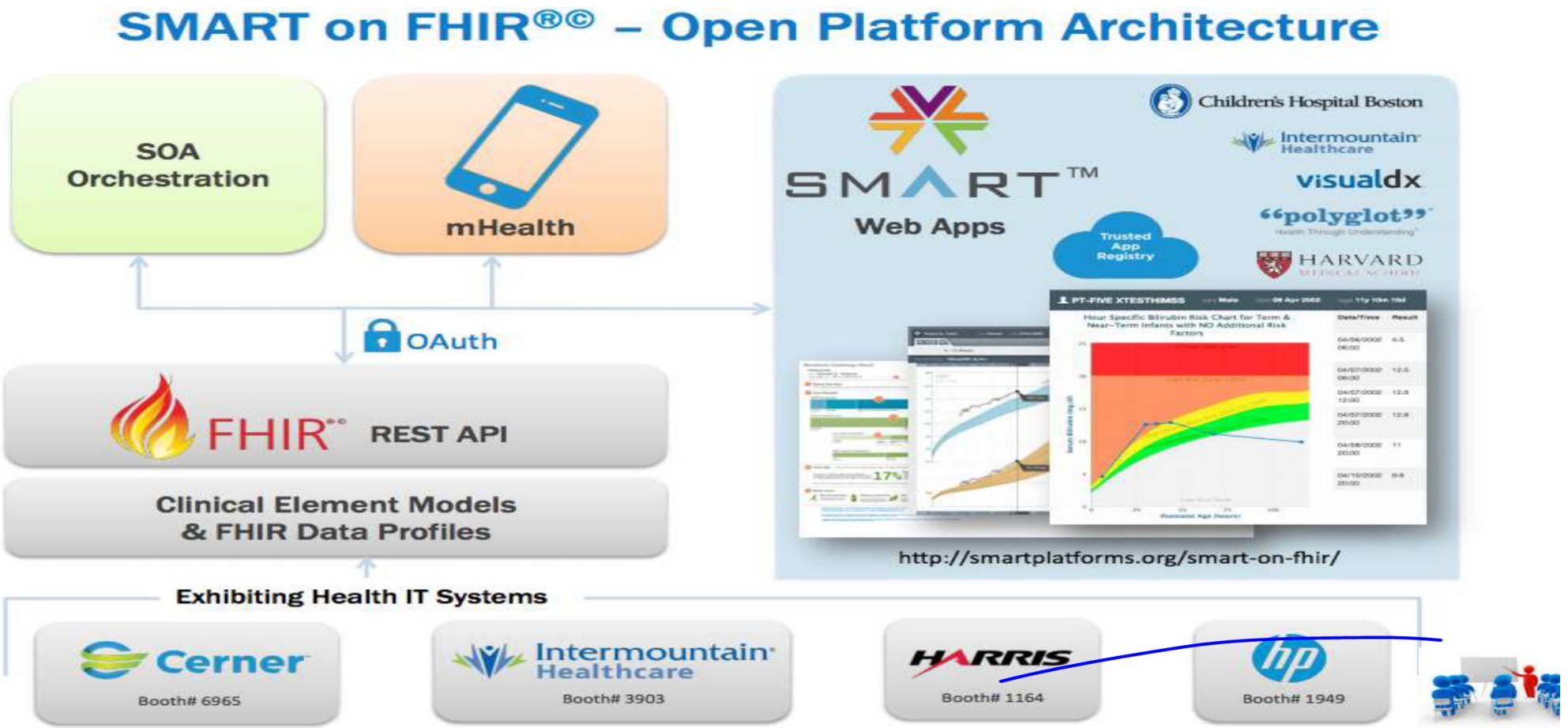
- The HL7 FHIR (Fast Healthcare Interoperability Resources) standard defines a set of Resources and a REST API for creating, retrieving, searching, and updating
  - https://www.hl7.org/fhir/
- The SMART on FHIR specification defines a framework for launching FHIR-based apps from an EHR that leverages OAuth2 and OpenID for authorization and authentication
  - https://smarthealthit.org/
- The CDS Hooks specification defines a framework for registering and launching Clinical Decision Support apps from an EHR at specific points in the clinical workflow
  - https://cds-hooks.org/
- HL7 Clinical Quality Language (CQL) is a high-level, domain-specific language focused on clinical quality and targeted at quality measure and decision support artifact authors
  - https://ecqi.healthit.gov/cql

Improving Clinical Efficacy with FHIR



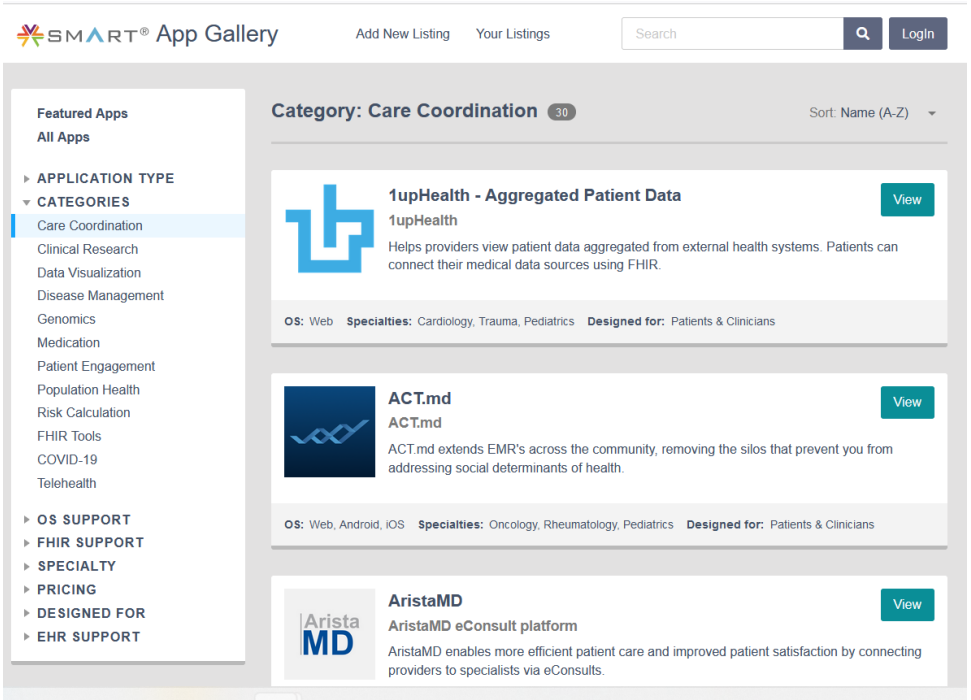
- SMART Health Cards are verifiable paper or digital versions of FHIR clinical data that implement the W3C Verifiable Credentials standard to prove the authenticity of the data
  - https://smarthealth.cards/en/
- FHIR Bulk Data Access provides an API for transferring large amounts of FHIR data
  - https://hl7.org/fhir/uv/bulkdata/
- FHIR RDF is an RDF representation of FHIR resources for knowledge applications that is an alternative to the XML and JSON representations
  - https://www.hl7.org/fhir/rdf.html
- Machine Learning can be used to train models that identify patterns in FHIR data that predict health outcomes

SMART on FHIR



SMART on FHIR App Marketplaces

- The SMART Health IT project maintains an App Gallery where developers can list their SMART on FHIR apps and others can try them out using a sandbox FHIR database
  - https://apps.smarthealthit.org/apps
- Many EHR vendors maintain their own App Galleries where third party developed SMART on FHIR apps are listed that have been tested and certified with the vendor's EHR system
  - Epic: https://apporchard.epic.com/
  - Cerner: https://code.cerner.com/apps
  - Allscripts: https://expo.allscripts.com/
  - and others .....



Representation of Care Plans in FHIR

Vision Today

Care Plan Cornerstones

Dynamic Behavior:

- Machine assisted care coordination

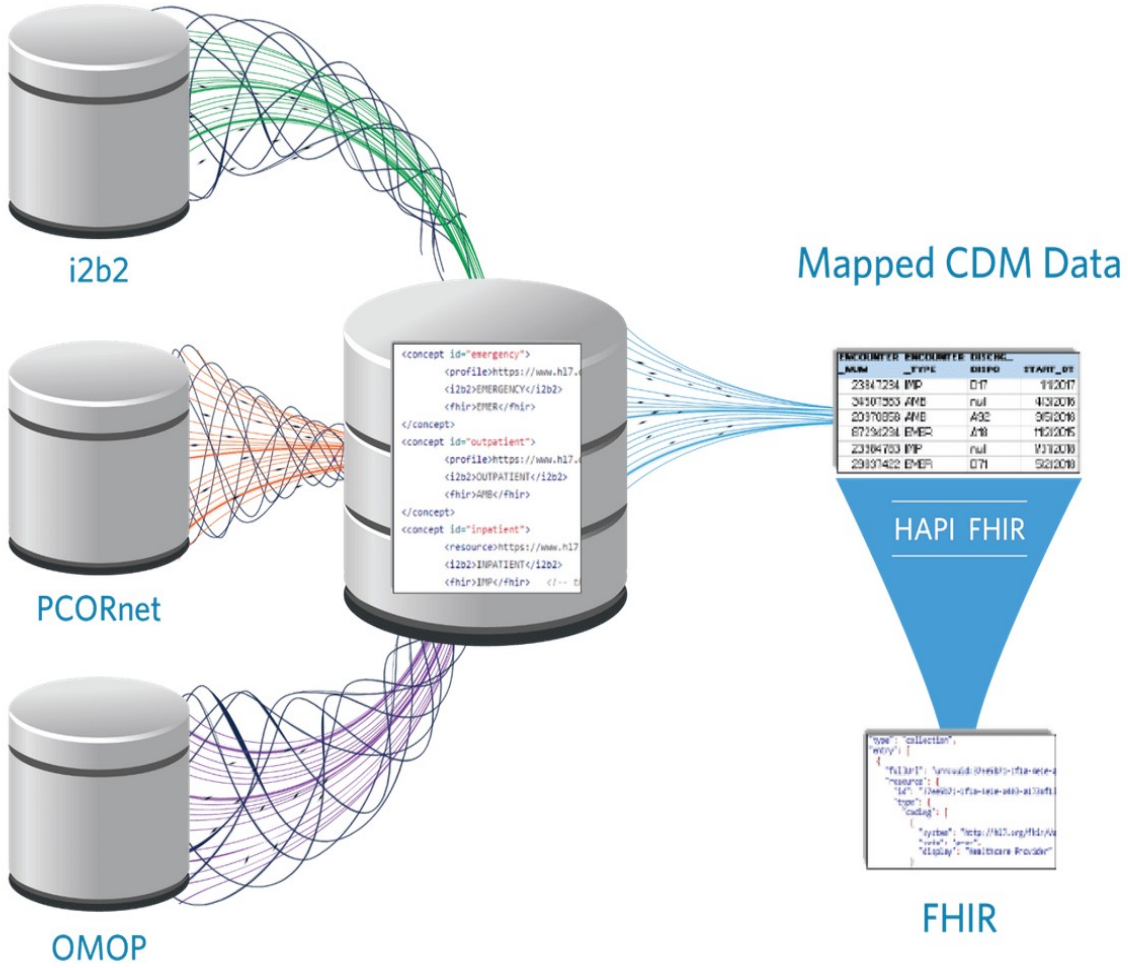
FHIR CarePlan Design:

FHIR CarePlan Resource
+
FHIR Goal Resource
+
Available extensions and resourceReferences
=
Machine assisted care coordination
Dynamic Care planning/coordination processes

Content:

- Health concern(s)
- Health goal(s)
- Activity/intervention(s)
- Progress/outcome

and more ...



Share with collaborators

Merge with new datasets

Expose via API

Convert to RDF

...

1 Start with a CDM

2 Map CDM data to FHIR

3 Convert to FHIR

4 Use Data

Reference

- https://smarthealthit.org/
- https://docs.smarthealthit.org/
- https://apps.smarthealthit.org/