Università degli Studi di Trieste

Corso di Laurea Magistrale in
INGEGNERIA CLINICA

LO STANDARD HL7-FHIR

Corso di Informatica Medica

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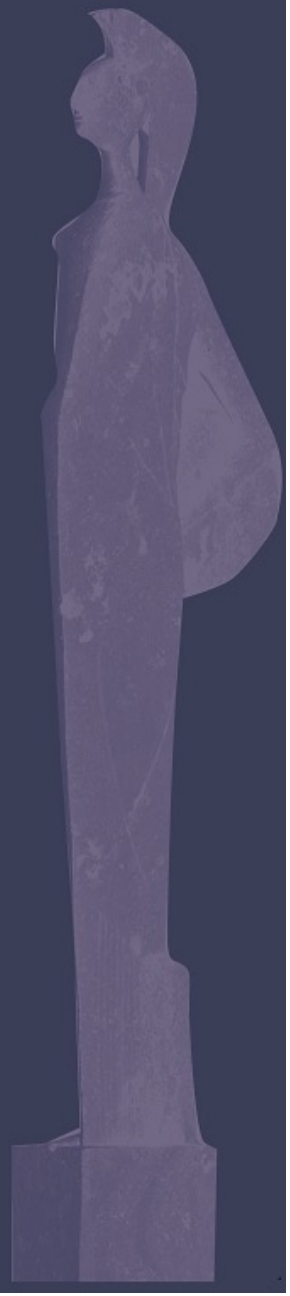

Dipartimento di Ingegneria e Architettura

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FHIR®

Fast Healthcare Interoperability Resources

WHAT IS FHIR

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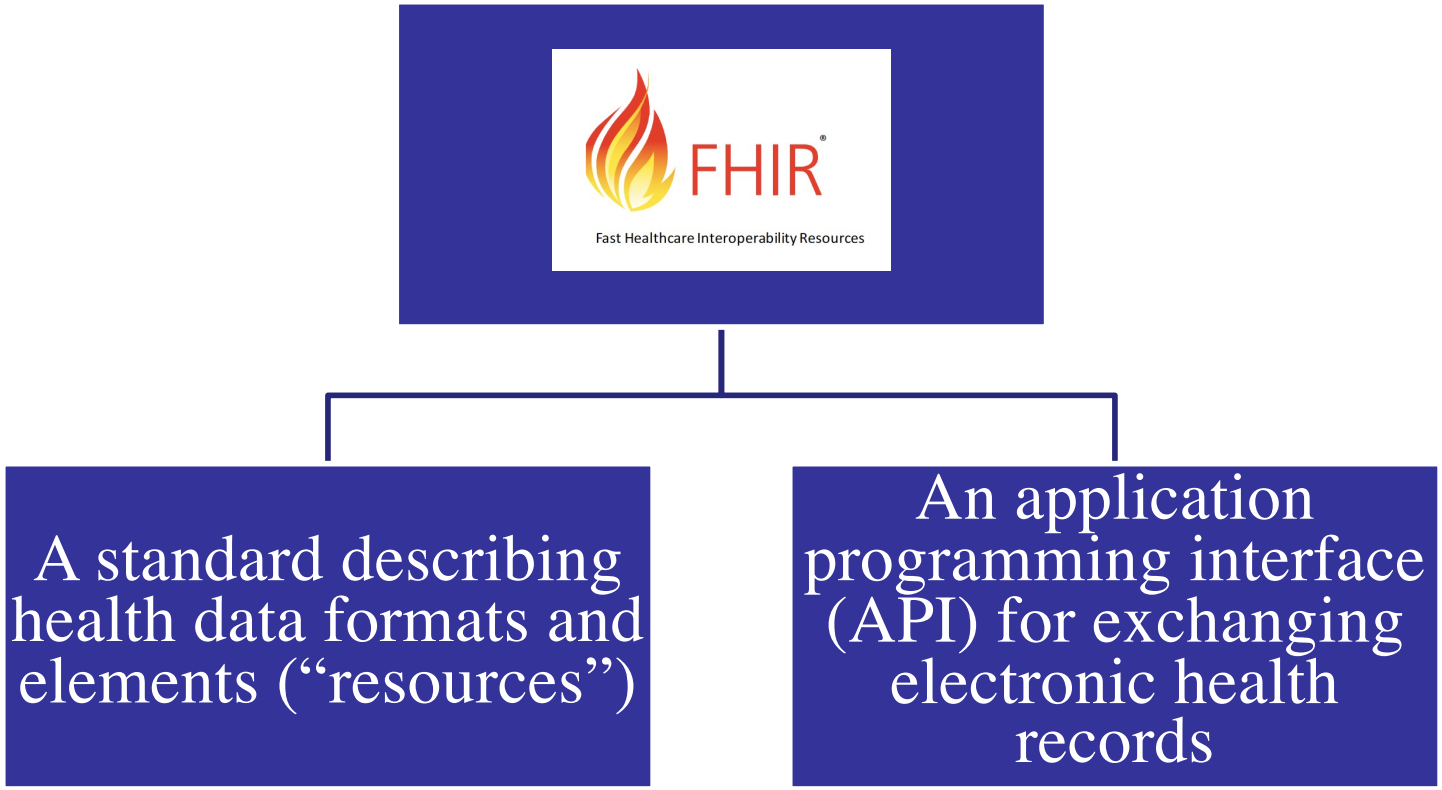


FHIR enables health data to be moved using standard Web protocols and allows developers to more easily interact with health data across diverse systems

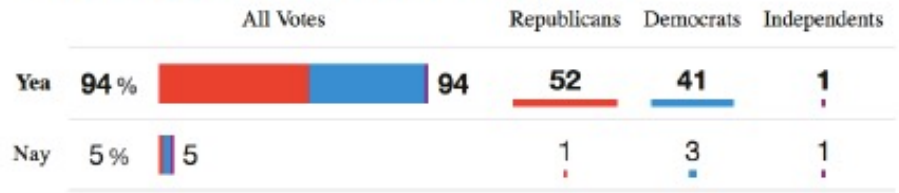
FHIR USE

21st Century Cures Act: Interoperability, Information Blocking, and the ONC Health IT Certification Program Proposed Rule

The Office of the National Coordinator for Health Information Technology

We propose to adopt a new API criterion in § 170.315(g)(10), which would replace the "application access – data category request" certification criterion (§ 170.315(g)(8)) and become part of the 2015 Edition Base EHR definition. This new certification criterion would require the use of Health Level 7 (HL7®) Fast Healthcare Interoperability Resources (FHIR®) standards and several implementation specifications.

- 21st Century Cures Act passed Congress in December 2016 with strong bipartisan support

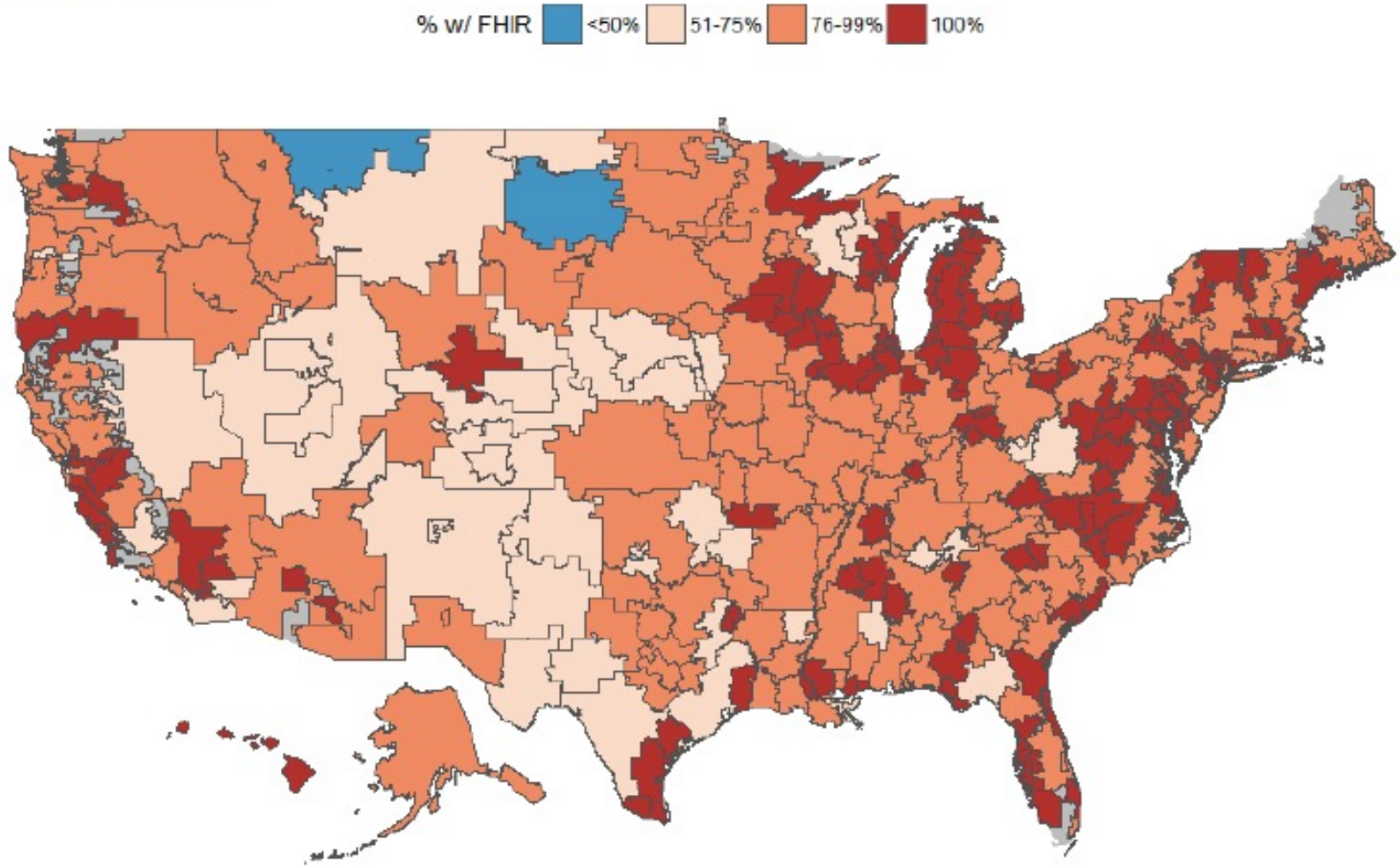


- Key interoperability provisions
  - Prevent information blocking
  - Establish FHIR as mechanism for moving data between EHRs (syntactic interoperability)
  - Establish standardized codes for moving data between EHRs (semantic interoperability)

FHIR USE

Percent of hospitals with a 2015 Edition certified-API enabled with FHIR

By Hospital Referral Region



FHIR TIMELINE

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FIGURE 2: HL7 FHIR TIMELINE

* Draft Standard for Trial Use

Standard for Trial Use

+ Normative Edition

Information courtesy of HL7 International.

FHIR USE

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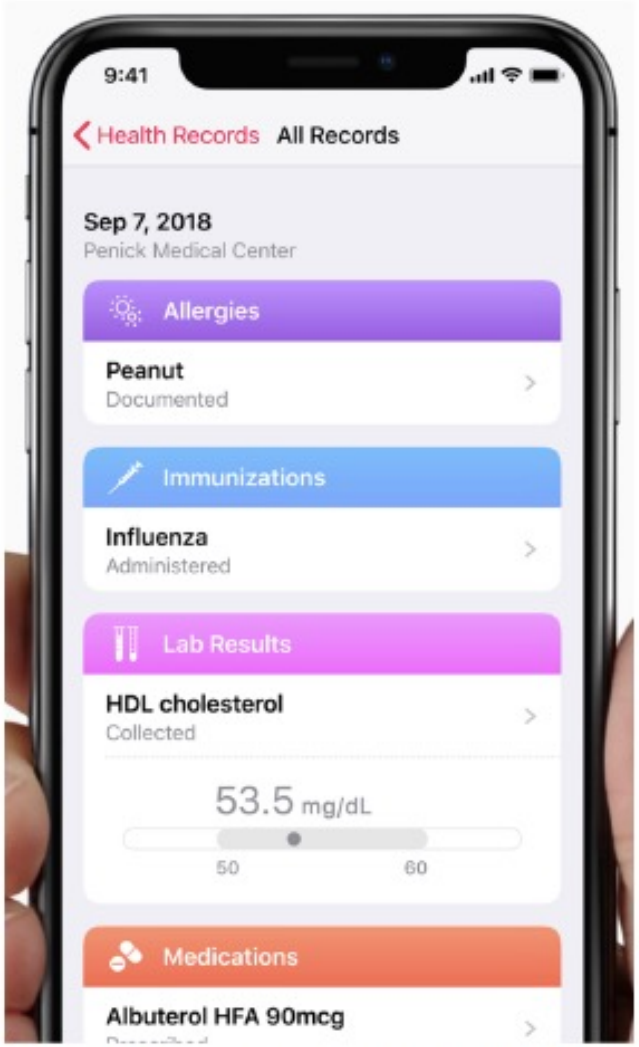
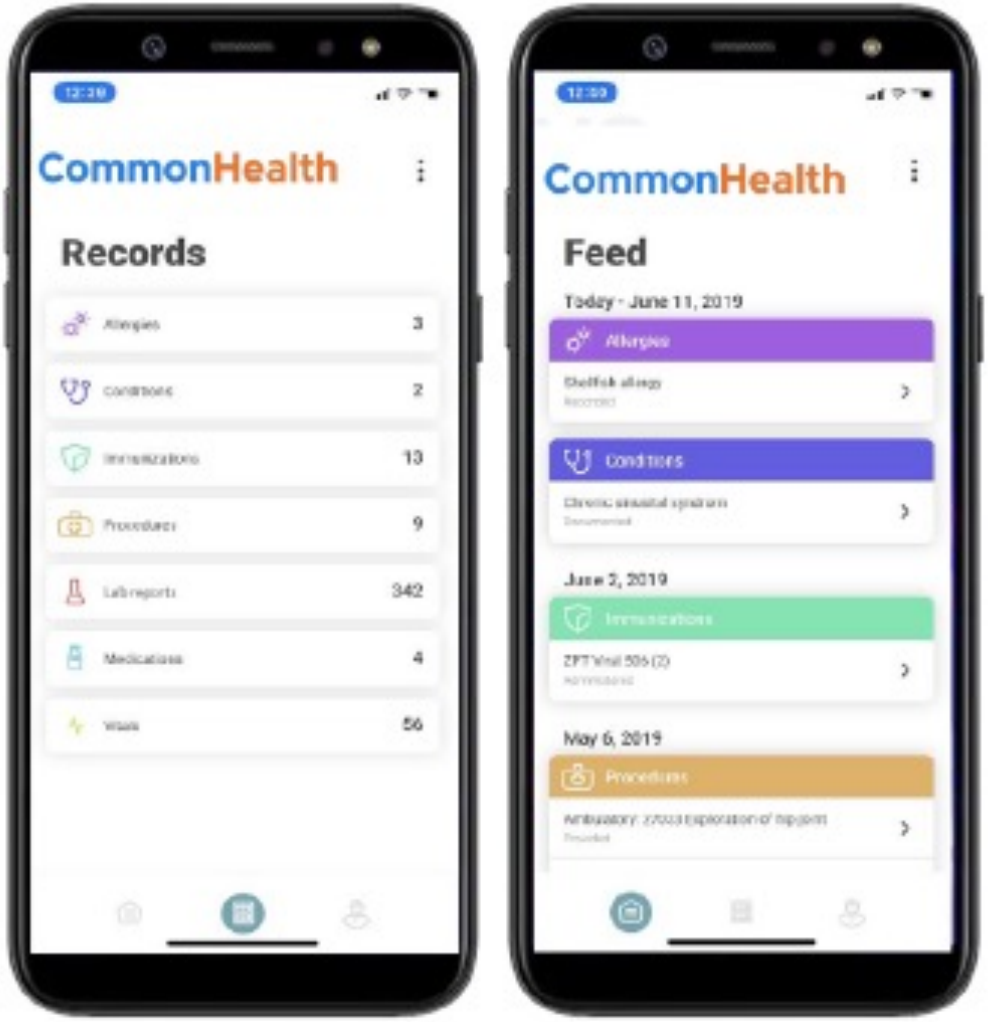


Apple Health uses FHIR



CommonHealth is a similar initiative for Android

FHIR RESOURCES

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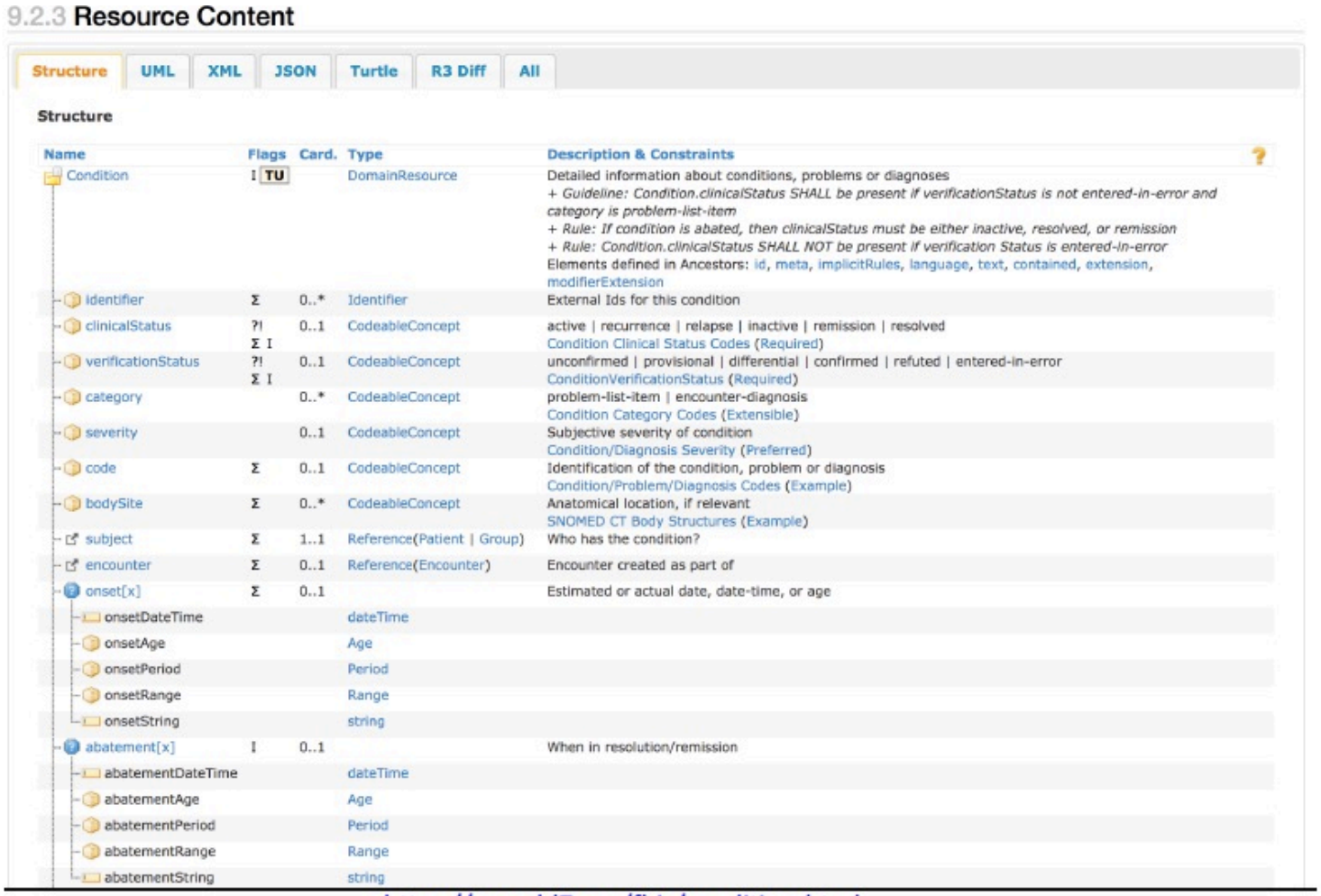
- Specification of information structure in FHIR
- Basic building blocks to manage any type of information



9.2.3 **Resource Content**

Structure | UML | XML | JSON | Turtle | R3 Diff | All

Structure

Name	Flags	Card.	Type	Description & Constraints
Condition	I TU		DomainResource	Detailed information about conditions, problems or diagnoses + *Guideline: Condition.clinicalStatus SHALL be present if verificationStatus is not entered-in-error and category is problem-list-item* + *Rule: If condition is abated, then clinicalStatus must be either inactive, resolved, or remission* + *Rule: Condition.clinicalStatus SHALL NOT be present if verification Status is entered-in-error* Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
identifier	Σ	0..*	Identifier	External Ids for this condition
clinicalStatus	?! Σ I	0..1	CodeableConcept	active | recurrence | relapse | inactive | remission | resolved Condition Clinical Status Codes (Required)
verificationStatus	?! Σ I	0..1	CodeableConcept	unconfirmed | provisional | differential | confirmed | refuted | entered-in-error ConditionVerificationStatus (Required)
category		0..*	CodeableConcept	problem-list-item | encounter-diagnosis Condition Category Codes (Extensible)
severity		0..1	CodeableConcept	Subjective severity of condition Condition/Diagnosis Severity (Preferred)
code	Σ	0..1	CodeableConcept	Identification of the condition, problem or diagnosis Condition/Problem/Diagnosis Codes (Example)
bodySite	Σ	0..*	CodeableConcept	Anatomical location, if relevant SNOMED CT Body Structures (Example)
subject	Σ	1..1	Reference(Patient | Group)	Who has the condition?
encounter	Σ	0..1	Reference(Encounter)	Encounter created as part of
onset[x]	Σ	0..1		Estimated or actual date, date-time, or age
onsetDateTime			dateTime	
onsetAge			Age	
onsetPeriod			Period	
onsetRange			Range	
onsetString			string	
abatement[x]	I	0..1		When in resolution/remission
abatementDateTime			dateTime	
abatementAge			Age	
abatementPeriod			Period	
abatementRange			Range	
abatementString			string	

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

DIFFERENT VIEWS

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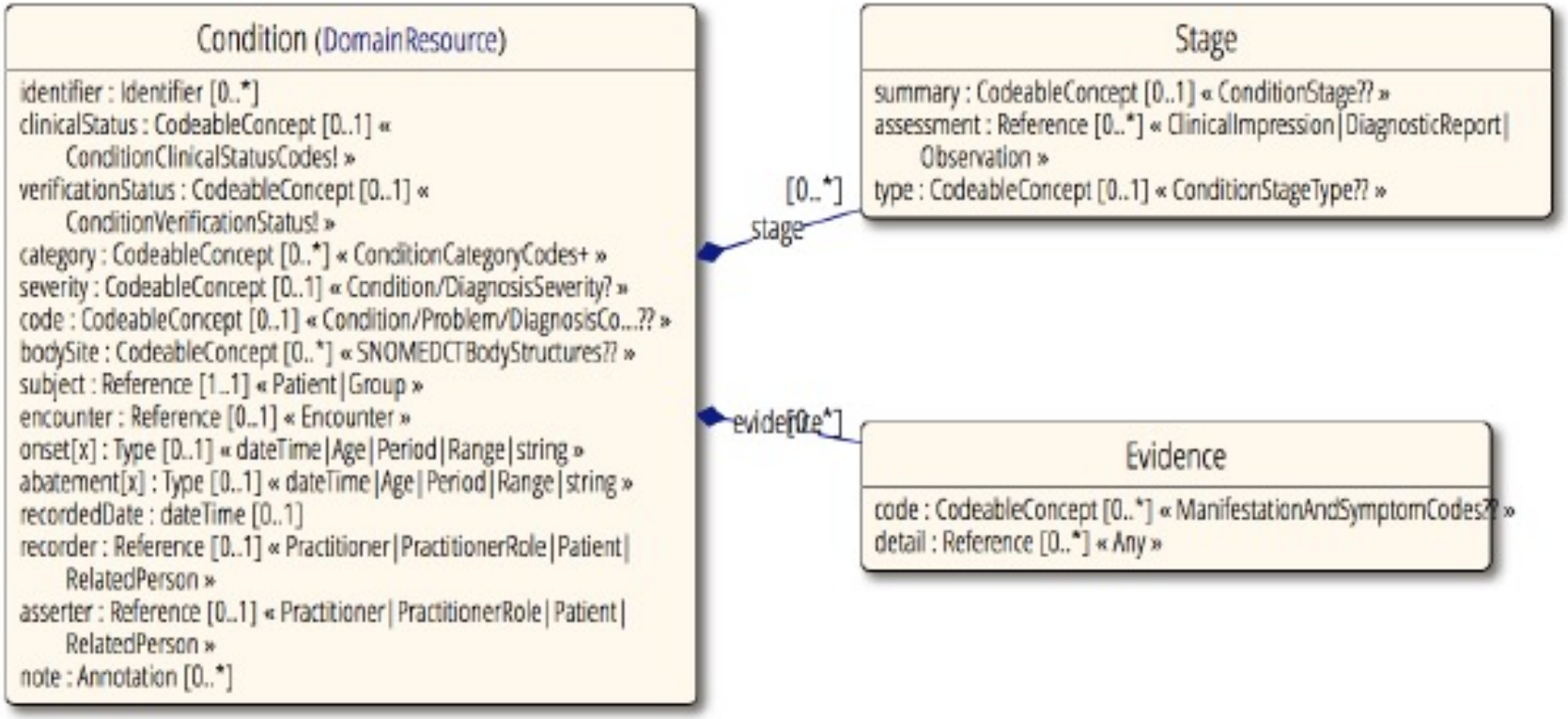
9.2.3 Resource Content

Structure | UML | XML | JSON | Turtle | R3 Diff | All

UML Diagram (Legend)



DIFFERENT VIEWS

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Structure | UML | XML | JSON | Turtle | R3 Diff | All

JSON Template

```
{
  "resourceType" : "Condition",
  // from Resource: id, meta, implicitRules, and language
  // from DomainResource: text, contained, extension, and modifierExtension
  "identifier" : [{ Identifier }], // External Ids for this condition
  "clinicalStatus" : { CodeableConcept }, // C? active | recurrence | relapse | inactive | remis
sion | resolved
  "verificationStatus" : { CodeableConcept }, // C? unconfirmed | provisional | differential | c
onfirmed | refuted | entered-in-error
  "category" : [{ CodeableConcept }], // problem-list-item | encounter-diagnosis
  "severity" : { CodeableConcept }, // Subjective severity of condition
  "code" : { CodeableConcept }, // Identification of the condition, problem or diagnosis
  "bodySite" : [{ CodeableConcept }], // Anatomical location, if relevant
  "subject" : { Reference(Patient|Group) }, // R!  Who has the condition?
  "encounter" : { Reference(Encounter) }, // Encounter created as part of
  // onset[x]: Estimated or actual date,  date-time, or age. One of these 5:
  "onsetDateTime" : "<dateTime>",
  "onsetAge" : { Age },
  "onsetPeriod" : { Period },
  "onsetRange" : { Range },
  "onsetString" : "<string>",
  // abatement[x]: When in resolution/remission. One of these 5:
  "abatementDateTime" : "<dateTime>",
  "abatementAge" : { Age },
  "abatementPeriod" : { Period },
  "abatementRange" : { Range },
  "abatementString" : "<string>",
  "recordedDate" : "<dateTime>", // Date record was first recorded
  "recorder" : { Reference(Practitioner|PractitionerRole|Patient|
   RelatedPerson) }, // Who recorded the condition
  "asserter" : { Reference(Practitioner|PractitionerRole|Patient|
   RelatedPerson) }, // Person who asserts this condition
  "stage" : [{ // Stage/grade, usually assessed formally
    "summary" : { CodeableConcept }, // C? Simple summary (disease specific)
    "assessment" : [{ Reference(ClinicalImpression|DiagnosticReport|Observation) }], // C? Forma
l record of assessment
    "type" : { CodeableConcept } // Kind of staging
  }],
  "evidence" : [{ // Supporting evidence
    "code" : [{ CodeableConcept }], // C? Manifestation/symptom
    "detail" : [{ Reference(Any) }] // C? Supporting information found elsewhere
  }],
  "note" : [{ Annotation }] // Additional information about the Condition
}
```

lition.html#tabs-struc

```
{
  "resourceType": "Condition",
  "id": "example2",
  "category": [
    {
      "coding": [
        {
          "system": "http://snomed.info/sct",
          "code": "439401001",
          "display": "diagnosis"
        }
      ]
    }
  ],
  "severity": {
    "coding": [
      {
        "system": "http://snomed.info/sct",
        "code": "6736007",
        "display": "Moderate"
      }
    ]
  },
  "code": {
    "coding": [
      {
        "system": "http://snomed.info/sct",
        "code": "368009",
        "display": "Heart valve disorder"
      }
    ]
  },
  "bodySite": [
    {
      "coding": [
        {
          "system": "http://snomed.info/sct",
          "code": "40768004",
          "display": "Left thorax"
        }
      ],
      "text": "heart structure"
    }
  ],
  "subject": {
    "reference": "Patient/f001",
    "display": "P. van de Heuvel"
  },
  "encounter": {
    "reference": "Encounter/f001"
  },
  "onsetDateTime": "2011-08-05",
  "recordedDate": "2011-10-05",
```

REST API

- REST = REpresentational State Transfer
- It is an architectural style used to build Web services that are lightweight, maintainable, and scalable in nature.
- A service which is built on the REST architecture is called a RESTful service.
- The underlying protocol for REST is usually HTTP, which is the basic web protocol. However, other protocols (SMTP etc) can be used.
- REST makes resources available through an URI

REST KEY COMPONENTS

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Resources – Element that contains the information.

Request Verbs - Description of what you want to do with the resource.

- The basic request is GET (= retrieve data)
- POST (=create a new element)
- PUT (= update an existing element)
- DELETE (= delete an element)

Request Headers – Additional instructions sent with the request (type of response required, authorization details)

Request Body - Data is sent with the request (usually in a POST call

Response Body – This is the main body of the response (XML document, JSON)

Response Status codes –General codes which are returned along with the response from the web server. (200 = OK, 404 = NOT FOUND)

JSON

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JSON = JAVASCRIPT OBJECT NOTATION

Format to represent data exchanged in the Internet based on the concept of

key = value

HTTP 200 OK

Response Headers

```
X-Powered-By: HAPI FHIR 4.2.0-SNAPSHOT REST Server
Content-Type: application/fhir+xml;charset=utf-8
X-Request-ID: vQJLqXpBkhlx8A7J
```

Response Body


```
{
  "resourceType": "Observation",
  "id": "839",
  "meta": {
    "versionId": "1",
    "lastUpdated": "2019-09-18T20:40:37.908+00:00",
    "source": "#77d2e7673cdb260d"
  },
  "status": "final",
  "code": {
    "text": "urineVolumeDelta"
  },
  "subject": {
    "reference": "Patient/829"
  },
  "effectivePeriod": {
    "start": "2019-09-18T20:40:37+00:00",
    "end": "2019-09-18T20:40:47+00:00"
  },
  "issued": "2019-09-18T20:40:37.653+00:00",
  "valueQuantity": {
    "value": 4.0,
    "unit": "ml"
  }
}
```

FHIR JSON EXAMPLE


```
"entry": [
  {
    "fullUrl": "http://gt-apps.hdap.gatech.edu/gt-fhir/fhir/Condition/364163",
    "resource": {
      "resourceType": "Condition",
      "id": "364163",
      "category": [
        {
          "coding": [
            {
              "system": "None",
              "code": "OMOP generated",
              "display": "Inpatient detail - 5th position"
            }
          ]
        }
      ],
      "code": {
        "coding": [
          {
            "system": "http://snomed.info/sct",
            "code": "269214009",
            "display": "Contusion of face, scalp and neck, excluding eye(s)"
          }
        ]
      },
      "subject": {
        "reference": "Patient/29610",
        "display": "CAITLYN BOHAC"
      },
      "context": {
        "reference": "Encounter/1346"
      },
      "onsetDateTime": "2149-04-22T00:00:00+00:00",
      "abatementDateTime": "2149-05-02T00:00:00+00:00"
    }
```

RESOURCES EVOLVE IN TIME

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LIST OF RESOURCES FOR THE DRAFT STANDARD FOR TRIAL USE (DSTU)

Alphabetical

A-D:

- AllergyIntolerance 1
- Appointment 1
- AppointmentResponse 1
- AuditEvent 2
- Basic 1
- Binary 1
- BodySite 0
- Bundle 2
- CarePlan 1
- Claim 0
- ClaimResponse 0
- ClinicalImpression 0
- Communication 1
- CommunicationRequest 1
- Composition 2
- ConceptMap 2
- Condition (aka Problem) 2
- Conformance 2
- Contract 0
- DetectedIssue 1
- Coverage 0
- DataElement 1
- Device 1

D-L:

- DeviceComponent 1
- DeviceMetric 1
- DeviceUseRequest 0
- DeviceUseStatement 0
- DiagnosticOrder 1
- DiagnosticReport 3
- DocumentManifest 1
- DocumentReference 2
- EligibilityRequest 0
- EligibilityResponse 0
- Encounter 1
- EnrollmentRequest 0
- EnrollmentResponse 0
- EpisodeOfCare 1
- ExplanationOfBenefit 0
- FamilyMemberHistory 1
- Flag 1
- Goal 1
- Group 1
- HealthcareService 1
- ImagingObjectSelection 1
- ImagingStudy 2
- Immunization 1

I-P:

- ImmunizationRecommendation 1
- ImplementationGuide 0
- List 1
- Location 1
- Media 1
- Medication 1
- MedicationAdministration 1
- MedicationDispense 1
- MedicationOrder 1
- MedicationStatement 1
- MessageHeader 2
- NamingSystem 1
- NutritionOrder 1
- Observation 3
- OperationDefinition 1
- OperationOutcome 2
- Order 0
- OrderResponse 0
- Organization 1
- Parameters 1
- Patient 3
- PaymentNotice 0
- PaymentReconciliation 0
- Person 1

P-Z:

- Practitioner 1
- Procedure 1
- ProcessRequest 0
- ProcessResponse 0
- ProcedureRequest 1
- Provenance 1
- Questionnaire 2
- QuestionnaireResponse 2
- ReferralRequest 1
- RelatedPerson 1
- RiskAssessment 0
- Schedule 1
- SearchParameter 1
- Slot 1
- Specimen 1
- StructureDefinition 2
- Subscription 1
- Substance 1
- SupplyRequest 0
- SupplyDelivery 0
- TestScript 0
- ValueSet 3
- VisionPrescription 0

RESOURCES EVOLVE IN TIME

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LIST OF RESOURCES FOR R4 (FIRST NORMATIVE)

A-D:

- Account 2
- ActivityDefinition 2
- AdverseEvent 0
- AllergyIntolerance 3
- Appointment 3
- AppointmentResponse 3
- AuditEvent 3
- Basic 1
- Binary N
- BiologicallyDerivedProduct 0
- BodyStructure 1
- Bundle N
- CapabilityStatement N
- CarePlan 2
- CareTeam 2
- CatalogEntry 0
- ChargeItem 0
- ChargeItemDefinition 0
- Claim 2
- ClaimResponse 2
- ClinicalImpression 0
- CodeSystem N
- Communication 2
- CommunicationRequest 2
- CompartmentDefinition 1
- Composition 2
- ConceptMap 3
- Condition (aka Problem) 3
- Consent 2
- Contract 1
- Coverage 2
- CoverageEligibilityRequest 2
- CoverageEligibilityResponse 2
- DetectedIssue 1
- Device 2

D-L:

- DeviceMetric 1
- DeviceRequest 1
- DeviceUseStatement 0
- DiagnosticReport 3
- DocumentManifest 2
- DocumentReference 3
- EffectEvidenceSynthesis 0
- Encounter 2
- Endpoint 2
- EnrollmentRequest 0
- EnrollmentResponse 0
- EpisodeOfCare 2
- EventDefinition 0
- Evidence 0
- EvidenceVariable 0
- ExampleScenario 0
- ExplanationOfBenefit 2
- FamilyMemberHistory 2
- Flag 1
- Goal 2
- GraphDefinition 1
- Group 1
- GuidanceResponse 2
- HealthcareService 2
- ImagingStudy 3
- Immunization 3
- ImmunizationEvaluation 0
- ImmunizationRecommendation 1
- ImplementationGuide 1
- InsurancePlan 0
- Invoice 0
- Library 2
- Linkage 0
- List 1
- Location 3

M-P:

- Measure 2
- MeasureReport 2
- Media 1
- Medication 3
- MedicationAdministration 2
- MedicationDispense 2
- MedicationKnowledge 0
- MedicationRequest 3
- MedicationStatement 3
- MedicinalProduct 0
- MedicinalProductAuthorization 0
- MedicinalProductContraindication 0
- MedicinalProductIndication 0
- MedicinalProductIngredient 0
- MedicinalProductInteraction 0
- MedicinalProductManufactured 0
- MedicinalProductPackaged 0
- MedicinalProductPharmaceutical 0
- MedicinalProductUndesirableEffect 0
- MessageDefinition 1
- MessageHeader 4
- MolecularSequence 1
- NamingSystem 1
- NutritionOrder 2
- Observation N
- ObservationDefinition 0
- OperationDefinition N
- OperationOutcome N
- Organization 3
- OrganizationAffiliation 0
- Parameters N
- Patient N
- PaymentNotice 2
- PaymentReconciliation 2
- Person 2

P-Z:

- PractitionerRole 2
- Procedure 3
- Provenance 3
- Questionnaire 3
- QuestionnaireResponse 3
- RelatedPerson 2
- RequestGroup 2
- ResearchDefinition 0
- ResearchElementDefinition 0
- ResearchStudy 1
- ResearchSubject 1
- RiskAssessment 1
- RiskEvidenceSynthesis 0
- Schedule 3
- SearchParameter 3
- ServiceRequest 2
- Slot 3
- Specimen 2
- SpecimenDefinition 0
- StructureDefinition N
- StructureMap 2
- Subscription 3
- Substance 2
- SubstancePolymer 0
- SubstanceProtein 0
- SubstanceReferenceInformation 0
- SubstanceSpecification 0
- SubstanceSourceMaterial 0
- SupplyDelivery 1
- SupplyRequest 1
- Task 2
- TerminologyCapabilities 0
- TestReport 0
- TestScript 2
- ValueSet N

FHIR SERVER

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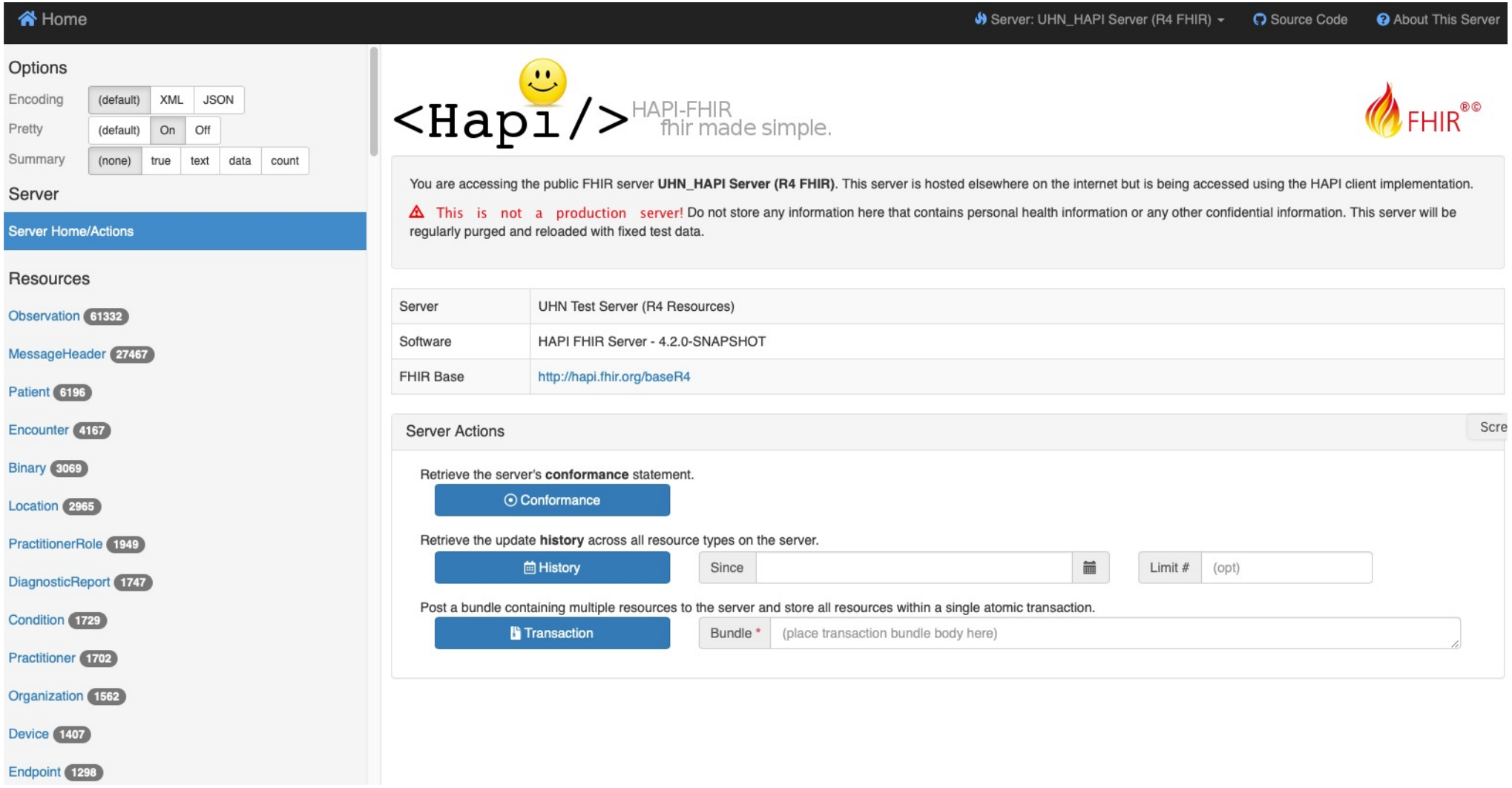

https://fhirtest.uhn.ca/home?encoding=null&pretty=true

CONFORMANCE STATEMENT

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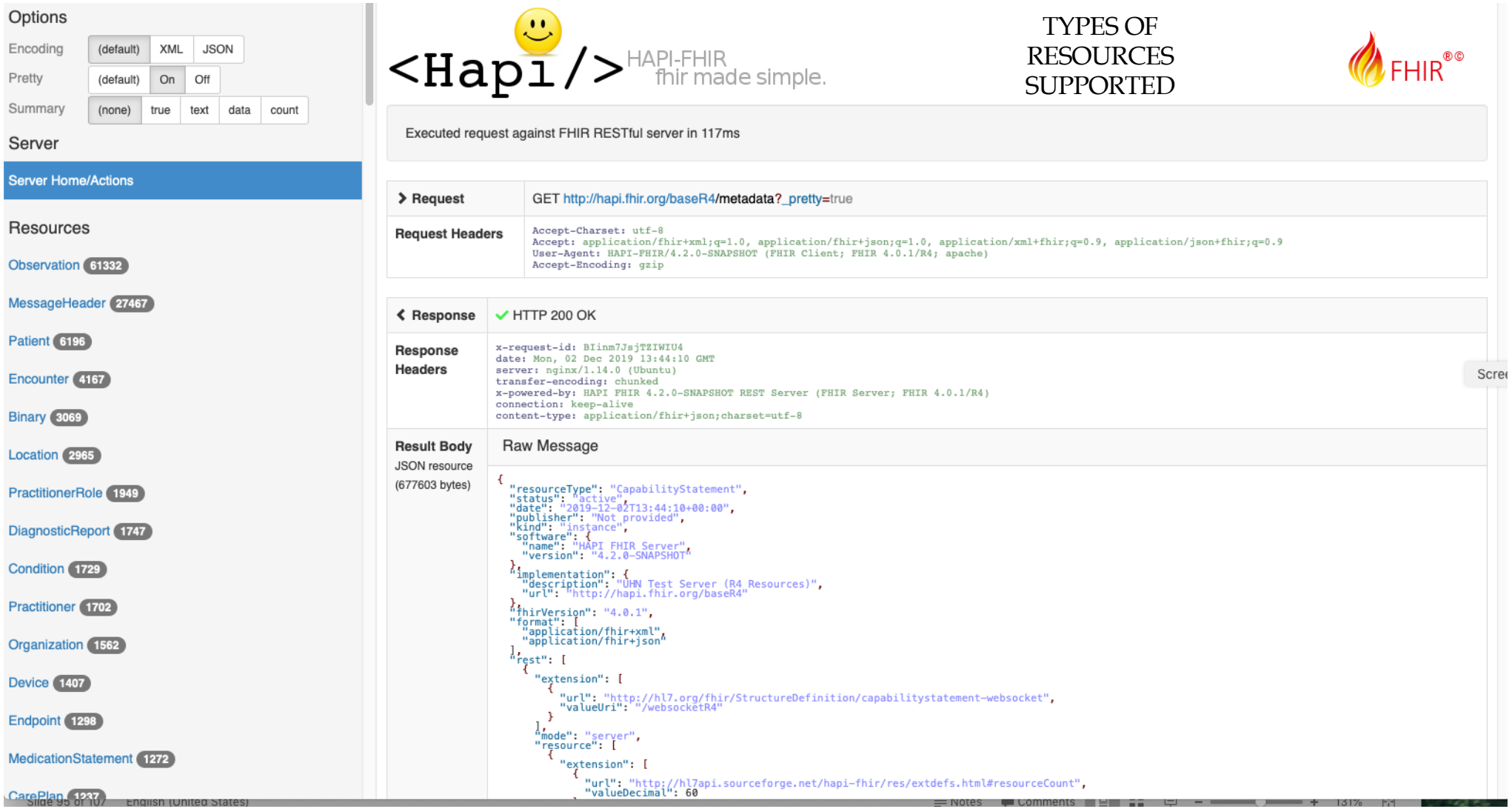

EXAMPLES

FHIR Resource	Allscripts	athenahealth	Cerner	Epic	Meditech
Patient	Read	Read, Write	Read, Write	Read, Write	Read
Provider	Read	Read	Read	Read	Read
Allergy	Read	Read	Read, Write	Read, Write	Read
Care Plan	Read	Read	Read	Read	Read
Condition	Read	Read	Read, Write	Read, Write	Read
Contract			Read		
Device	Read	Read	Read	Read	Read
Diagnostic Report	Read	Read	Read	Read	Read
Document	Read	Read	Read, Write	Read	Read
Encounter		Read	Read	Read	
Family history				Read	
Immunization	Read	Read	Read	Read	Read
Location				Read	
Medication	Read	Read	Read	Read	Read
Medication Order	Read	Read	Read	Read	Read
Observation	Read	Read	Read	Read, Write	Read
Person			Read		
Procedure	Read	Read	Read	Read	Read
ProcedureRequest			Read		
RelatedPerson			Read		
Schedule			Read, Write	Read, Write	

SMART ON FHIR

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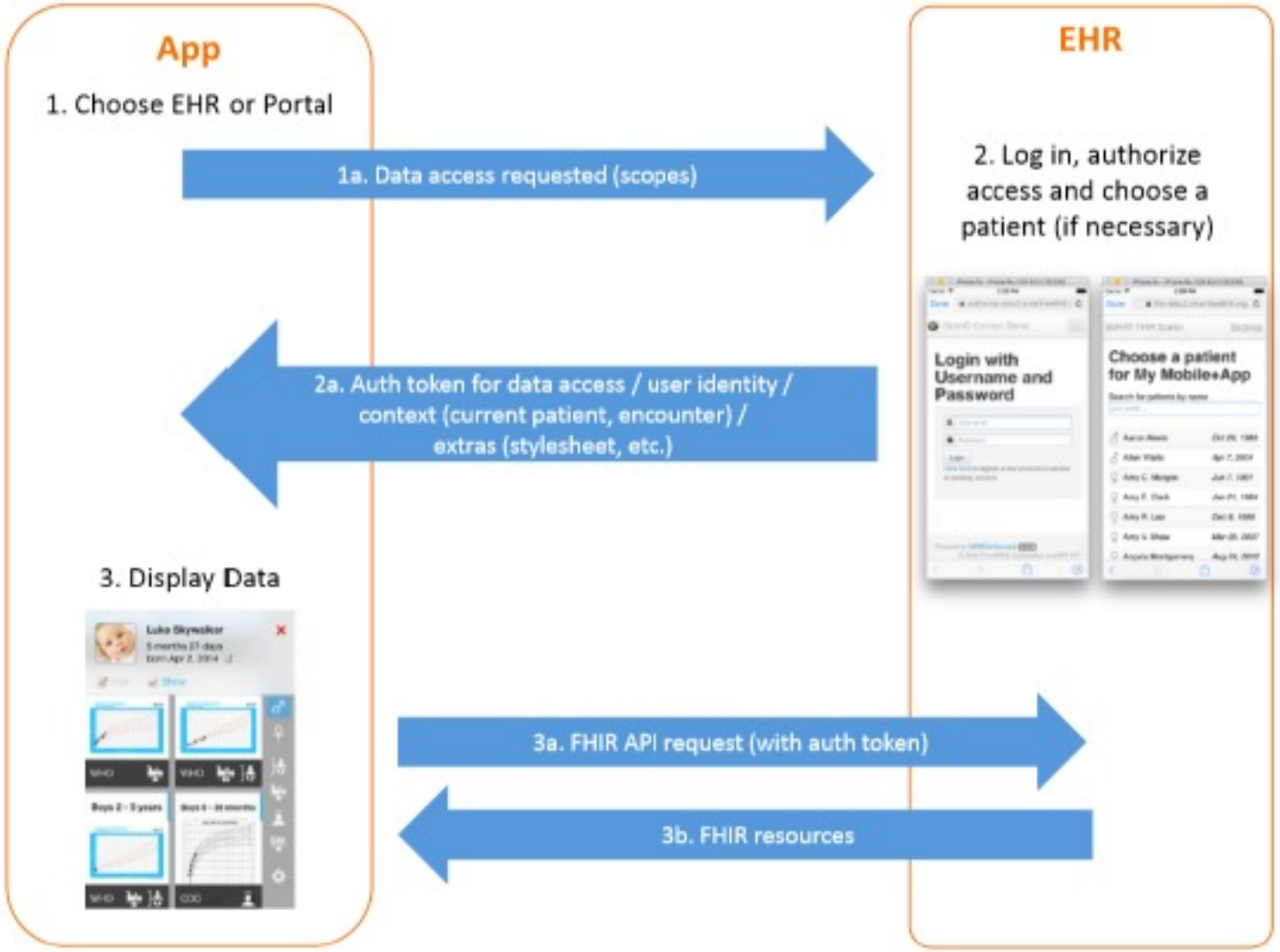
SMART

smarthealthit.org



- Authentication framework between EHR and FHIR
- Allows the FHIR app to work without knowing the FHIR server

SMART ON FHIR

- When the patient's authentication is done, you can retrieve data without knowing the patient (works with the "current" patient) → smart.patient.api

```
// Search for the current patient's conditions
smart.patient.api.search({type: 'Condition'});

// Search for the current patient's prescriptions
smart.patient.api.search({type: 'MedicationOrder'});
```

- At the population level→ smart.api

```
// Search for conditions added today
var todaysDiagnoses = smart.api.search({type: 'Condition', query: {dateRecorded: '2014-05-01'}});

// Search for all statins prescribed today
var statinRxs = smart.api.search({type: 'MedicationOrder', query: {dateWritten: '2014-05-01', nam
e: 'statin'}});
```

FHIR vs CDA2

FHIR

- Atomic access to medical data via a RESTful API
- Allows interaction with data (update, create, etc)
- Modular approach, no limitation on contents
- Human readable
- Based on HL7 v3

CDA-2

- Definition of a structured document for patient's record
- Built as a read-only document
- The content of the document is expressed using a complex and extremely abstract model based on HL7's "Clinical Statement"
- Human readable
- Based on HL7 v3