

OPS DDCC/RACSEL LACPASS Seminars:

”HL7 FHIR and Servers”

Pan American Health Organization

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Description

An approach to the HL7 FHIR interoperability standard and related servers. The **goal** is for the participants to be able to recognize and describe the general concepts of the HL7 FHIR interoperability standard and its application.

Agenda

- What is the HL7® FHIR® standard?
- Architectural Principles of FHIR®
- Resources
- Data types
- Operations
- Terminology
- FHIR® servers

What is the HL7® FHIR® standard?



Fast
Healthcare
Interoperability
Resource

What is the HL7® FHIR® standard?

It's a standard developed by HL7 (with its first official version in 2014) in response to the increasing use of electronic health records (EHR).

The specification is based on and adapts the modern and vastly used **RESTful practices** to allow the provision of integrated medical attention in a vast range of teams and organizations.

http://hl7.org/fhir/

HL7® FHIR®

Its goal is to create a basic set of resources which satisfies the majority of the common use cases.

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What is the HL7® FHIR® standard?

“Simplify implementation without sacrificing information integrity”

To do that, HL7 FHIR “leverages existing logical and theoretical models to provide a consistent, easy to implement, and rigorous mechanism for exchanging data between healthcare applications”.

HL7® FHIR®

It can be used as an independent data exchange standard or together with other existing standards (DICOM, CIE-10, SNOMED CT, LOINC, etc).

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Architectural Principles of FHIR®

Reutilization and composition capability

(80/20)

Scalability

(stateless transactions)

Performance

(JSON / XML)

Usability

(human-readable)

Information accuracy

(linkage and validation of clinical terminology)

Implementability

(high adoption in developer communities)

The primary purpose of FHIR is approaching interoperability through structured data, simple and expressive data models, by means of efficient exchange mechanisms.

Resources

FHIR is based on the fundamental concept of resources, where a resource is the basic unit of interoperability, the smallest unit whose exchange makes sense. The resources are representations of sanitary concepts: patient, doctor, health problem, observation...

The resources can be used in its simplest form or can be grouped as messages, like the versions 2 and 3 of HL7 (where the resources resemble the segments in messages), documents, in a similar way as the CDA documents (like a collection of grouped resources), or in form of services (using one or more resources).



Resources

The resources have a set of common characteristics:

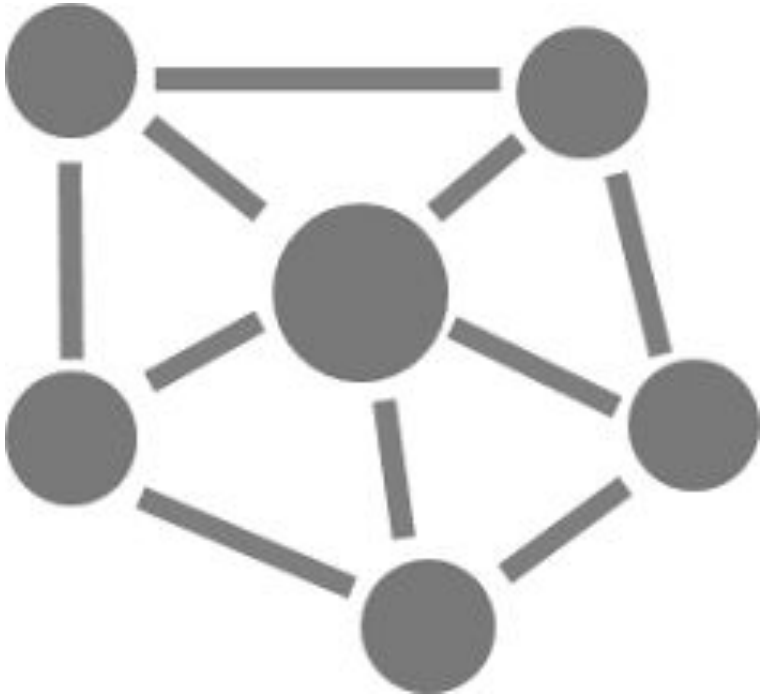
- An URL which identifies the resource
- Metadata
- A summary for general reading
- A set of attributes to represent an entity
- An extensions structure which allows variations depending on the context


```
{
  "resourceType": "Patient",
  "id" : "23434",
  "meta" : {
    "versionId" : "12",
    "lastUpdated" : "2014-08-18T15:43:30Z"
  }
  "text": {
    "status": "generated",
    "div": "<!-- Snipped for Brevity -->"
  },
  "extension": [
    {
      "url": "http://example.org/consent#trials",
      "valueCode": "renal"
    }
  ],
  "gender": "male",
  "birthDate": "1932-09-24",
  "active": true
}
```

Resources

FHIR supports 5 information exchange architectures/paradigms:

- RESTful API
- Messages
- Documents
- Services / SOA
- Databases / Persistence



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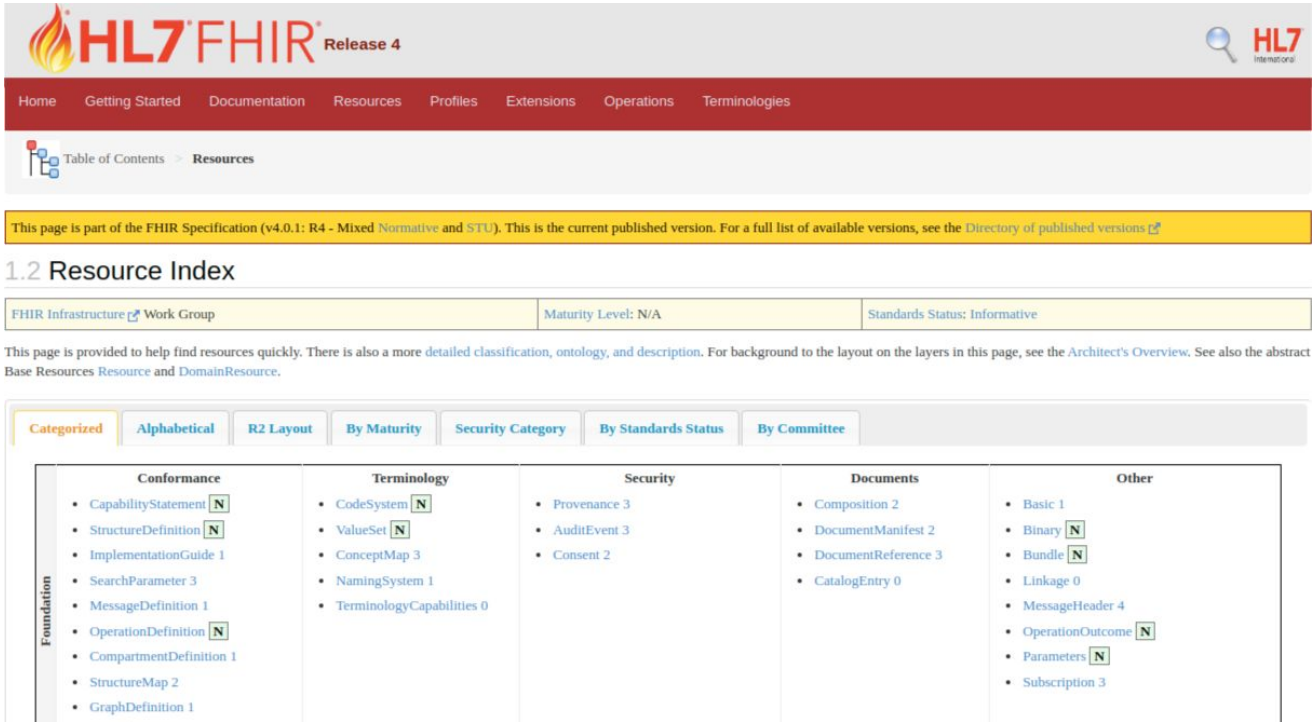

The origin of many answers can be found in **https://www.hl7.org/fhir/resourcelist.html**

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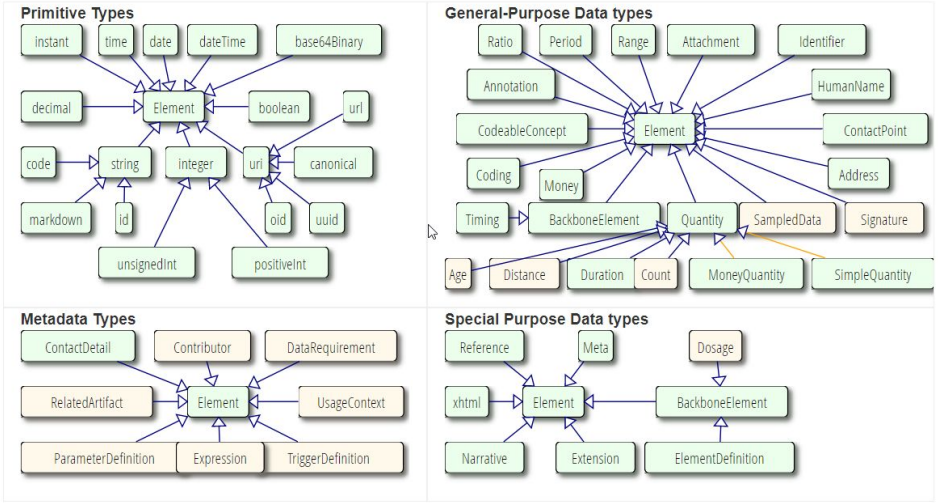
Data types

HL7 FHIR® defines 4 data types that can contain the resources:

- Primitive types
- General-purpose type (complex data)
- Metadata type
- Special purpose type



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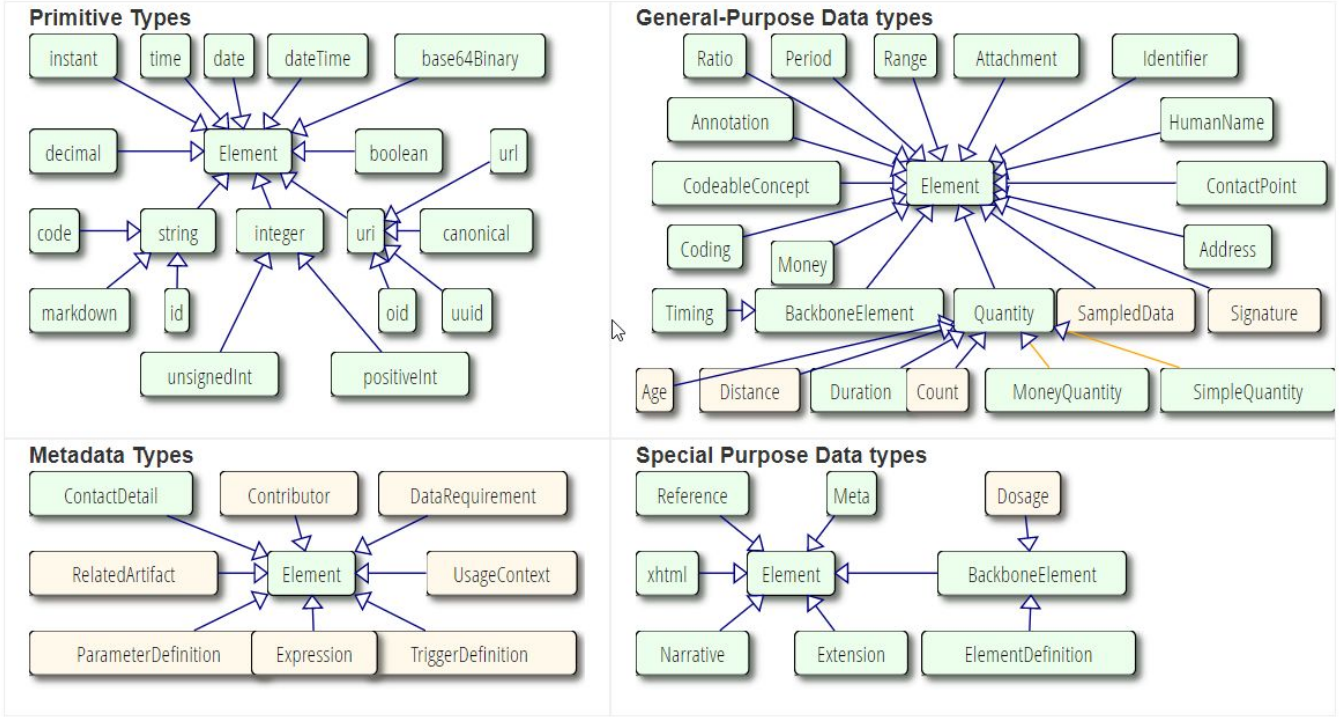
Data types



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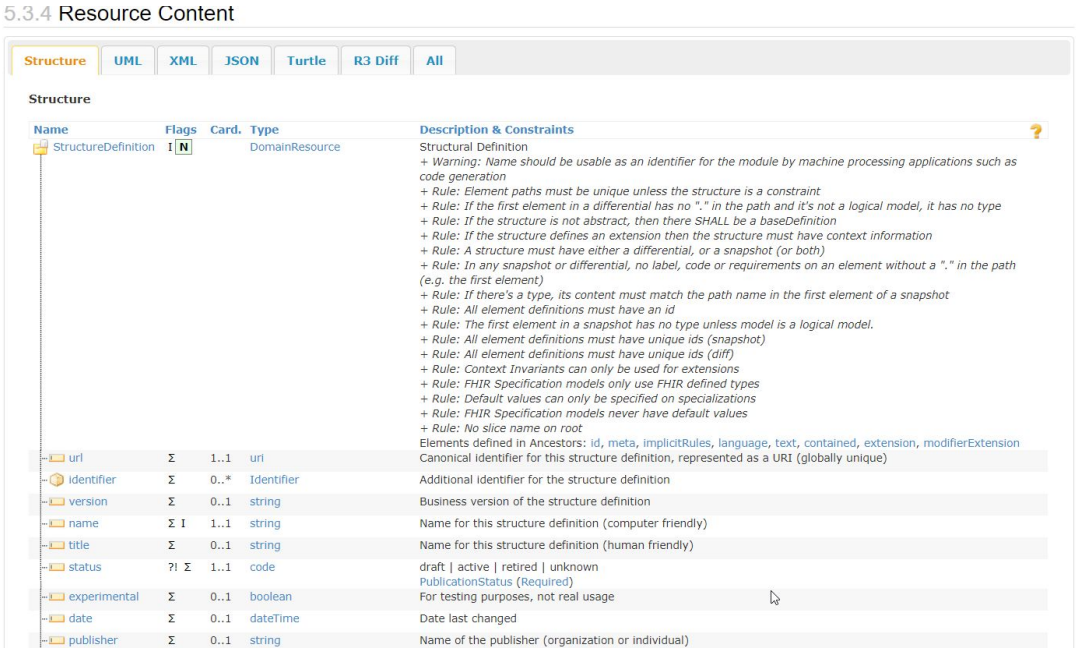
Profiles

The resources don't always adapt 100% to the use cases.

Solution: Profiles
(StructureDefinition)

- Allows the definition of new fields and rules for existing resources.
- Using these editions ensures that the resources adapt to the case being resolved.



5.3.4 Resource Content

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

Structure

Name	Flags	Card.	Type	Description & Constraints
StructureDefinition	I N		DomainResource	Structural Definition + Warning: Name should be usable as an identifier for the module by machine processing applications such as code generation + Rule: Element paths must be unique unless the structure is a constraint + Rule: If the first element in a differential has no "." in the path and it's not a logical model, it has no type + Rule: If the structure is not abstract, then there SHALL be a baseDefinition + Rule: If the structure defines an extension then the structure must have context information + Rule: A structure must have either a differential, or a snapshot (or both) + Rule: In any snapshot or differential, no label, code or requirements on an element without a "." in the path (e.g. the first element) + Rule: If there's a type, its content must match the path name in the first element of a snapshot + Rule: All element definitions must have an id + Rule: The first element in a snapshot has no type unless model is a logical model. + Rule: All element definitions must have unique ids (snapshot) + Rule: All element definitions must have unique ids (diff) + Rule: Context Invariants can only be used for extensions + Rule: FHIR Specification models only use FHIR defined types + Rule: Default values can only be specified on specializations + Rule: FHIR Specification models never have default values + Rule: No slice name on root Elements defined in Ancestors: id, meta, implicitRules, language, text, contained, extension, modifierExtension
url	Σ	1..1	uri	Canonical identifier for this structure definition, represented as a URI (globally unique)
identifier	Σ	0..*	Identifier	Additional identifier for the structure definition
version	Σ	0..1	string	Business version of the structure definition
name	Σ I	1..1	string	Name for this structure definition (computer friendly)
title	Σ	0..1	string	Name for this structure definition (human friendly)
status	?! Σ	1..1	code	draft | active | retired | unknown PublicationStatus (Required)
experimental	Σ	0..1	boolean	For testing purposes, not real usage
date	Σ	0..1	dateTime	Date last changed
publisher	Σ	0..1	string	Name of the publisher (organization or individual)

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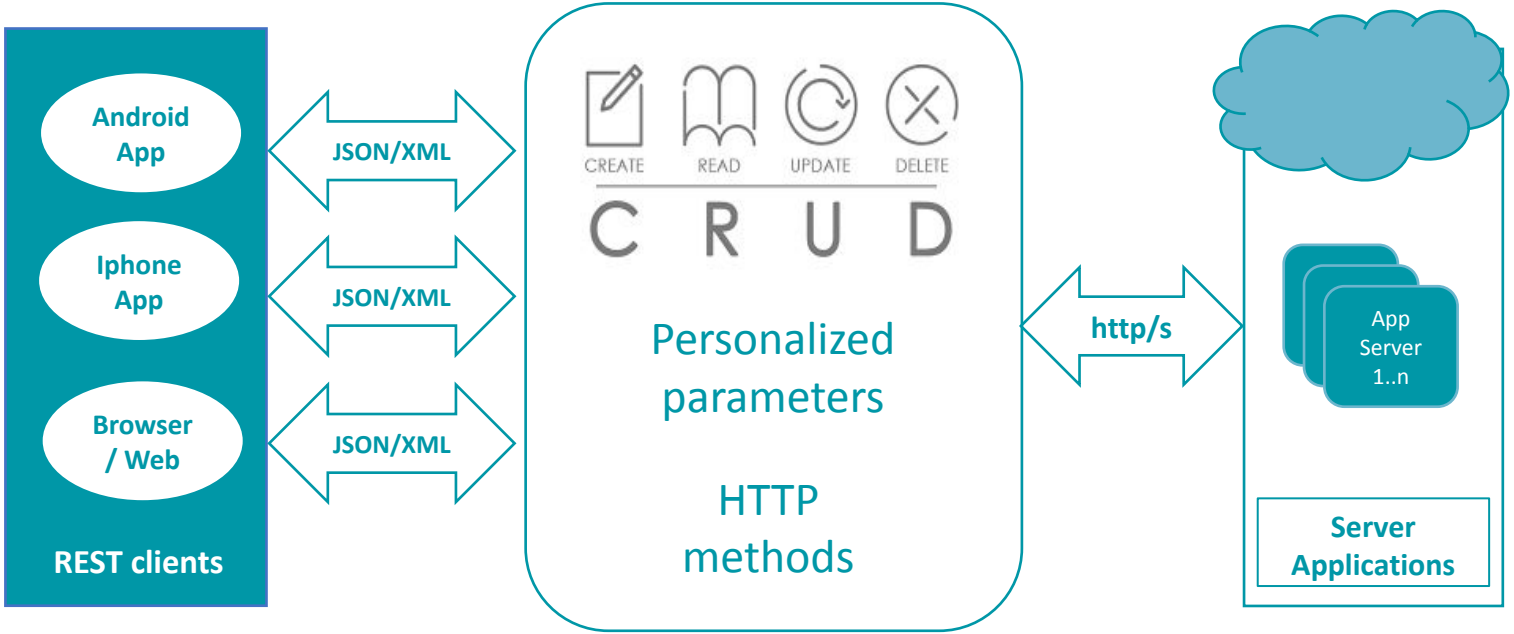
REST and the operations



Operations

Read:	GET	[base]/Patient
	GET	[base]/Patient/example
Create:	POST	[base]/Patient
Update:	PUT	[base]/Patient/example
Delete:	DELETE	[base]/Patient/example



```
<Patient xmlns="http://hl7.org/fhir">
  <id value="xds"/>
  <text>
    <status value="generated"/>
    <div xmlns="http://www.w3.org/1999/xhtml">

      <p> Patient John Doe, M, 27-May 1956. ID: 89765a87b</p>

    </div>
  </text>
  <identifier>
    <use value="usual"/>
    <type>
      <coding>
        <system value="http://hl7.org/fhir/v2/0203"/>
        <code value="MR"/>
      </coding>
    </type>
    <system value="urn:oid:1.2.3.4.5"/>
    <value value="89765a87b"/>
  </identifier>
  <active value="true"/>
  <name>
    <family value="Doe"/>
    <given value="John"/>
  </name>
  <gender value="male"/>
  <birthDate value="1956-05-27"/>
  <address>
    <line value="100 Main St"/>
    <city value="Metropolis"/>
    <state value="Il"/>
    <postalCode value="44130"/>
    <country value="USA"/>
  </address>
  <managingOrganization>
    <reference value="Organization/2"/>
  </managingOrganization>
</Patient>
```

Operations

- Create = POST https://example.com/path/{resourceType}
- Read = GET https://example.com/path/{resourceType}/{id}
- Update = PUT https://example.com/path/{resourceType}/{id}
- Delete = DELETE https://example.com/path/{resourceType}/{id}
- **Search = GET https://example.com/path/{resourceType}?search parameters...**
- **History = GET https://example.com/path/{resourceType}/{id}/_history**
- **Transaction = POST https://example.com/path/ (POST a transaction bundle to the system)**
- **Operation = GET https://example.com/path/{resourceType}/{id}/${opname}**

Terminology

Semantic interoperability

- **CodeSystem:** Defines concepts and gives them a meaning through formal definitions, and assigns them certain codes which represent the concept.
- **ValueSet:** Code set belonging to a CodeSystem which can be used in a specific context.
- **ConceptMap:** Defines a mapping of a defined ValueSet in a CodeSystem towards another one, specifying the type of equivalence.

FHIR® servers

- A FHIR server fully or partially implements the standard definition.
- Every version has specific characteristics (Dstu2, stu3, R4, R4b, R5).
- It's possible to incorporate new functionalities which aren't defined in the standard.



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FHIR® servers

Basic functions:

- Crud operations
- Versioning
- Resource validation
- Transactions
- Operations
- Searches
- Capability Statement
- History



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FHIR® servers

The operations a server should support by type:

- **Instance: [base]/[type]/[id]**
- **Resource: [base]/[type]**
- **General: [base]**

Instance Level Interactions	
read	Read the current state of the resource
vread	Read the state of a specific version of the resource
update	Update an existing resource by its id (or create it if it is new)
patch	Update an existing resource by posting a set of changes to it
delete	Delete a resource
history	Retrieve the change history for a particular resource
Type Level Interactions	
create	Create a new resource with a server assigned id
search	Search the resource type based on some filter criteria
history	Retrieve the change history for a particular resource type
Whole System Interactions	
capabilities	Get a capability statement for the system
batch/transaction	Update, create or delete a set of resources in a single interaction
history	Retrieve the change history for all resources
search	Search across all resource types based on some filter criteria

FHIR® server - Types

- **Generic servers:**
  - Implement the FHIR® standard almost completely.
  - The user only has to install and configure in order to get an operating server.

- **Specific servers:**
  - Implement only the parts of the standard relating to the solution.
  - The developer has to implement everything.

HAPIFHIR
SmileCDR
FIRELY
IBM FHIR Server
Spark Server…





IBM

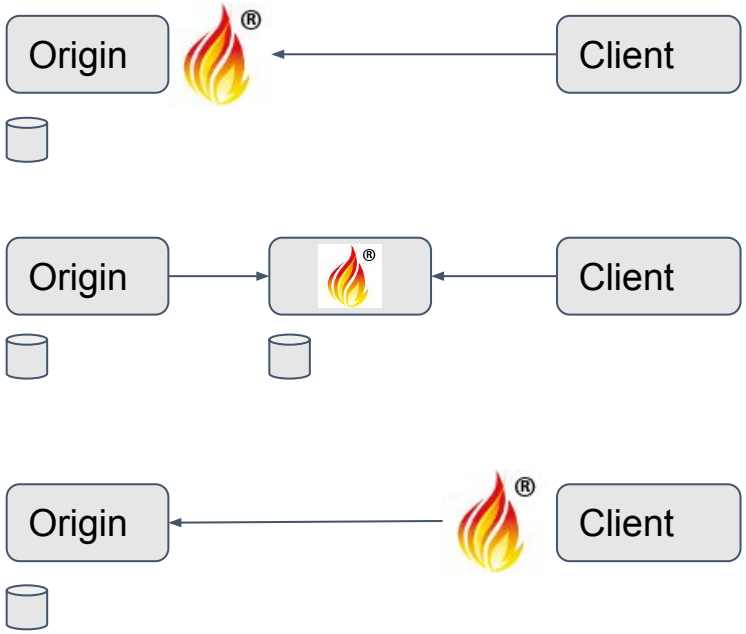
Spark

smile CDR

FHIR® servers

Types of FHIR implementations

- **API as facade in server:** Used to transform data from origins in the moment they are queried.
- **Intermediate API:** Between client and server: It's a server which immediately stores the information and allows to query it.
- **API as facade in client:** Transforms requests from a client into FHIR® requests.



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FHIR® servers

Server implementations:

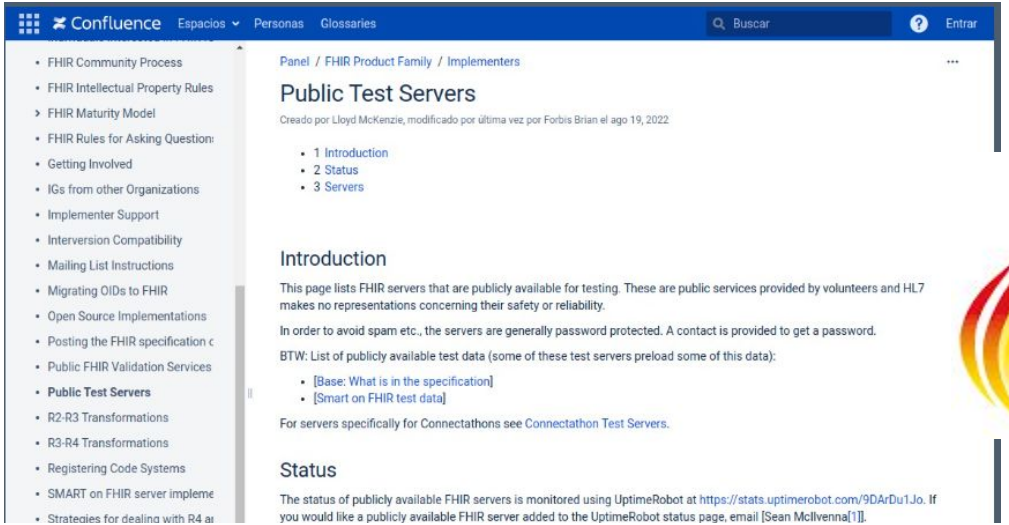
- **Grahame's test server(Pascal):** https://github.com/grahamegrieve/fhirserver
- **Firely Server(.NET):** https://server.fire.ly/
- **HAPI FHIR Server(Java):** http://hapifhir.io/
- **Smile CDR**: https://www.smilecdr.com/
- **Spark(C#):** https://github.com/FirelyTeam/spark
- **Java - IBM FHIR Server:** https://github.com/LinuxForHealth/FHIR
- **CSIRO's Ontoserver - R4:** https://r4.ontoserver.csiro.au/fhir
- **onfhir.io - HL7 FHIR Based secure data repository:** https://github.com/srdc/onfhir

FHIR cloud services:

- **Azure API for FHIR:** https://azure.microsoft.com/es-es/services/azure-api-for-fhir/
- **Cloud Healthcare API:** https://cloud.google.com/healthcare-api/

Public FHIR® servers

https://confluence.hl7.org/display/FHIR/Public+Test+Servers



HL7® FHIR®

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Thank you



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