Kiran Sangem

Kiran has been working with various US Healthcare clients for over a decade and very passionate about his work. He loves to take up challenges and come up with solutions best suited. He carries a 'Never Give Up' attitude and loves to learn new technologies.
In this digital era, every individual wants to see updated health data as he/she moves around the healthcare ecosystem i.e. providers, patients and caregivers should have the data available, discoverable and easily understandable. Furthermore, to support business intelligence, analytics, clinical decision support and other machine-based processing, the data must be structured and standardized in a way that supports healthcare digitization. This has led to a growing pressure to broaden the scope of interoperability across organizations, handheld devices, mobile & cloud based applications; to ease the implementation process to ensure faster integration and enable flexible custom workflows.

With the new Medicare Access & CHIP Reauthorization Act of 2015 (MACRA) which reforms Medicare payment, interoperability is a critical element of any delivery system reform vision where electronic health information is unlocked and securely accessible to achieve the MACRA goal set by CMS for better care, smarter spending and healthier people.

*When one hears interoperability, HL7 is the word that comes to mind.*

**HL7 – The problem child**

*So where does the problem lie?*

- Almost 20 years old, HL7 V2 does not provide support to modern platforms for internal processing and manipulation of healthcare data. The flat file approach is too old school, hard to customize and extend as needed by the healthcare industry today.
- The implementation required for HL7 V3 is more time consuming and complex due to many customized tools. It has a very steep learning curve and as of now, has limited market adoption.
- A standard that emerged with EHR Incentive Program - CDA implementation was mandatory but it requires an extensive knowledge of RIM. Extensibility was offered but it required a lot of pre-processing. Every vendor in the market has its own style for extensions leading to errors while incorporating CDA from a different EHR vendor.

*So what’s next?*

The HL7 organization wanted to come up with a new standard framework for exchanging healthcare information that combines the best features of HL7 V2, V3 and CDA.
Reasons driving the change are:

1. Interoperability requirements are increasing by leaps and bounds to
   a. Increase collaborative care – need for coordination
   b. Adapt to changing payment models
   c. Aid patient engagement via patient portals
   d. Improve clinical decision support within EHR
   e. Provide access to primary care/community data
   f. Make population health analytics possible
2. Need for real time access (API) E.g. Mobile devices
3. Increase in the amount, type and source of data
4. Analytics- population health solutions dictating the need to collect from many data sources

This necessitates the need for a next generation healthcare interoperable standard that can be used in electronic exchange of patient health information across heterogeneous systems by combining the best features of HL7v2, v3 and CDA.

This latest standard from HL7 organization that aims to address this need is “FHIR”
FHIR – The next generation healthcare interoperable standard

FHIR pronounced as ‘Fire’, stands for

- **F** – Fast (to design and implement)
- **H** – Healthcare
- **I** – Interoperability
- **R** – Resources (Building blocks)

Defining FHIR

FHIR defines a set of “Resources” that represent granular clinical concepts. The resources can be managed in isolation, or aggregated into complex documents. Technically, FHIR is designed for the web; the resources are based on simple XML or JSON structures, with an http-based RESTful protocol where each resource has predictable URL.¹

The philosophy behind FHIR is to build a base set of resources that, either by themselves or when combined, satisfy the majority of common healthcare use cases. FHIR resources aim to define the information content and structure for the core information set that is shared by most implementations. There is a built-in extension mechanism that provides support for the remaining content.

Is it for me?

The digital world has evolved, and interoperability plays a major role for healthcare today and in the coming times. There are innumerable instances where we need a set of standards followed across healthcare scenarios.

- If someone is building a new iOS healthcare app (and thousands are), what standard do we point them to?
- If someone wants to provide a cloud based health app that integrates with social networks, what standard should they use?
- If a vendor wants to provide a simple to use standards based API to cloud based health integration services, what standard should they extend?
- If a government wants to implement a national EHR, who should they talk to?

*The answer to all these is FHIR*
The Holy Grail – What is a part of FHIR?

**Pre-defined Resources and API**
- Common way to represent data as building blocks and rules for connecting them
- Target support for common scenarios

**Implementer Friendly**
- Familiar tooling and technologies using web standards
- Multiple Libraries available for faster implementations

**Mobile friendly**
- Concise and easily understood specifications, RESTful API and JSON
- Leverages cross industry web technologies

**Multi-paradigm, all architectures, all clients**
- Thick client, browser or mobile devices
- Supports human readability as base level of interoperability

**Large community for support**
- Heaps of open source software and training events, webinars and connectathons
- Specification feedback welcomed, including update requests-tracker

**Out-of-the-box interoperability**
- Base resources can be used as it is, can also be adopted for local requirements
- Seamless exchange of information using messages or document

*Figure 2: What is part of FHIR?*
FHIR - Nuts and Bolts

Interoperability paradigms

FHIR supports 4 interoperability paradigms. FHIR implementation may implement one or many paradigms according to the design and requirement of the workflow involved.

FHIR leverages the same data models and profiles (everywhere regardless of interoperability approach) REST, Documents, Messages, and Services. These are lessons learned from HL7 version 3, where different models are being used depending on the integration approach, leading to additional implementation challenges.

![Figure 3: Four interoperability paradigms supported by FHIR](image)

**Building blocks**

What does FHIR entail? Let us take a look at the basic building blocks of FHIR

**Resources**

FHIR solutions are built from a set of modular components called “Resources”. An instance of data that is stored or exchanged can be termed as a resource.

A resource is an entity that-
1. Has a known identity (a URL) by which it can be addressed
2. Identifies itself as one of the types of ‘resources’ defined in this specification
3. Contains a set of structured data items as described by the definition of the resource type
4. Contains a human-readable XHTML representation of the content of resource
5. Has an identified version that changes if the contents of the resource changes

Resources have multiple representations and can be represented as JSON/XML. FHIR based systems can then map the clinical and administrative actions by performing a search/read/create/update/delete of the interlinked resources.


**Bundling**

One common operation performed with resources is to gather a collection of resources into a single XML instance. In FHIR this is referred to as "Bundling" the resources together. The resource bundle is not just a list of references to resources, but includes their whole content.

These resource bundles are useful for a variety of different reasons, including:

1. Returning a set of resources that meet some criteria as part of a server operation; this interaction searches a set of resources based on some filter criteria, which can be performed by several different HTTP commands
2. Returning a set of versions of resources as part of the history operation on a server
3. Storing a collection of resources
4. Exchanging a set of resources as part of a message transaction; where a ‘request message’ is sent from a source application to a destination application when an event happens
5. Grouping a self-contained set of resources to act as an exchangeable and persist-able group with clinical integrity (i.e. a clinical document)

**Extensions**

Every element in a resource or data type includes an optional "extension" child element that may be present any number of times.

It is a three step process:

1. Define the extension
2. Register the extension
3. Use it in the instance

**Example**: A social web provider of personal healthcare record (PHR) services might be obliged to keep track of the particular policy under which a patient has created their relationship with the PHR provider, and share this with their participants via their FHIR API. If they wish, they can extend the patient resource to represent the patient’s participation agreement.
**Modifier Extension**

Extensions also allow modification of the meaning of the resource that contains it (Example – to negate the meaning of the resource).

- An anti-prescription: recording an instruction not to take a medication
- Asserting that a performer was not actually involved in a Procedure
- Recording that a Supply was not provided (i.e. refusal to fill)

**Profiles**

Profile is a special resource that provides additional rules about how a type of resource is utilized in particular context of use or for a particular use case.

Profile resources have 3 main parts:

1. A metadata section that describes the purpose of profile & helps with location & versioning of profile
2. Structure that define and describe how a resource or data type is used
3. Extension definitions that define extensions (if required) that can be used in structures

**Examples:** A Laboratory service producing a set of different reports - general chemistry, blood count, etc. Typical labs would support several hundred different reports which form a Conformance profile.

**Security mechanisms**

FHIR is not a security protocol, nor does it define any security related functionality. However FHIR does define exchange protocols and content models that need to be used with various security protocols defined elsewhere.

**Security standards defined as part of FHIR**

- Communications Security - all exchange of production data should be secured using TLS/SSL (e.g. https)
- Authentication - Users/Clients may be authenticated in any way desired. For web-centric use, oAuth is recommended.
- Authorization/Access Control - FHIR defines a Security Label infrastructure to support access control management.
- FHIR may also define a set of resources to administer access control management, but currently nothing is defined.
- Audit - FHIR defines provenance and security event resources suitable for tracking the origins, authorship, history, status and access of resources
- Digital Signatures - FHIR includes several specifically reserved locations for digital signatures
- Attachments - FHIR allows for binary resources and attachments. These have their own concerns
- Labels - FHIR allows for set of security related tags that affect the way resources are handled
- Data Management Policies - FHIR defines a set of capabilities to support data exchange.
Business Case for FHIR

FHIR has been able to solve both rigid custom HL7 V2 integration and non-practical cum hard-to-do HL7 V3 integrations. In the EHR space in doctor’s practices, HL7 integration has already become the exception rather than the norm. While many of the different EHR vendors are encouraging integration through their own web service APIs, the quality of those APIs vary from EMR vendor to vendor – some are RESTful, some use SOAP, but these still use custom implementation. While each EHR vendor is trying to create an eco-system of compatible products that can complement their products – implementing FHIR based APIs will allow such vendors to develop compatible APIs which can be used for interoperability and exchange of data.

EHR Interoperability

EHR vendors are required to use Public APIs to obtain MU3 certification. This is the right opportunity for an EHR to expose significant resources using FHIR.

This is how FHIR can be easily built into EHR & later all the data exchanges can be converted via FHIR API. The diagram below represents how Electronic Health Record system can update few resources like Patient, Medications, Allergies, Labs, Appointments, and Diagnosis into a FHIR repository with the help of HTTP PUT operations while doing CRUD operations on these objects in their database. These resources can then be bundled together in the context of patient portal which can query FHIR server for these resources and get updated copy each time. Same implementation can be done with the mobile device using same real time API for a read-only view of patient information and basic clinical data.

Same Restful API can be used to meet Application Access certification criteria for meaningful use wherein serialized JSON response of FHIR resource can be used to generate exchange data with third party application.

ONC has already added below mentioned criteria in MU3 wherein EMR need to develop Public API to facilitate exchange of information from EMR to third party system.

Here is the list of measures:

<table>
<thead>
<tr>
<th>§170.315(g)(7)</th>
<th>Application Access – Patient Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability of EHR API to be able to receive a query for a specific patient id and return data which can be used by subsequent requests</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>§170.315(g)(8)</th>
<th>Application Access – Data Category Request</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ability of an API to request for patient data for each of the individual data categories specified in the Common Clinical Data Set and returns the full set of data for that data category as well as ability to respond to patient data requests based on specific date criteria.</td>
<td></td>
</tr>
</tbody>
</table>
From HL7 V2 and CDA to FHIR

Most healthcare provider organizations already have to deal with multiple standards (e.g. HL7 v2, CDA, X12, DICOM) and mappings between them, the mapping between FHIR and these other standards is no different from any the current mappings. Given that FHIR is based on HL7 V2 and CDA, and that there is a conscious effort to align the resource definitions with CDA, the mapping between the various HL7 standards will be relatively straightforward. Any of the existing interface engines should be able to support such mappings. Tools for mapping of current standards to and from FHIR are expected to become available as the use of FHIR spreads.

For example, in a laboratory systems when tests are ordered by sending a HL7 message to the lab and the results are received in an HL7 format and incorporated within the application, or when a provider sends a referral to another provider through a CCDA document structure.

Extensibility to new platforms

There is no specification in FHIR that a system should only support one paradigm. A complex implementation will involve using multiple paradigms smartly.

For e.g. A hospital may be using primarily messaging paradigm for meeting request/response workflow for exchanging information, but it needs to use documents paradigm for supporting exchange/storage.
of discharge summaries, progress notes, clinical summaries etc. It may also need to expose registries, appointments, patient portal and referral information via REST & few custom services for decision support. Various platforms like the PMS, EHR, Patient portal, Labs, CDC’s can be integrated using FHIR. Once the APIs are exposed, any other system can communicate using FHIR once the authentication is granted.

**Bottom Line**

With providers complaining of the current EHR systems lacking the necessary formatting regulations that ensure smooth communications between all sources, the idea of a centralized interoperability using FHIR gives way to more flexible concept and promises to be a long term solution over multiple existing standards. FHIR is easy to learn and implement with lower cost. It’s free, flexible, and scales well from simple to complex systems. It has the potential to address the real need of the healthcare ecosystem.

As the regulatory requirements aid the adoption of truly interoperable solution throughout the ecosystem, healthcare solution providers are looking at FHIR as a viable option now. With a few of them ahead of the curve already, others seem to be following suit. We at Nalashaa have been toying with FHIR for quite some time now. We understand the ways in which one can leverage FHIR and make it work with existing EHRs with minimal changes. In case you are looking for a more transformative approach, we can assist you achieve that too. If you would like to know more about how we could be of help, we would be glad to catch up.
References