MODUL

STANDARISASI DAN INTEROPERABILITAS

Argonaut Profiles

- FHIR allows a large amount of variability between systems
- Most EHR applications require very little variability in order to work correctly
- To address this fact, US implementors have created a set of profiles for this purpose in the US called the **"Argonaut Profiles"**

Argonaut provides constraints on a set of FHIR types commonly used for EHR Applications:

- Patient
- Condition
- Observation, DiagnosticReport
- Medication, MedicationStatement, MedicationOrder
- AllergyIntolerance
- Immunization
- CarePlan
- Goal

Each resource is constrained for use by an EHR Application. For example:

- Patient must have a name, gender, date of birth, and at least 1 identifier
- Extensions are specified for race and ethnicity
- A communication language should be specified

These requirements may not be perfect for Vietnam, but they are a great starting point

FHIR Testing : Technical and community

FHIR Testing

One of the best parts of working with FHIR is the existence of great test servers

- The following servers are available for free for testing around the world (and there are many more):

Grahame's Server:

http://test.fhir.org/r3

James's Server:

http://hapi.fhir.org/baseDstu3

FHIR Community

Another great thing about FHIR is the large, helpful, international community.

- The focal point of this community is chat.fhir.org (Zulip)

- We have created a “stream” in Zulip for Vietnam, but there are many others as well

http://chat.fhir.org

Community Projects

FHIR also has a very large open source community devoted to helping implementors on various platforms:

- Java: HAPI FHIR (We will cover this tomorrow)
- .NET / C# API: https://github.com/ewoutkramer/fhir-net-api
- JavaScript FHIR.js: https://github.com/FHIR/fhir.js
- Python Client: https://github.com/smart-on-fhir/client-py
- iOS / Swift: https://github.com/smart-on-fhir/Swift-FHIR
- Android / Java: https://github.com/jamesagnew/hapi-fhir
- Pascal: https://github.com/grahamegrieve/fhirserver

Testing

- FHIR defines a special resource called TestScript which can be used to specify client and server tests
- There are currently two platforms for executing these tests:
    - Crucible (free tool): https://projectcrucible.org/
    - Touchstone (paid tool): http://touchstone.com

Community Starter Projects

The following link has a collection of starter projects in various languages:

https://github.com/furore-fhir/fhirstarters

Validation

- You are only interoperable if you can produce valid FHIR
- There are several kinds of valid:
    - Valid JSON / XML
    - Valid FHIR
    - Valid FHIR for a specific purpose
- FHIR servers define an endpoint called /$validate which can be used to validate FHIR payloads, e.g.

POST /base/Patient/$validate

Content-Type: application/fhir+json

{

"resourceType": "Patient"

"name": [ ]

}

Profiles

- To make FHIR useful in a specific context, we often want to create Profiles
    - E.g. "In my system, Observations will use LOINC codes"
- FHIR defines a special set of resources which may be used to constrain FHIR for a specific use:
    - **StructureDefinition**: Set field cardinality, add terminology binding, add extensions
    - **CodeSystem** & **ValueSet**: Define sets of codes for a given purpose
- Tools exist to validate against a Profile (we will cover HAPI on Thursday)

FHIR Versions

Versions

- The FHIR specification itself has had several releases:
    - FHIR DSTU1 (v0.0.82) - 2014
    - FHIR DSTU2 (v1.0.2) - 2015
    - FHIR STU3 - (v3.0.1) - 2017
    - FHIR R4 - Under development
- The version names mean slightly different things but people often use them interchangeably (DSTU3 / STU3 / R3)

Vietnam Affiliate and Implementation Guide

Making FHIR work for you

- International Specification defines overall framework
- Countries / Regions / Vendors / Institutions publish adaptations to local culture/regulations etc
- Individual projects use conformance resources to describe the project rules
    - Terminology usage rules
    - Rules about elements, usage, content flows
    - Extensions
- All of this can be published through http://registry.fhir.org

Example National Profiles

- US: http://www.hl7.org/fhir/us/core/
- Australia: http://build.fhir.org/ig/hl7au/au-fhir-base/
- Concerns:
    - National identifiers
    - National code systems
    - Specific additional patient information (race/ethnicity)
    - Basic Documentation, Community Governance

Candidate National Vietnamese IG

- Found at: http://build.fhir.org/ig/grahamegrieve/vietnam-poc/index.html
- Demonstration of the production of this

HL7 Affiliate for Vietnam

- Some formal organization needs to manage the vietnamese national implementation guide
- Needs to be connected to HL7
- Best to be an HL7 Affiliate
- Registration in process

Affiliate Requirements

- Must be an NGO
- Must accept any Vietnamese organization as a member
- Must have a constitution with leadership elected by members
- Can work very closely with Department of Health

Welcome to the First FHIR Connectathon In Vietnam

Connectathon Goals

The FHIR Connectathon is an event for implementers. It is held 3 times each year by HL7, and often in other contexts like this one.

We have 2 equally important goals:

- Helping implementers learn to use the FHIR specification
- Helping to develop the FHIR specification

(We often use Connectathons to try new ideas too!)

Where To Start

If you are a beginner:

- Do the Postman tutorial with James: https://goo.gl/5a5RQg

If you have your own application:

- Enter your details into the spreadsheet: http://tiny.cc/tu15oy

Advanced features:

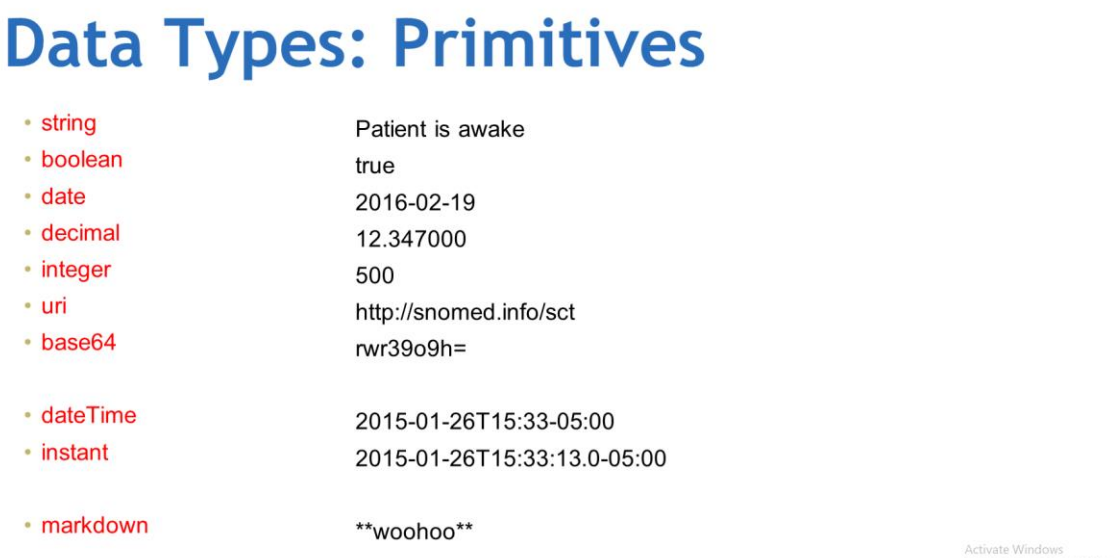
- Security, Mapping existing data,

FHIR and HAPI FHIR

The FHIR Data Model

- FHIR's model is available online
    - http://hl7.org/fhir/
- The FHIR data model is useful even by itself
- Take advantage of the collective work of 100s of people!

Data Types: Primitives



Activate Windows
Go to Settings to activate Windows.

Data Types: Primitives

ISO8601 - Human Times: Timezone is mandatory

- date 2016-02-19
- decimal 12.347000
- integer 500
- uri http://snomed.info/sct

- dateTime 2015-01-26T15:33-05:00
- instant 2015-01-26T15:33:13-05:00

- markdown **woohoo**

Activate Windows
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Data Types: Primitives

System Times, fixed precision

- date
- decimal 12.347000
- integer 500
- uri http://snomed.info/sct

- dateTime 2015-01-26T15:33-05:00
- instant 2015-01-26T15:33:13.0-05:00

- markdown **woohoo**

Activate Windows
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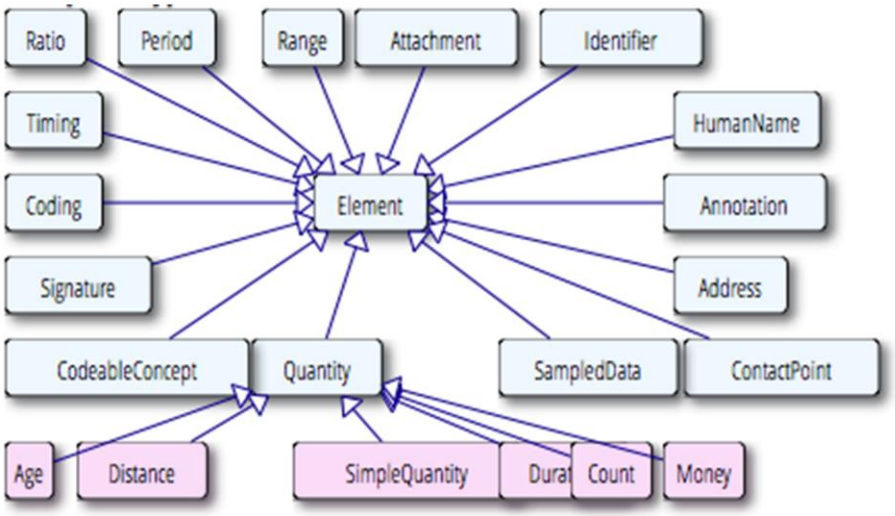
Data Types: Composites



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Data Types: Composites

Name	Flags	Card.	Type	Description & Constraints
Address	Σ		Element	An address expressed using postal conventions (as opposed to Elements defined in Ancestors: id, extension
use	?! Σ	0..1	code	home | work | temp | old - purpose of this address AddressUse (Required)
type	Σ	0..1	code	postal | physical | both AddressType (Required)
text	Σ	0..1	string	Text representation of the address
line	Σ	0..*	string	Street name, number, direction & P.O. Box etc. This repeating element order: The order in which lines should
city	Σ	0..1	string	Name of city, town etc.
district	Σ	0..1	string	District name (aka county)
state	Σ	0..1	string	Sub-unit of country (abbreviations ok)
postalCode	Σ	0..1	string	Postal code for area
country	Σ	0..1	string	Country (e.g. can be ISO 3166 2 or 3 letter code)
period	Σ	0..1	Period	Time period when address was/is in use

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Other Model Concepts: Identifiers

- FHIR resources are scoped around identifiable things (Patients, Orders, Locations, etc.)
- Identifiers consist of a **System** and an **Identifier**
- For example:
    - System (URI): http://uhn.ca/ns/mrn

    - Identifier: 7000135
- Other systems:
    - http://hl7.org/fhir/sid/us-ssn (US SSN)
    - urn:oid:2.16.840.1.113883.4.3.1 (Alabama Driver's License)

Identifier Systems

- Old identifiers are sometimes OIDs, example: 0.1.2.3.4.5
- New identifiers are URLs
- Creating your own is fine!

http://hospital.vn/patient

Other Model Concepts: Coded Values

- Many things are drawn from a set of allowable coded values
- A coded value consists of a **Code System** and a **Code**, and optionally a **Display Text**
- For example:
    - System: http://snomed.info/sct
    - Code: 267038008
    - Display: Edema (finding)

Resource Identities

- Every FHIR resource has a unique identity, which is in fact a URL

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Resource Identities

- Resources can also have a version specific ID

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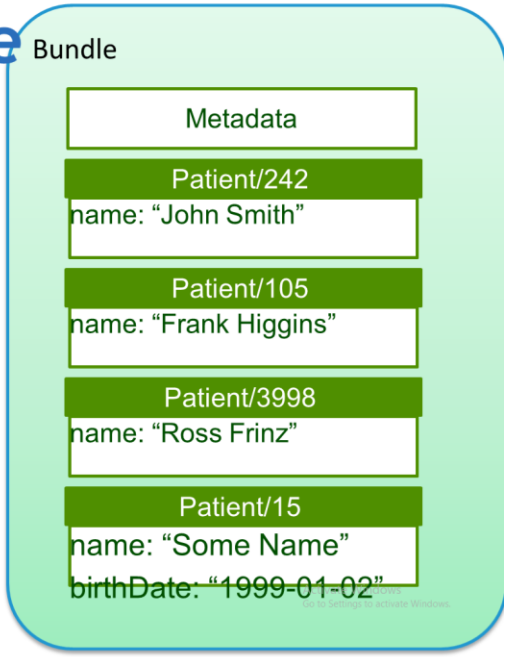
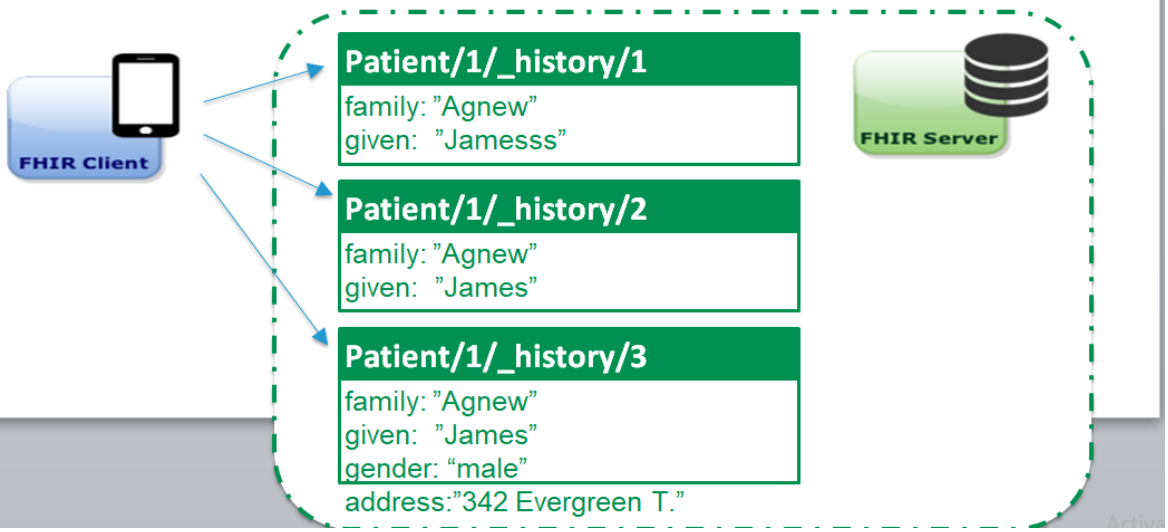
The Bundle Resource

- Sometimes we need to package multiple resources together
- We use a special container resource called "Bundle"



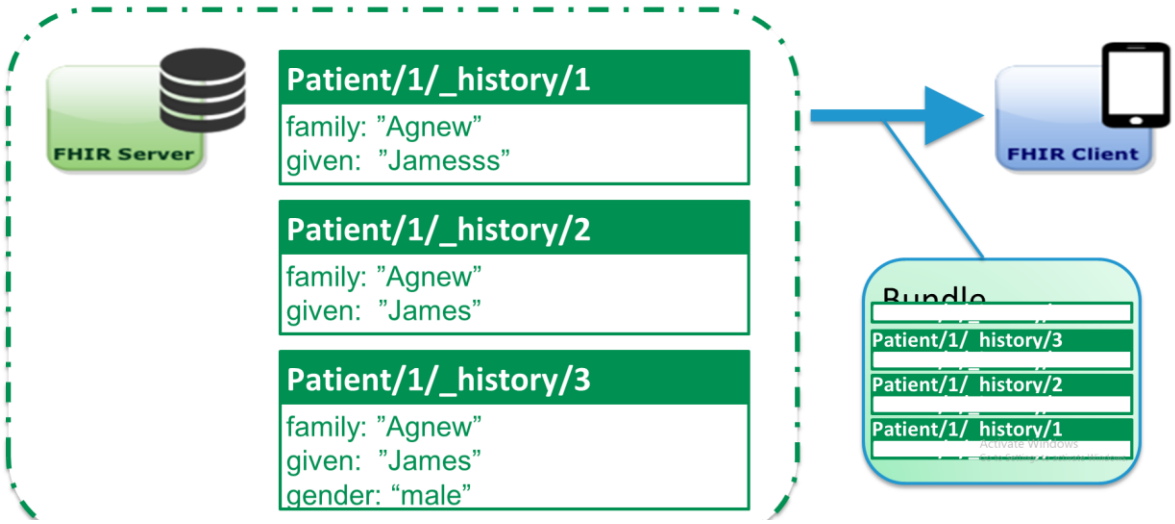
Resource History

- FHIR servers keep track of the complete history of a given resource instance
- This way, the client doesn't need to keep track



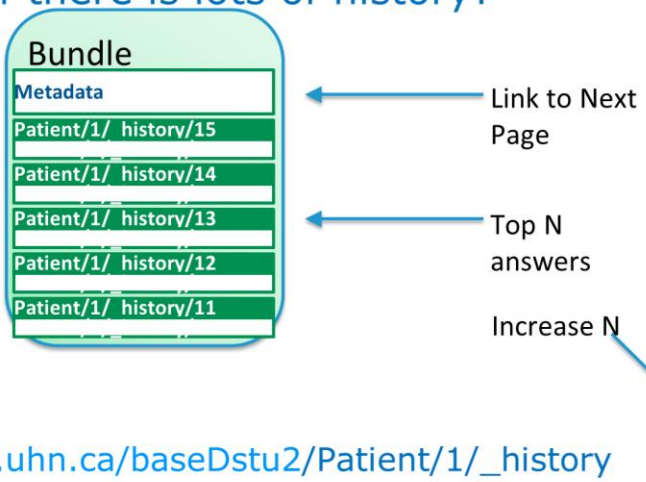
The History Operation

http://fhirtest.uhn.ca/baseDstu2/Patient/1/_history



The History Operation: Paging

- What if there is lots of history?



http://fhirtest.uhn.ca/baseDstu2/Patient/1/_history
http://fhirtest.uhn.ca/baseDstu2/Patient/1/_history?_count=100

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The History Operation: Modes

- There are 3 kinds of history

- Server (all resources) http://fhirtest.uhn.ca/baseDstu2/_history
- Type (same type) http://fhirtest.uhn.ca/baseDstu2/Patient/_history
- Instance (same ID) http://fhirtest.uhn.ca/baseDstu2/Patient/1/_history

  - History can be used as a simple polling mechanism for subscription

http://fhirtest.uhn.ca/baseDstu2/Patient/1/_history?
_since=2011-02-23T15:00:01.0032-05:00

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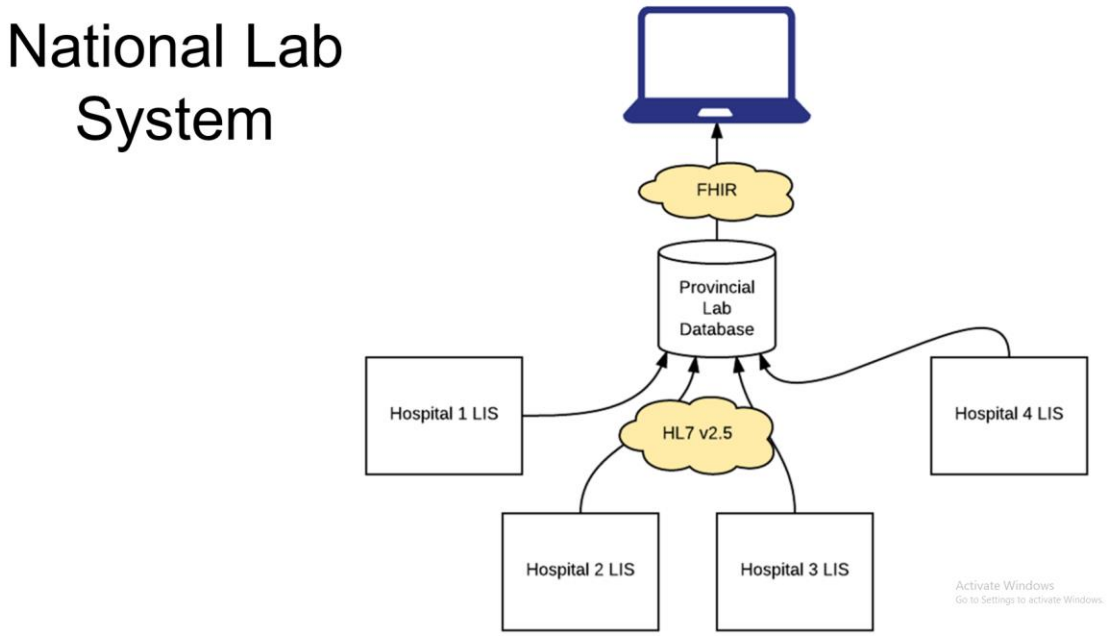
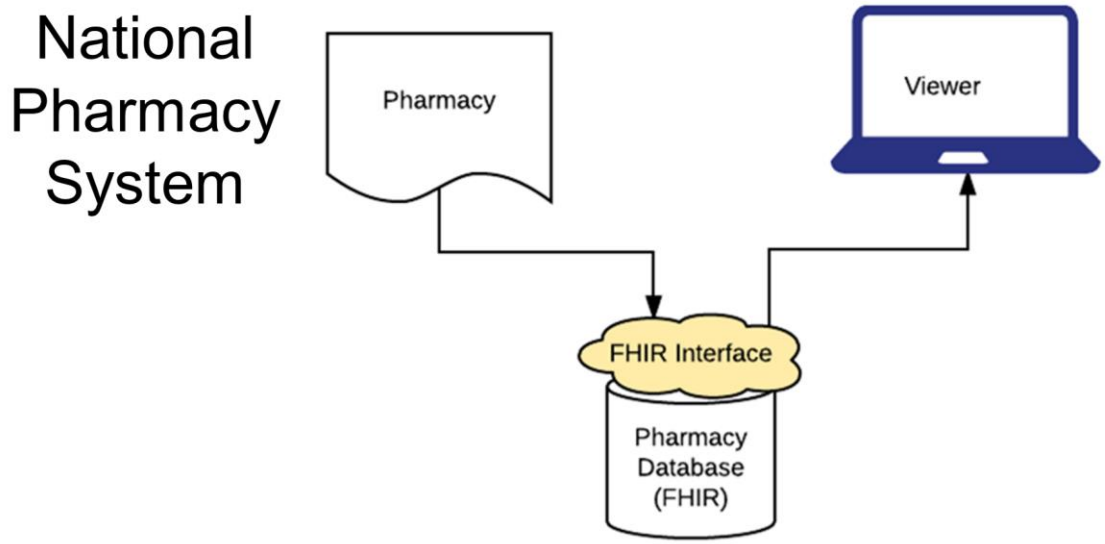
Examples





HAPI

- HAPI FHIR Beginner? Intermediate? Expert?
- Using FHIR today?

Design Goals

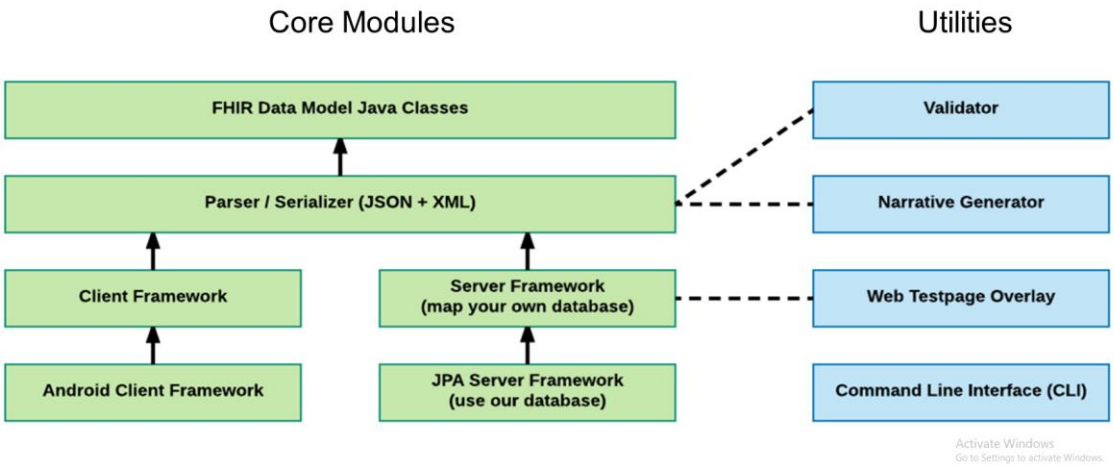
- Use Anywhere
    - Apache 2.0 License for all components

- Minimal dependencies

- Be Flexible
  - Loosely coupled, pluggable components
- Be Powerful
  - “Borrow” all the best ideas from existing frameworks: JAX-WS, Springframework, .NET FHIR API ☺

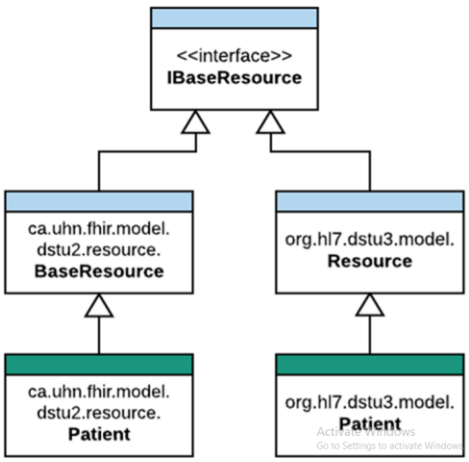
..etc..

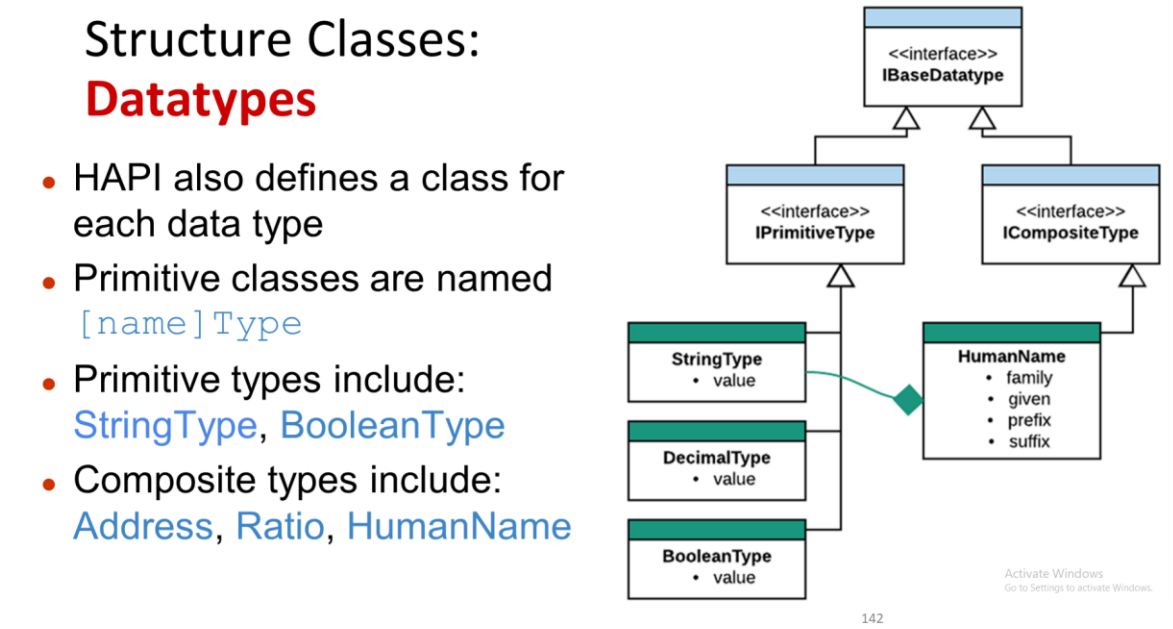
HAPI FHIR Modules



Structure Classes: Resources

- HAPI Defines several sets of classes which form the data model
- Resource definition classes implement `IBaseResource`
- Examples: Patient, CarePlan, Encounter, Practitioner, Medication





Structure Classes:

Docs

- JavaDocs for structures are available here:

  http://hapifhir.io/apidocs-dstu2/index.html

  http://hapifhir.io/apidocs-dstu3/index.html

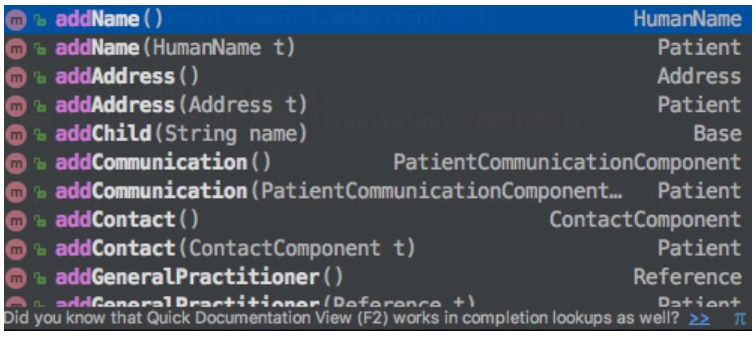
Creating A Resource

```
public class Example01_CreateAPatient {
  public static void main(String[] theArgs) {
    // Create a resource instance
    Patient pat = new Patient();
    // Add a "name" element
    HumanName name = pat.addName();
    name.setFamily("Simpson").addGiven("Homer").addGiven("J");
    // Add an "identifier" element
    Identifier identifier = pat.addIdentifier();
    identifier.setSystem("http://acme.org/MRNs").setValue("7000135");
```

```
    // Model is designed to be chained
    pat.addIdentifier().setSystem("http://acme.org/MRNs").setValue("12345");
  }
}
```

Use your IDE Autocomplete

```
public class Example01_CreateAPatient {
  public static void main(String[] theArgs) {
    // Create a resource instance
    Patient pat = new Patient();
    // Add a "name" element
    HumanName name = pat.addName();
    name.setFamily("Simpson").addGiven("Homer").addGiven("J");
    // Add an "identifier" element
    Identifier identifier = pat.addIdentifier();
    identifier.setSystem("http://acme.org/MRNs").setValue("7000135");
    // Model is designed to be chained
    pat.addIdentifier().setSystem("http://acme.org/MRNs").setValue("12345");
  }
}
```

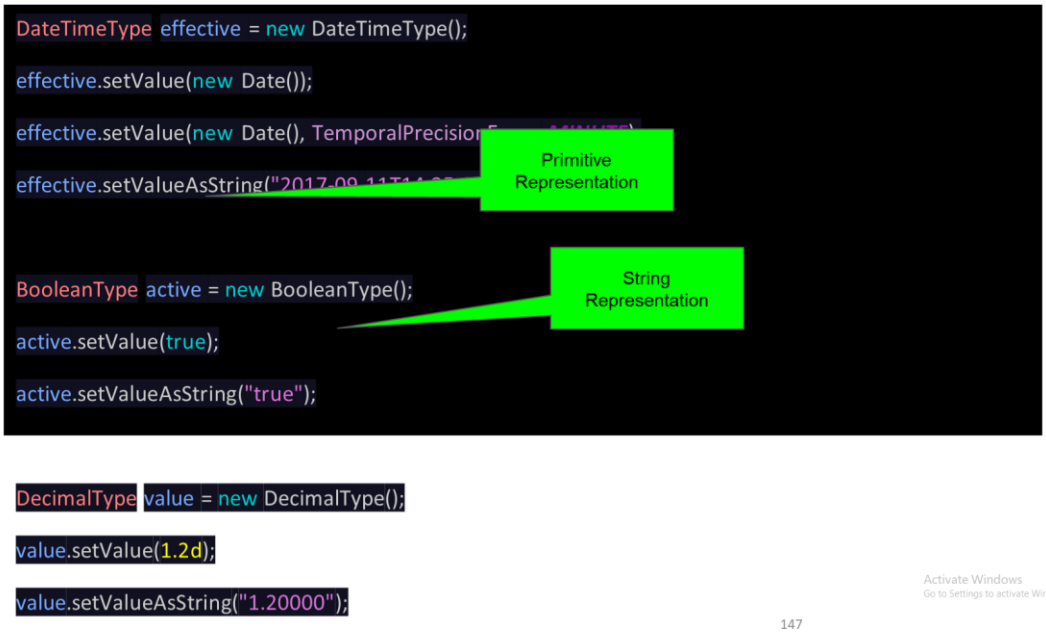


Enumerated Types

```
public class Example02_EnumeratedTypes {
```

```
 public static void main(String[] theArgs) {
    Patient pat = new Patient();
    pat.addName().setFamily("Simpson").addGiven("Homer").addGiven("J");
    pat.addIdentifier().setSystem("http://acme.org/MRNs").setValue("7000135");
    // Enumerated types are provided for many coded elements
    ContactPoint contact = pat.addTelecom();
    contact.setUse(ContactPoint.ContactPointUse.HOME);
    contact.setSystem(ContactPoint.ContactPointSystem.PHONE);
    contact.setValue("1 (416) 340-4800");
    pat.setGender(Enumerations.AdministrativeGender.MALE);
 }
}
```

Primitive Types




```
DecimalType value = new DecimalType();
value.setValue(1.2d);
value.setValueAsString("1.20000");
```

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Primitive Types (2)

```
Observation obs = new Observation();


// These are equivalent
obs.setComment("This is a comment");
obs.setCommentElement(new StringType("This is a comment"));


// Get the primitive or get the FHIR type
String comment = obs.getComment();
StringType commentElement = obs.getCommentElement();
```

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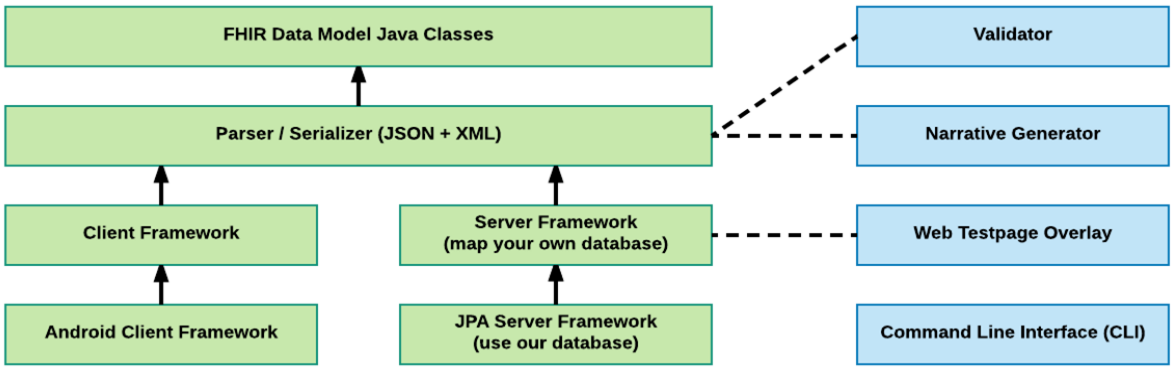
Server Framework



Server Architecture

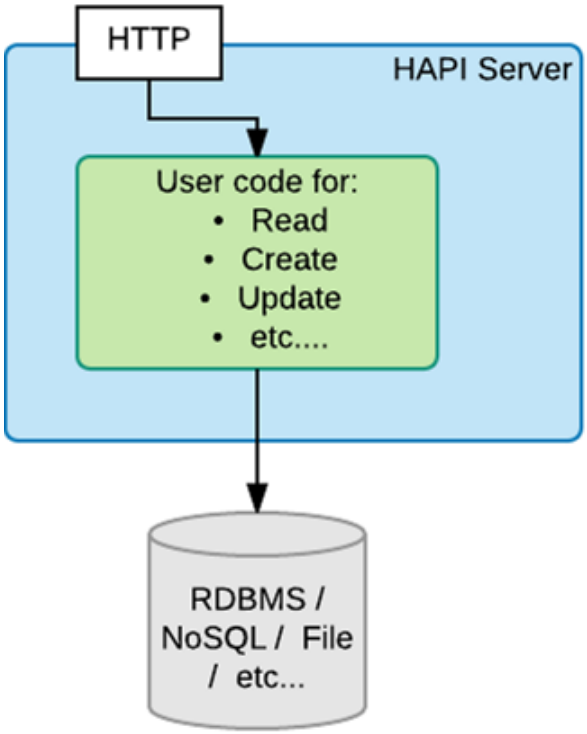
- **HAPI FHIR provides a REST Server framework**
- **Based on standard JEE/Servlet 2.5+**
  (Tomcat, Glassfish, Websphere, JBoss, etc)
- **Inspired by (but not based on) JAX-RS, RestEasy, Spring REST, etc.**

*** A JAX-RS HAPI module is available but it is not covered here**

Server Architecture (2)

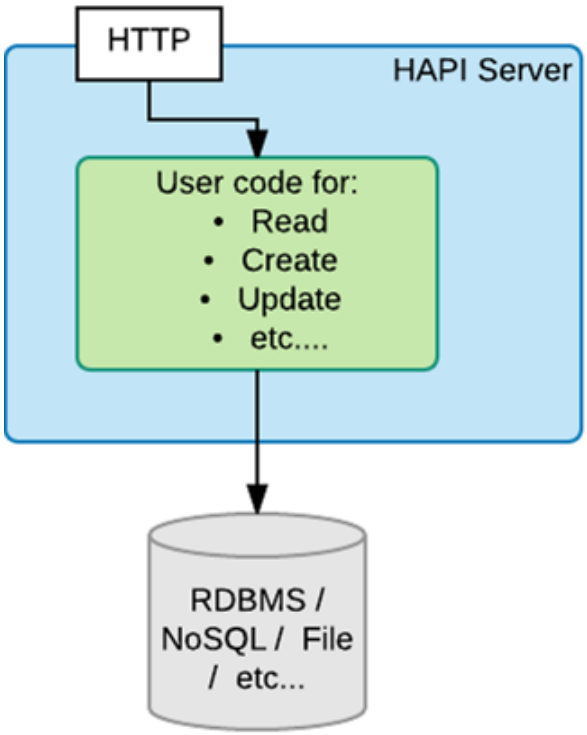
- **You supply Java code for CRUD operations you want to support in your server**

- **Read**
- **Create**
- **Update**
- **Delete**
- **Search**
- **etc…**



Server Architecture (3)

- **HAPI FHIR will:**
  - **Handle parsing and encoding**
  - **Route URLs, Verbs, and parameters to appropriate methods**
  - **Understand FHIR escaping rules**



Server Architecture (3)

- The primary component is the `IResourceProvider` implementation which you create

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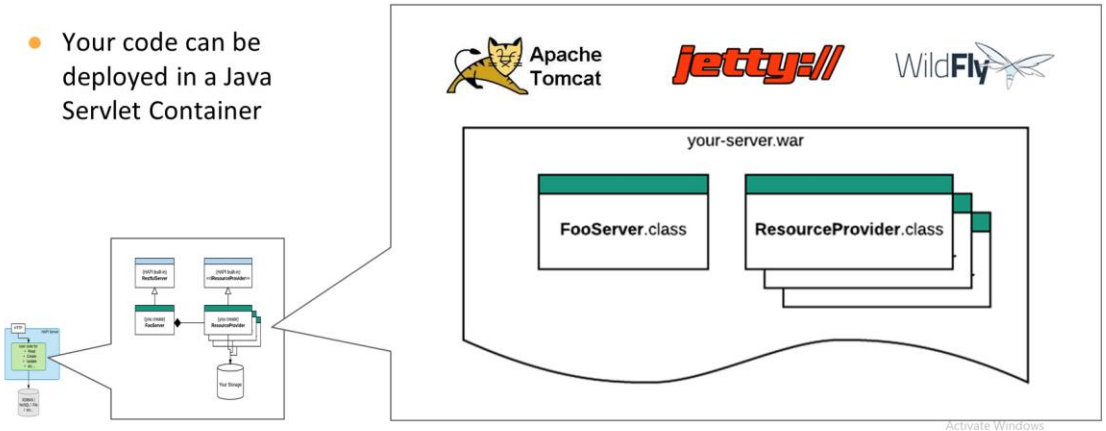
Server Architecture (3)

- Your code can be deployed in a Java Servlet Container



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Resource Providers

- ResourceProviders implement the `IResourceProvider` interface and the `getResourceType()` method
- You create one resource provider **per resource type**

```
public class Example01_StubResourceProvider implements IResourceProvider {


  public Class<? extends IBaseResource> getResourceType() {
    return Patient.class;
  }

  // your code to handle resources

}
```

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Go to Settings to activate Windows.


```
public class Example01_StubResourceProvider implements IResourceProvider {
  public Class<? extends IBaseResource> getResourceType() {
    return Patient.class;
  }
  @Read
  public Patient read(@IdParam IdType theId) {
```

```
    return null; // populate this
  }
 @Create
  void create(@ResourceParam Patient thePatient) {
    // save the resource
  }
  @Search
  List<Patient> search(
    @OptionalParam(name="family") StringParam theFamily,
    @OptionalParam(name="given") StringParam theGiven
    ) {
     return null; // populate this
  }
}
```

Rest Server

- Not much needs go in your REST server (set a context and register providers)

```
@WebServlet("/*")
public class Example03_SimpleRestfulServer extends RestfulServer {

  @Override
  protected void initialize() throws ServletException {
    // Create a context for the appropriate version
    setFhirContext(FhirContext.forDstu3());

    // Register resource providers
    registerProvider(new Example04_PatientResourceProviderWithCreate());
```

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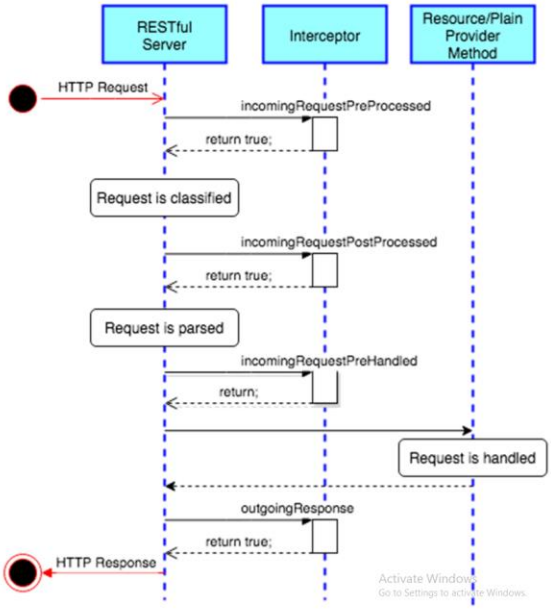
Server Interceptors

Server Interceptors are registered to the server and they can:

- Examine the request
- Change the request
- Deny the request
- Examine the response
- Change the response



Built-in Interceptors

- **LoggingInterceptor**
  - **Log requests as they come in (highly configurable)**
  - **http://hapifhir.io/apidocs/ca/uhn/fhir/rest/server/interceptor/LoggingInterceptor.html**
- **CorsInterceptor**
  - **Allow CORS (JavaScript requests from another server)**
- **RequestValidatingInterceptor and ResponseValidatingInterceptor**
  - **Validate payoads (more on validation later)**
- **ResponseHighlighterInterceptor**
  - **Use a nice HTML response for browsers**
- **AuthorizationInterceptor**
  - **Authorize individual requests (more shortly)**

Using Interceptors

- Interceptors are registered with the server just like resource providers

```
@WebServlet("/*")
public class Example02_SimpleRestfulServer extends RestfulServer {

 @Override
 protected void initialize() throws ServletException {
  // Create a context for the appropriate version
  setFhirContext(FhirContext.forDstu3());

  // Register resource providers
  registerProvider(new Example01_PatientResourceProvider());

  // Format the responses in nice HTML
  registerInterceptor(new ResponseHighlighterInterceptor());
 }
}
```

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Authorization Interceptor

- **AuthorizationInterceptor is a class you extend to provide authorization (AuthZ) and possibly authentication (AuthN) on your FHIR server**
- **You supply permissions that the requestor should have**
- **HAPI enforces these permissions**
- **E.g:**
    - **Based on an incoming header, the user has read access but not write access**

```
public class Example03_AuthorizationInterceptor extends AuthorizationInterceptor {
 @Override
 public List<IAuthRule> buildRuleList(RequestDetails theRequestDetails) {
  // Process this header
  String authHeader = theRequestDetails.getHeader("Authorization");
  // Apply rules
  RuleBuilder builder = new RuleBuilder();
  builder
   .allow().metadata().andThen()
   .allow().read().allResources().withAnyId().andThen()
```

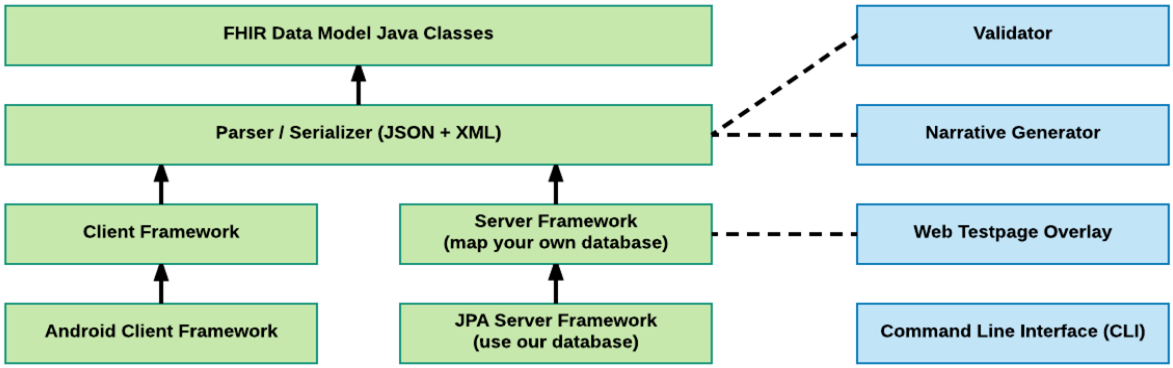
```
      .allow().write().resourcesOfType(Observation.class).inCompartment("Patient", new
IdType("Patient/123"));

    return builder.build();

  }

}
```

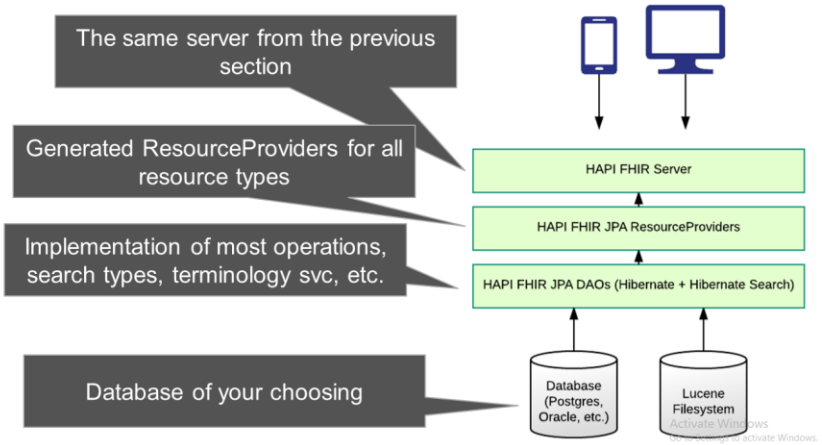
JPA Server Framework



JPA Server Framework

- HAPI JPA Server is a complete server implementation from the database schema up
- It includes:
    - All standard REST verbs (create, read, update, delete)
    - Many fancy REST features (ETag, conditional, patch, etc.)
    - Extensive search support including custom parameters
    - Terminology services
    - Subscription services
    - Many configurable settings

JPA Architecture



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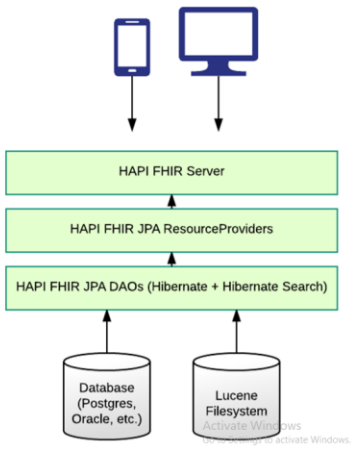
JPA Architecture

- The JPA Server uses Hibernate, which means it supports several RDBMS platforms:
  - Oracle, Postgres, MySQL, SQL Server
- Most examples use Derby
  - Derby is great for testing, but it not a production option!



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Lucene

- HAPI uses Apache Lucene to provide two features:
  - Fulltext searching within resources (_text and _content parameters)
  - Terminology Services
- Lucene stores its files on the filesystem
- Lucene can be safely disabled

Using JPA

- JPA Server is a collection of components that need to be “glued together”
- Examples are available which provide this glue

https://github.com/furore-fhir/fhirstarters/tree/master/java/hapi-fhirstarters-jpaserver-example

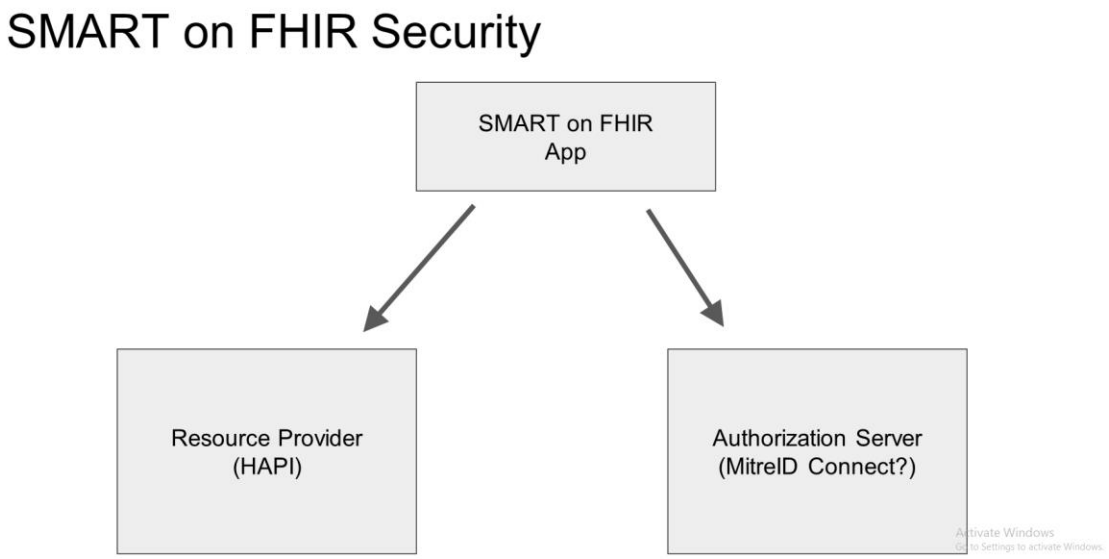
HAPI as a Potential Architecture for a National HER

Model: Service Façade

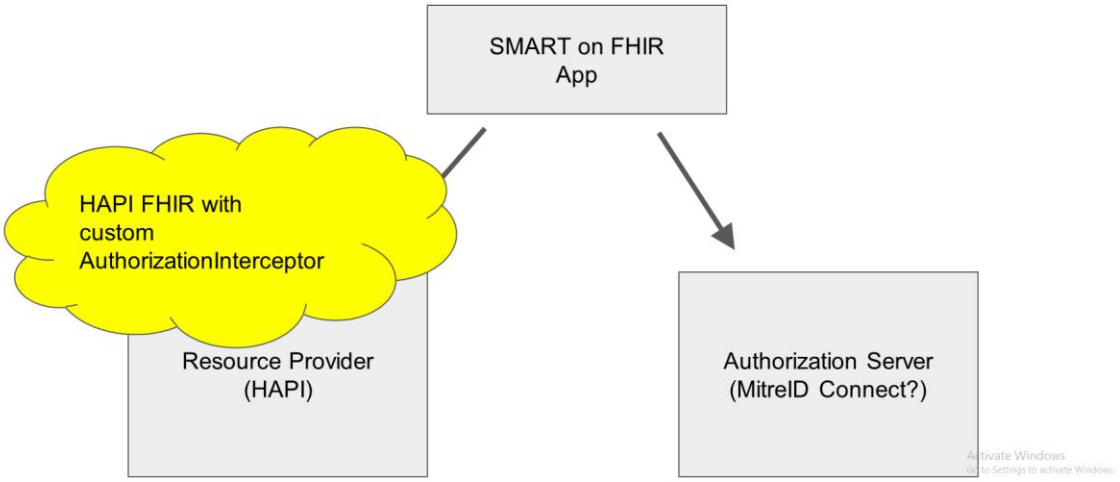
- This refers to building reusable services on existing sources of data
- Examples include:
    - Hospital and doctor EHRs
    - Laboratory systems
    - Radiology
- This pattern allows you to create consistent APIs (consistent in terms of data, API, Security, etc.)
- HAPI RestfulServer can act as a bridge between existing databases and your FHIR interfaces

Model: Repository

- The HAPI Server can also act as a complete FHIR repository
- This could be useful as:
    - A Patient index
    - A central store of lab tests, radiology reports
    - A backend for applications



SMART on FHIR Security



Activate Windows
Go to Settings to activate Windows.