HL7 and FHIR Standards

HL7 v2 Messages

- Pipe-delimited format
- ADT, ORM, ORU message types
- Widely adopted legacy standard
- Complex parsing required

FHIR Resources

- JSON/XML formats
- Patient, Observation, Medication
- Modern web-based standard
- Easy to implement

RESTful APIs

- HTTP GET, POST, PUT, DELETE
- Resource-based URLs
- OAuth 2.0 authentication
- SMART on FHIR apps

Implementation Guides

- US Core profiles
- Argonaut specifications
- Country-specific extensions
- Validation tools

1. HL7 v2 Messages - Detailed Overview

HL7 Version 2 is the most widely implemented healthcare messaging standard in the world, used for transmitting clinical and administrative data between different hospital information systems. Despite being considered a "legacy" standard, it remains the backbone of healthcare interoperability in many institutions.

> **Key Characteristic:** HL7 v2 uses a pipe-delimited (|) format to separate data fields, making it compact but challenging to read and parse.

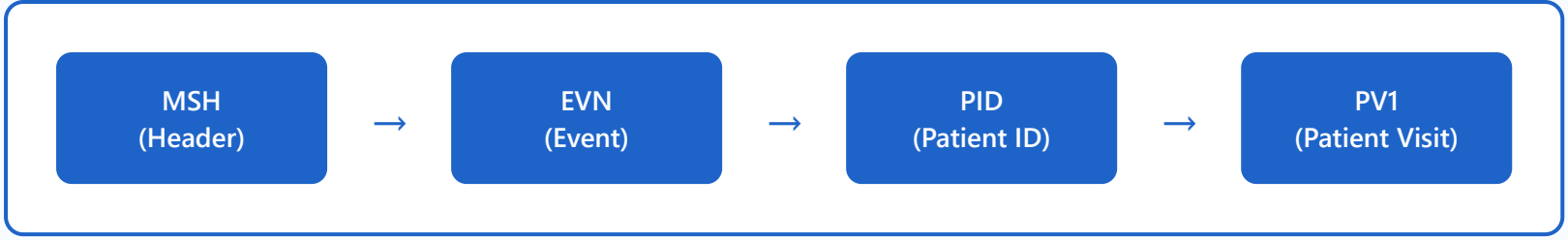
Common Message Types:

Message Type	Purpose	Example Trigger Events
ADT (Admission, Discharge, Transfer)	Patient demographics and visit information	A01 (Admit), A03 (Discharge), A08 (Update)
ORM (Order Message)	Medical orders (lab, radiology, pharmacy)	O01 (Order), O02 (Cancel Order)
ORU (Observation Result)	Lab results and clinical observations	R01 (Unsolicited observation)

Example: ADT^A01 Message (Patient Admission)

```
MSH|^~\&|SENDING_APP|FACILITY|RECEIVING_APP|FACILITY|20231115083000||ADT^A01|MSG00001|P|2.5
EVN|A01|20231115083000 PID|1||MRN123456^^^Hospital^MR||Doe^John^A||19800115|M|||123 Main
St^^Boston^MA^02101^USA||||||| PV1|1|I|ICU^101^01^Main
Hospital||||123456^Smith^Robert^A^^^MD^L|||||||||V123456|||||||||||||||||||||||20231115080000
```

Message Structure Breakdown:



Challenges:

- Complex parsing logic required due to delimiters
- Optional fields create inconsistency across implementations
- Limited data validation capabilities
- Version incompatibilities (2.1 through 2.8)

2. FHIR Resources - Modern Healthcare Standard

Fast Healthcare Interoperability Resources (FHIR) is the next-generation standard that leverages modern web technologies. It represents healthcare data as modular "resources" that can be easily exchanged via RESTful APIs.

> **Key Innovation:** FHIR uses familiar web standards (JSON/XML, HTTP, OAuth) making it accessible to modern developers and easy to implement.

Core FHIR Resources:

Resource	Description	Key Elements
Patient	Demographics and administrative information	name, gender, birthDate, address, telecom

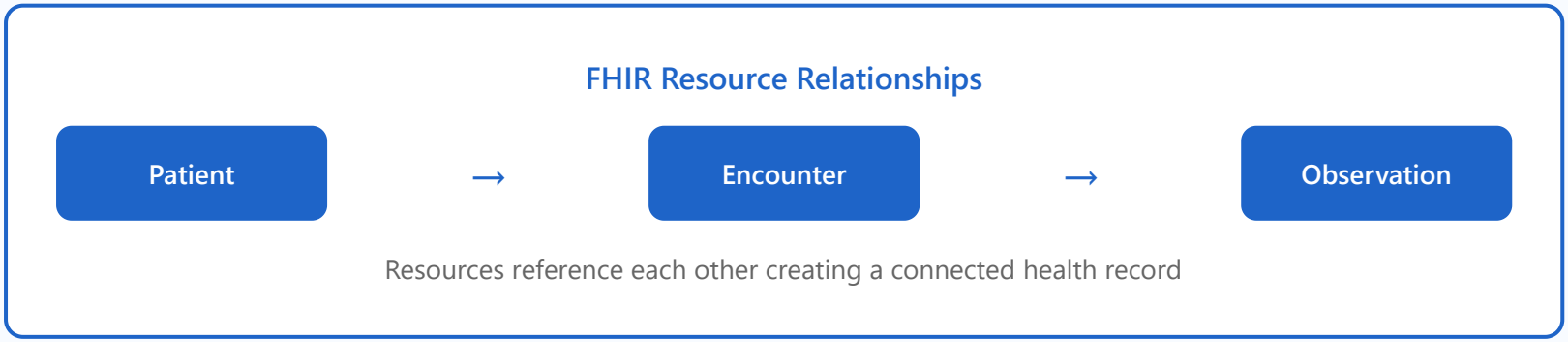
Observation	Measurements and simple assertions	code, value, status, effectiveDateTime
Medication	Medication definitions and orders	code, form, ingredient, amount
Encounter	Healthcare service interaction	status, class, period, participant

Example: Patient Resource (JSON Format)


```
{ "resourceType": "Patient", "id": "example", "identifier": [{ "system":
"http://hospital.org/mrn", "value": "MRN123456" }], "name": [{ "family": "Doe", "given": ["John",
"A"] }], "gender": "male", "birthDate": "1980-01-15", "address": [{ "line": ["123 Main St"],
"city": "Boston", "state": "MA", "postalCode": "02101", "country": "USA" }], "telecom": [{
"system": "phone", "value": "555-1234", "use": "home" }] }
```


Example: Observation Resource (Lab Result)


```
{ "resourceType": "Observation", "id": "glucose-001", "status": "final", "category": [{ "coding":
[{ "system": "http://terminology.hl7.org/CodeSystem/observation-category", "code": "laboratory" }]
}], "code": { "coding": [{ "system": "http://loinc.org", "code": "15074-8", "display": "Glucose
[Mass/volume] in Blood" }] }, "subject": { "reference": "Patient/example" }, "effectiveDateTime":
"2023-11-15T08:30:00Z", "valueQuantity": { "value": 95, "unit": "mg/dL", "system":
"http://unitsofmeasure.org", "code": "mg/dL" } }
```

Advantages over HL7 v2:

- Human-readable JSON/XML formats
- Built-in validation with profiles and schemas
- RESTful API architecture (GET, POST, PUT, DELETE)
- Extensible design with custom extensions
- Strong community support and tooling

3. RESTful APIs - FHIR Implementation

FHIR leverages RESTful (Representational State Transfer) principles to create a standardized way of accessing and manipulating healthcare data over HTTP. This makes FHIR naturally compatible with web and mobile applications.

> **Core Principle:** Every FHIR resource has a unique URL and can be accessed using standard HTTP methods, making integration straightforward for developers.

HTTP Methods and FHIR Operations:

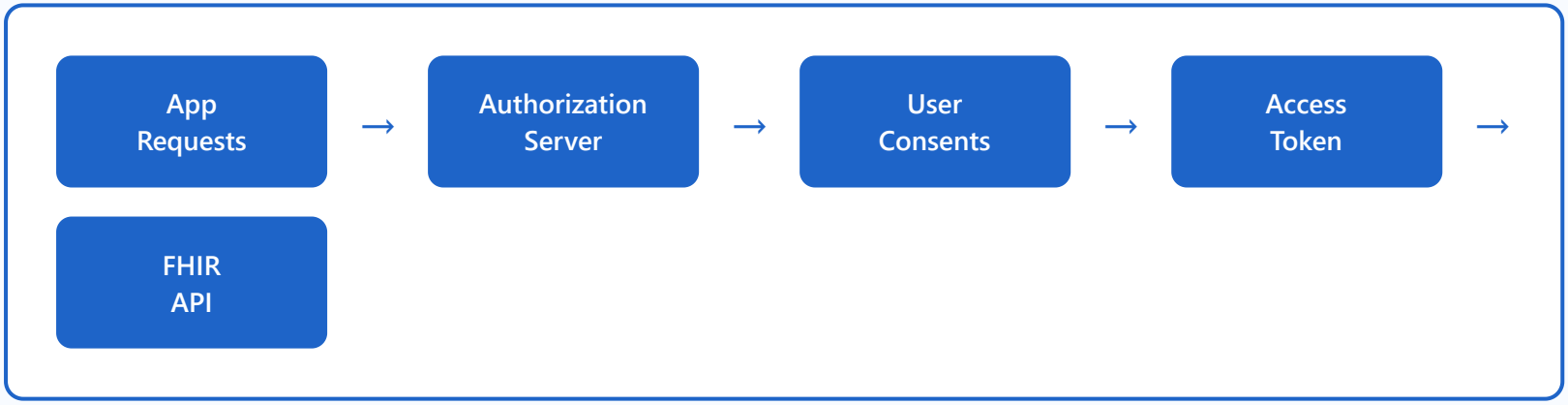
HTTP Method	FHIR Operation	Example URL
GET	Read/Search resources	GET /Patient/123 GET /Observation?patient=123
POST	Create new resource	POST /Patient
PUT	Update existing resource	PUT /Patient/123

DELETE	Remove resource	DELETE /Patient/123

Example API Requests:

```
// 1. GET - Retrieve a specific patient GET https://fhir.hospital.org/Patient/123 Authorization: Bearer {access_token} // 2. GET - Search for patients by name GET https://fhir.hospital.org/Patient?name=John&family=Doe // 3. GET - Get all observations for a patient GET https://fhir.hospital.org/Observation?patient=123&category=laboratory // 4. POST - Create a new patient POST https://fhir.hospital.org/Patient Content-Type: application/fhir+json Authorization: Bearer {access_token} { "resourceType": "Patient", "name": [{"family": "Smith", "given": ["Jane"]}], "gender": "female", "birthDate": "1985-03-20" }
```

OAuth 2.0 Authentication Flow:



SMART on FHIR:

SMART (Substitutable Medical Applications, Reusable Technologies) on FHIR is a framework for building healthcare apps that can run across different electronic health record (EHR) systems. It combines OAuth 2.0 for authorization with FHIR APIs for data access.

```
// SMART App Launch Sequence // 1. Discover FHIR endpoints GET https://fhir.hospital.org/.well-known/smart-configuration // 2. Authorization request GET https://auth.hospital.org/authorize?
```

```
response_type=code& client_id=app123& redirect_uri=https://app.example.com/callback&
scope=patient/*.read launch& state=abc123& aud=https://fhir.hospital.org // 3. Exchange code for
token POST https://auth.hospital.org/token Content-Type: application/x-www-form-urlencoded
grant_type=authorization_code& code=AUTH_CODE& redirect_uri=https://app.example.com/callback&
client_id=app123
```

Common SMART Scopes:

- **patient/*.read** - Read all patient resources
- **user/Patient.read** - Read patient resources in user context
- **patient/Observation.write** - Write observations for the patient
- **launch** - Launch context from EHR

4. Implementation Guides - FHIR Profiles and Standards

Implementation Guides (IGs) are detailed specifications that constrain and extend the base FHIR specification to meet specific use cases or regulatory requirements. They ensure consistent interpretation and implementation of FHIR across different systems.

> **Why Implementation Guides?** Base FHIR is intentionally flexible. IGs add necessary constraints and extensions to ensure interoperability for specific regions, specialties, or use cases.

Major Implementation Guides:

Implementation Guide	Region/Purpose	Key Features

US Core	United States (ONC mandate)	Minimum conformance requirements, USCDI data elements
Argonaut	US - Early adopters	Provider directories, clinical notes, scheduling
IPS (International Patient Summary)	Global	Cross-border patient summary, minimal dataset
UK Core	United Kingdom	NHS-specific extensions and terminology

US Core Profile Example:

US Core defines specific requirements for common resources. For example, the US Core Patient profile requires:

```
{ "resourceType": "Patient", "meta": { "profile":
["http://hl7.org/fhir/us/core/StructureDefinition/us-core-patient"] }, // REQUIRED elements:
"identifier": [/*must have at least one*/], "name": [/*must have at least one*/], "gender":
"male|female|other|unknown", // MUST SUPPORT (if available): "birthDate": "1980-01-15", "address":
[{/*postal addresses*/}], "telecom": [{/*contact points*/}], // Extensions for US-specific data:
"extension": [{ "url": "http://hl7.org/fhir/us/core/StructureDefinition/us-core-race",
"extension": [{ "url": "ombCategory", "valueCoding": { "system":
"urn:oid:2.16.840.1.113883.6.238", "code": "2106-3", "display": "White" } }] }] }
```

Validation Tools:

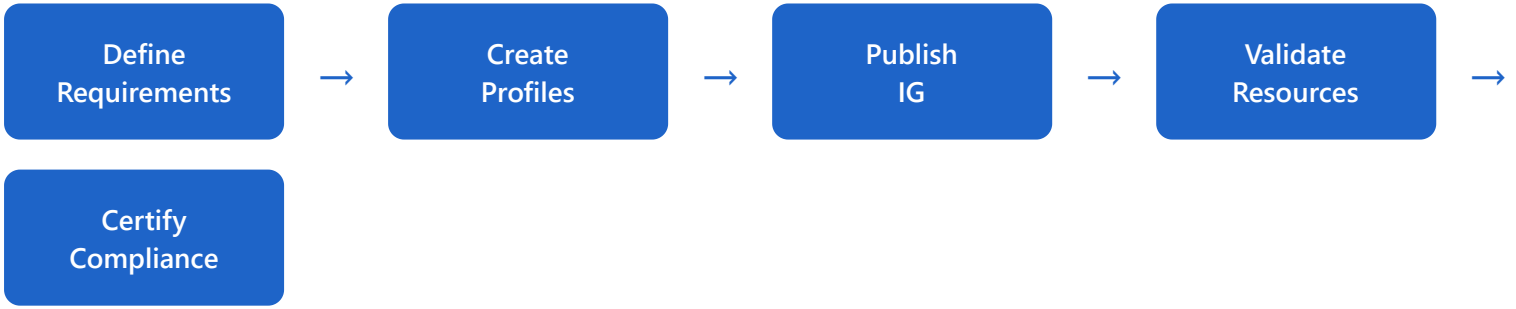
HL7 FHIR Validator	Official Java-based validator from HL7
Inferno Testing Tool	ONC-certified testing for US Core compliance
Touchstone	AEGIS platform for conformance testing

FHIR Profiling Tool	Forge/Simplifier for creating custom profiles

Country-Specific Extensions Example:

```
// Korean Social Security Number Extension (Example) { "resourceType": "Patient", "extension": [{ "url": "http://example.org/fhir/StructureDefinition/kr-resident-registration-number", "valueString": "800115-1234567" }], "identifier": [{ "system": "http://example.org/korean-national-id", "value": "800115-1234567" }] } // Australian Indigenous Status Extension { "extension": [{ "url": "http://hl7.org.au/fhir/StructureDefinition/indigenous-status", "valueCoding": { "system": "https://healthterminologies.gov.au/fhir/CodeSystem/australian-indigenous-status-1", "code": "1", "display": "Aboriginal but not Torres Strait Islander origin" } }] }
```

Implementation Guide Workflow:



Key Benefits of Implementation Guides:

- Ensures consistent data exchange across organizations
- Reduces ambiguity in FHIR resource interpretation
- Provides clear conformance criteria for certification

- Supports regulatory compliance (e.g., ONC, FDA)
- Enables automated validation and testing