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CONVERSION TO FHIR HL7 CODES – AN EASY JOURNEY

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Abstract - As part of the CMS ONC Interoperability rules, HL7 FHIR (Fast Healthcare Interoperability Resources) Standard defines how healthcare information can be exchanged between different systems irrespective of their formats. Even though FHIR describes the specific formats in which the data can be transferred, efficient mechanisms for this data conversion are not defined. Every organization have their own code systems and converting these huge codes to FHIR supporting codes will be a tedious task. This paper discusses about the current processes and how this process can be improved using technology.

***Key Words*:** FHIR, CMS ONC, Interoperability, Concept Map, HL7, Codeable Concept, Healthcare, US Healthcare

1.INTRODUCTION

Interoperability is the ability of a system to communicate with multiple other systems. The term can be well applied both in software as well as non-software systems or processes. Interoperability is in place wherever there is a need to introduce Standards or rules for easy sharing of information. Multiple domains like Manufacturing, Telecommunications, Digital Government services, Railways etc. introduce various levels of Interoperability in their systems as they must share data between a wide range of other systems/domains.

Interoperability in Healthcare domain helps in the seamless transfer of healthcare data between different systems and organizations. Health Information Exchange or HIE provides the capability to electronically transfer the healthcare data between different systems and maintain the meaning of those information's in these systems. The establishment of Standards in Interoperability helped in establishing a common language understood by different systems.

A standards organization, standards body, standards development organization (SDO) or standards setting organization is focused on developing, coordinating, promulgating, revising, amending, reissuing, interpreting, or otherwise producing standards that are intended to address the needs of some wide base of affected adopters.

Health Level Seven (HL7) is one among the standards which contains content and transport protocols. Content standards relate to the content of the data exchanged between systems. Transport standards address the format of messages exchanged between multiple systems.

Fast Healthcare Interoperability Standards (FHIR) is a HL7 standard which contains the transport protocols for exchanging data between multiple systems electronically. The basic building blocks of FHIR are resources which describes the health data formats and elements. FHIR also provides standardization for application programming interfaces (APIs). FHIR provides benefits and improvements as a modern healthcare standard including facilitating interoperable exchange with legacy standards, lower overhead, shorter learning curve, an ability to transmit only the necessary pieces of information, potential for patient mediated data, and an energized community of supporters and implementers.

While FHIR is being adopted in different flavor across the world, for USA market, there were govt mandates issued to enabled interoperability. "In March 2020, the Centers for Medicare & Medicaid Services (CMS) and Office of the National Coordinator for Health Information Technology (ONC) released separate but related final rules which are designed to drive interoperability through data sharing and empower patients through increased access to data." [1]

The HL7 FHIR APIs allow the exchange of healthcare data across nonclinical devices, whereas other HL7 standards share data between clinical devices. FHIR allows medical personnel to use mobile devices to communicate with key medical services remotely from virtually anywhere. FHIR allows patients to use personal devices to access their personal health records (PHRs) and to interface directly with some medical systems, for example to view their laboratory test results or to book a consultation.

2.INTEROPERABILITY CHALLENGES IN HEALTHCARE

There are few challenges faced by different organizations while trying to adapt to the Interoperability standards. Every organization is already following company specific standards in managing their data and code systems. Organizations with multiple source systems may have to work together to convert their data to HL7 FHIR standards. This involves multiple teams/domains to come together and hence time consuming.

Another challenge is the technology. Organizations are using specific technology to build their architecture and applications. But Interoperability brings new requirements into place and there is demand for a revised technology architecture. The current templates may not help in supporting HL7 FHIR standards.
Understanding the HL7 FHIR rules and constraints that are set for every clinical or claims resource is another bottle neck towards building the capability. The documentations are very robust. Understanding the concepts involves immense effort. Any misconception in the understanding of these concepts or

missing any details may lead to a failure in conforming to FHIR standards.
HL7 FHIR resources supports fields of type 'Codeable Concepts'. These can be Industry standard codes like ICD10, SnomedCT, RxNorm or codes defined as FHIR Code Systems. Any Organization can support their own legacy code systems. The conversion of these codes to FHIR supporting codes is complex. These codes can be any data related to the patient, ex. Patient race, ethnicity, language etc. HL7 FHIR has defined these codes as valuesets, and conversion is required by the organizations to support FHIR conformance. There may be vast number of codes for defining these datasets and conversion to FHIR supporting codes is time consuming and error prone.
HL7 FHIR is proposing a 'ConceptMap' resource for mapping a source code to 'Codeable Concept' data type. But the generation of the ConceptMap resource with huge number of source codes is a challenge.

3. CONCEPT MAPPING

As part of the CMS ONC Interoperability rules, HL7 FHIR (Fast Healthcare Interoperability Resources) Standard defines how healthcare information can be exchanged between different systems irrespective of their formats. Even though FHIR describes the specific formats in which the data can be transferred, efficient mechanisms for this data conversion are not defined. Every organization have their own code systems and converting these huge codes to FHIR supporting codes will be a tedious task.

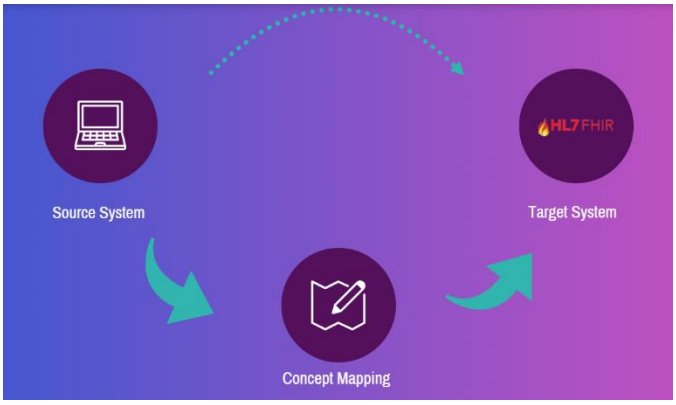

Fig – 1: Code Conversion via Concept Maps

HL7 FHIR is proposing a Concept Map [2] Resource for an easier conversion of set of source codes to target codes. The mappings are saved in the format of Concept Map's and $translate operation [3] can be used to retrieve the target code for a specific source code. The solution seems simple.

Now the questions are:

•What should be the process to save the mappings in Concept Map Resource format?

•How the complex structure can be created if there are 100s or more codes involved?

•Who would supply the list of source codes for each code system, if multiple teams engage in an organization?

•Who will supply the list of target codes for each code system, as this will involve having a complete understanding of the HL7 terminologies?

•Who will do the mapping for the set of source-target codes and how this data mapping can be converted into Concept Map Structure?

•Finally, how can we update the concept map resource if there are any changes or new addition of codes in the source systems?

4. CURRENT SCENARIO

When the CMS ONC Interoperability rules [4] were introduced, different teams in an organization working on multiple source systems had to come together and transform the data to HL7 FHIR Standards. The healthcare data is huge, and the presence of multiple source systems like Electronic Health Records (EHR), Enrollments, Pharmacy systems etc., complicates the conversion process. The same reason makes the task time consuming as well. Understanding the HL7 FHIR terminologies and concepts adds to the above points that makes the process more difficult to achieve. Not only the team implementing standards should have a deep understanding of the concepts, but the supporting source systems teams who helps with the conversion also need to have a better understanding of the same.

Fig – 2: Complex process of Code Conversion

As represented in the above diagram, minimal/no understanding of the HL7 FHIR concepts causes lot of back-and-forth communication between the teams and can end up having no results achieved even after investing lot of time and efforts.
Even if the mappings were prepared after investing lot of time and effort, the next task is to save the mappings in the Concept Map Resource format. Manually doing this is error prone and time consuming considering the number of source/target codes. Errors in converting the source code to the right target code causes FHIR conformance errors and can give incorrect patient details which questions the authenticity of the data exposed by

the organization. We need a process which is easy, correct, and quick.

5.PROBLEM SOLUTION: FHIR MAPPER DASHBOARD UI

Instead of manually collecting the codes from various source systems and mapping them to corresponding target codes which again is selected from a list of target codes, how about digitalizing the entire process? Converting the entire process into a UI Application can make it simpler and less error prone. The effort in evaluating the imposed mappings can also be reduced by the organizations and thus helps to reduce the time to market.

Fig – 3: FHIR Mapping Dashboard

The complete process can be broken down into five steps:

1)Requesting for the source codes from source systems or the responsible teams (It will be pulled/exported from the system database).
2)Importing the source codes using the UI Application. It can either be a bulk upload/ single upload.
3)Importing the target codes using the UI Application.
4)Using the UI Application user can map the codes from a list of source-target value sets and save the mapping in Concept Map format.
5)If a specific source/target valueset is not available in the UI Application, the user can import them by following steps (2) or (3).

Now, let ‘s see how the above 5 steps can simplify the existing process:

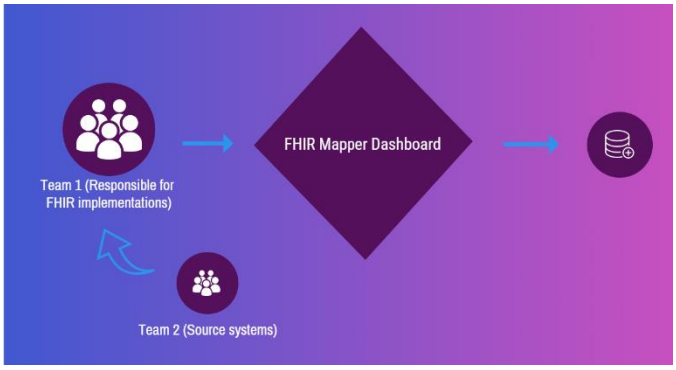

Fig – 4: Conversion via the automated process

As the readers can see the above process is linear and less dependent on other systems. It is more non-technical and organized. This solution helps us in solving all the questions (Page 5-6) that were raised while discussing the Concept Mapping approach.
Providers and Payers are imposing the CMS ONC Interoperability rules in United States and organizations are taking their baby steps to convert their data to FHIR HL7 standards. The process is in its nascent stages and proposals for digitalizing even small sections of this process can bring a great impact. The migration of code conversion/mapping from excel sheets to a UI application is going to make the process easier and manageable. The same idea can take us to a transformer which can convert data from any schema to FHIR HL7 standard data. The availability of such products in the market will not be far away.

6. TECHNOLOGY ARCHITECTURE

The technology architecture for this system consists of a User Interface Layer, Backend Layer, and mapping approval layer. The User Interface Layer can be an Angular/ReactJS application which helps the business/non-business user to pre-load the data sets and visually map the source target codes. The Mapping board allows the user to view the list of source and target codes and provides the user with an auto-complete list input which helps the user to easily select the target code for the source code.

The UI provides an effortless way for the source teams to pre-load their source codes. The application accepts excel sheets

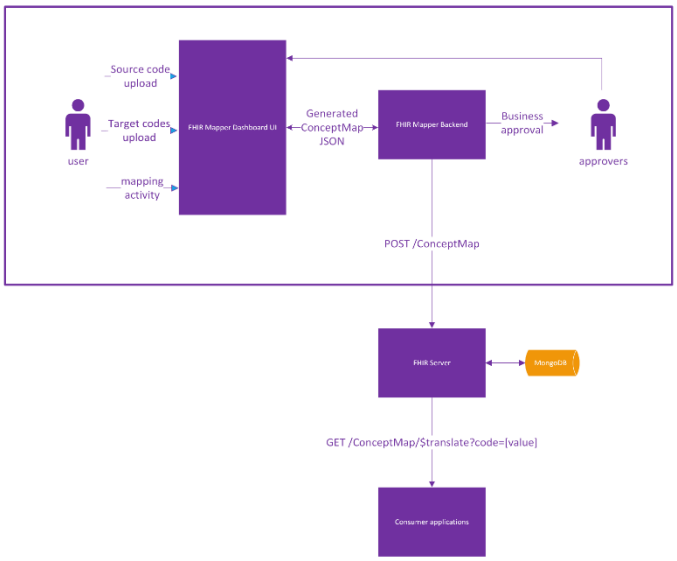

Fig – 5: Proposed Technical Architecture

for bulk uploading the source codes. User can download the template for these excel sheets from the application. The source system user does not have to worry about any FHIR terminologies and upload their codes into the system.

FHIR team can load the target codes as these are already defined in the guidelines released by HL7 FHIR. User/s can start mapping once all the source target codes are loaded in the system. Once the user selects the expected source and target system for a mapping from the UI, the request will be sent to the Backend system which will run a text mapping algorithm. This will result in potential matches that can be made and send

back to the UI. The user can review the results and update if any changes are required. The final mapping can be submitted to the system.

The submitted concept map status will be set as draft and saved to the Mongo database via the FHIR server. At the same time, an approval mail will be sent to the business approver/s. The approval mail will have link to the Mapper UI application, which the approver can use to review the mapping. Once reviewed, the mapping can be approved/rejected with comments. Rejected applications will trigger email notifications to the submitter. The submitter can work on the review comments and re-submit the mapping. Once approved, the mapping will be updated in the mongo dB as active.

All the active mappings can be viewed in the UI application. Edit or delete actions are also available for the mappings. This helps us to update the mappings in case there are any changes in the source or target codes.

Once the mappings are saved in the database, any consumer application in need of the data conversion can call the $translate API and get their source code converted to the mapped target code in FHIR standards.

7. DATA VISUALIZATION

Visualization layer in the FHIR Mapper dashboard can give insights about the Security, Audit, and other metrics related to the data translations happening in the application. Once the mappings are done using the UI, the completed mappings are sent for review to the configured approvers. Once approved, the mappings are saved in the database and gets ready to be used by any consumer systems for translation. Various kinds of metrics are captured at different points in the flow to enable the application to capture different insights. The different metrics captured are:

Security and Audit:
1)Timestamp for the concept map generation and who approved it?
2)Who mapped the codes?
3)What was the action performed on the codes? Whether it was a creation, updating or deletion?

Other metrics:
1)How many concept maps are generated, which gives us the count of legacy code systems maintained by the organization?
2)Frequency of code translations.

8. NEXT STEPS

As per the current solution, the user must manually match the source-target codes and submit them for review. Natural Language Processing (NLP) algorithms can be used to find the mappings and generate the ConceptMaps. Text mapping algorithms can be used to create the mappings. The FHIR Mapper Dashboard application can be loaded with the source and target codes. Once the data load is completed, the AI algorithm can find the matching mappings for every valueset. This makes the whole process more simple, intelligent, and easy. Approval process can still be integrated into this system, where once the mapping is done and ConceptMap's are generated, it will trigger the Approval process. The ConceptMap's can be set as active once the approval is successfully completed.

9. CONCLUSIONS

The transformation of data from different formats to FHIR Standard is one of the important requirements while building FHIR servers. There is lot of scope for digital technologies in Interoperability to streamline the process and make the process more automated and simpler. Cloud Providers like Microsoft Azure [5] is already bringing solutions to support FHIR Servers and functionalities. There are also other products available in the market like SmileCDR [6], Ellkay [7], TIBCO [8] which provides FHIR data transformation solutions. These capabilities may help us bring in trending digital technologies like Blockchain [9], AI [10], NLP [10] to be used in Healthcare Interoperability.

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