Laboratory Reports using HL7 CDA

***Abstract*- Clinical laboratory is an important domain in healthcare industry and plays a vital role in patient care. Laboratories need to communicate within or with other healthcare domain for information exchange. They use adhoc ways of communication like; telephoning mailing, emailing and local courier services. These channels of communication are either costly or inconsistent and are not reliable which results in the dissatisfaction of patient. Another problem is the persistent storage of lab reports. In real world scenario laboratory information is kept in paper document. In this paper, we propose solution of CDA. On one hand, it allows standard based lab reports to be shared and on the other hand the reports reflect the same structure required by the organization.**

I. INTRODUCTION

In this era of information technology, every industry needs to communicate within or beyond the boundaries of organization to be part of today's competitive world. Healthcare is one of the important industries and has the utmost need to adopt new technologies to do its job efficiently [1]. Clinical laboratory holds a key status in healthcare industry and the decision making about the patient disease status depends on laboratory reports. So there is intensive need to have efficient and accurate communication of these reports.

Laboratories receive specimens along with test orders locally or from remote branches/ collection points. So they need to communicate with each other to send or receive test orders or results . They use adhoc ways of communication to do this job like mailing, emailing, telephoning or messenger services [1]. These adhoc ways have maximum chances of errors and inconsistency and are not reliable sources of communication. These issues directly impact on the efficiency of laboratory services and causes serious problems for the patient and doctor.

Our system will create an interoperable environment overcoming the issues raised due to adhoc ways of communication. It will be cost effective, reliable and efficient way of communication along with the facility of labs document persistency; processable by machine and understandable by humans.

Laboratory provides services using various collection points and test centers distributed remotely. They collect the specimen in any collection point and send test order along with specimen to the central lab for desired test(s). Central lab receives the orders for tests and performs the desired tests and generates the result report to send to the desired destination. This communication during these interactions takes place using the adhoc ways. So we need an environment where labs can communicate test orders and result reports by minimizing the chances of errors and providing cost effective and interoperable communication. As we can see that most of the communication among labs occur in document format. CDA will be suitable solution for communicating test orders and result reports. CDA represent the document electronically with the essence of equivalent structure. It has many advantages over other technologies. As compared to HL7 message it is persistent while HL7 message is transient. It achieves interoperability deriving its contents from HL7 RIM. It follows XML rules and can be shown in any XML aware web browser [2]. It provides us rich structure where we can represent our contents. Special XSLT is needed to represent the contents of CDA document in human readable form. It is both machine processable and human readable. For security and reliability purpose the document must be authenticated. So HL7 CDA provides us such a standard that provides us interoperability, human readability, wholeness, potential for authentication and stewardship due to which it is the best solution for communication among labs and it also provides the foundation stone for Electronic Health Record (EHR).

II. CDA AND LABORATORY REPORTS

CDA CONCEPTS

The root element of a CDA document is <ClinicalDocument>. It consists of two parts CDA header and body. CDA body contains report data and CDA header contains metadata about the document. Different parts of header and body are related contextually e.g., the author identified in the header will be the author of the whole document, but we can also explicitly identify a different author on a section [3]. The header identify; who is the sender and receiver of the document, to whom it is generated, when it is generated, some personal information about one to whom the document is generated, who is responsible to legally authenticate the document, all those who have participate in this document, what is the order and other document related to this document, and many more.

Body of the CDA document is surrounded by <StructureBody> element. It contains original data to be transfer in between sender and receiver. CDA document body is composed of different section and each section is enclosed in <Section> element. The section contains title of the section enclosed with <title> elements and data for human readability to be rendered by means of XSLT in this case. The XSLT is applied to only those elements of CDA document, which

are authenticated and needed to be rendered. There is no need to render the element contain machine processable data. A CDA Refined Message Information Model (RMIM) is composed of so many logically related classes, but we will select only those classes required in specific report generation. Basically all RMIMs are derived from HL7 RIM but they are refined further. Like HL7 RIM CDA RMIM is also composed of six backbones classes [3]. Different logically related classes are selected from these RMIM classes to design a Clinical Document.
In order to generate CDA document data is loaded from database tables and mapped to CDA RMIM.

LABORATORY REPORTS AS A CASE STUDY

In this section we will take as an example one sample laboratory reports and subsequent sections discussion is based on this report.

We have selected a report produced for the Hepatitis B Surface Antigen and Anti H.C.V Antibody. This report contains the *name* and *id* of the patient, *gender*, and *referral doctor*, *test names*, *observed values*, *reference values*, and *remarks*, *method used* for test, *machine used* and its *company*. This all information is presented in a well mannered and attractive style so that it can be easily interpreted.

MAPPING OF LAB REPORT TO CDA RMIM

Before generating the CDA document the information covered in laboratory report is mapped to CDA RMIM. Some information will come in the header of the document. In our case study the *name*, *gender* and *id* of patient, *referral doctor*, *title* of the document and *date*. Some information is the part of the document body and to be mapped to the body component of the document. Information about the *test names* their *observed values* and *reference ranges*, *method used*, *machine used* and its *company*. Body has different components and each component can have one or many sections. So the information is mapped to the related section of the body.

III. PROPOSED ARCHITECTURE

CDA MAPPING, DOCUMENT GENERATING AND TRANSPORTATION ARCHITECTURE (CMDGTA)

The proposed architecture is shown in figure 1.

CDA DOCUMENT ENGINE

The CDA Generator is responsible for generating CDA XML document and CDA Parser is responsible to parse and check the validity of the CDA document. Generation and parsing of the CDA document is done through Java SIG API

CDA MAPPER COMPONENT

CDA Mapper map data from data store tables to the related classes of RMIM. At the receiver side CDA Persist layer is called to persist CDA XML document to Data store.

TRANSPORTATION COMPONENTS

Using web services [4] the CDA document is exchanged between healthcare systems. Web services will be exposed on both sides of communicating system and CDA document along with the XSLTs is transmitted. XSLT is used to display CDA XML document in human readable form. A single document can be display in different form according to the requirement with different XSLTs designed for this document. Web services technology are built on SOAP protocols with WSDL format in XML form and send it over http, https or TCP.

IV. TEST REPORT SCENARIO

Figure 2 shows the test report scenario in graphical form. Lab A sends specimen to Lab B in order to perform tests for these specimens. The laboratory technician performs tests on specimen and sends report to Lab A.

Initially Lab Technician performs tests and stores the information into a local database. After storing the information into local database she/he felt the need to communicate the information with Lab A in order to inform him about the specimen test result. She/he needs a standard format for communicating the information that can be easily interoperable at the receiver side. The proposed architecture fulfills the needs of labs to communicate in standard way.

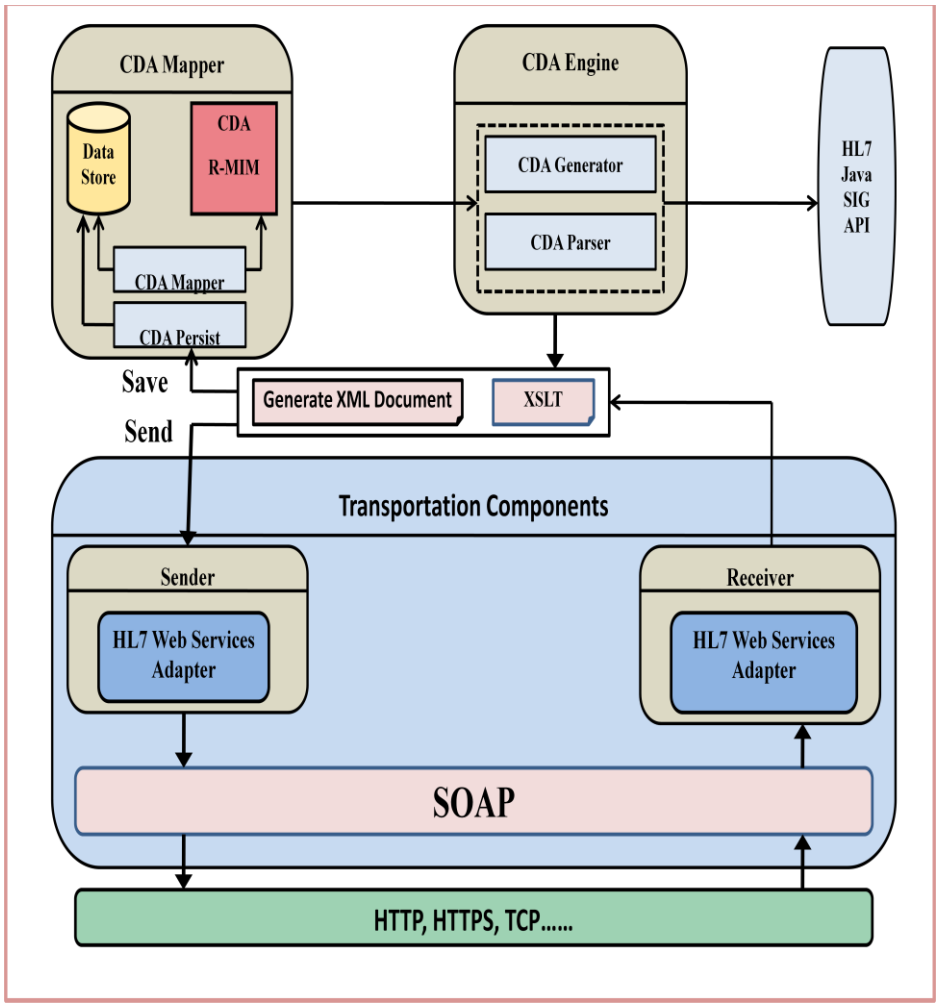

Figure 1: CDA Mapping, Document Generating and Transportation Architecture

First the desired data is loaded from required database tables and mapped to CDA RMIM using Mapper component and then send the mapped information to CDA Engine which generate CDA XML document by invoking HL7 Java SIG API. An XSLT is attached with this document which displays the document in human readable format. The document is viewed by calling CDA Viewer which displays the document.

The HL7 Web Adapter is used for sending the generated XML document to Lab A. The Lab A receives the document and performs necessary action on it. At the receiver side the document is parsed through CDA Engine by calling HL7 Java SIG API. The Lab A calls the specific XSLT to display the document and persists the whole CDA XML document to database. At the persisting time some attribute from the header of the CDA document are removed e.g. information needed for the transpiration of the document.

V. Implementation and Deployment Strategy

This application system is developed in Java using NetBeans IDE 6.7.1, Rational Unified Process (RUP) [5], [6], and XSL as style sheet language to develop XSLT for XML CDA lab report document. We developed a CDA core engine which generates the needed structure of report in XML format using interface of HL7 Java SIG API. The same Java SIG API interface is used to parse the CDA XML lab report document in order to form CDA RMIM object. A CDAMapper layer is generated which maps data from related tables of database to CDA RMIM classes.

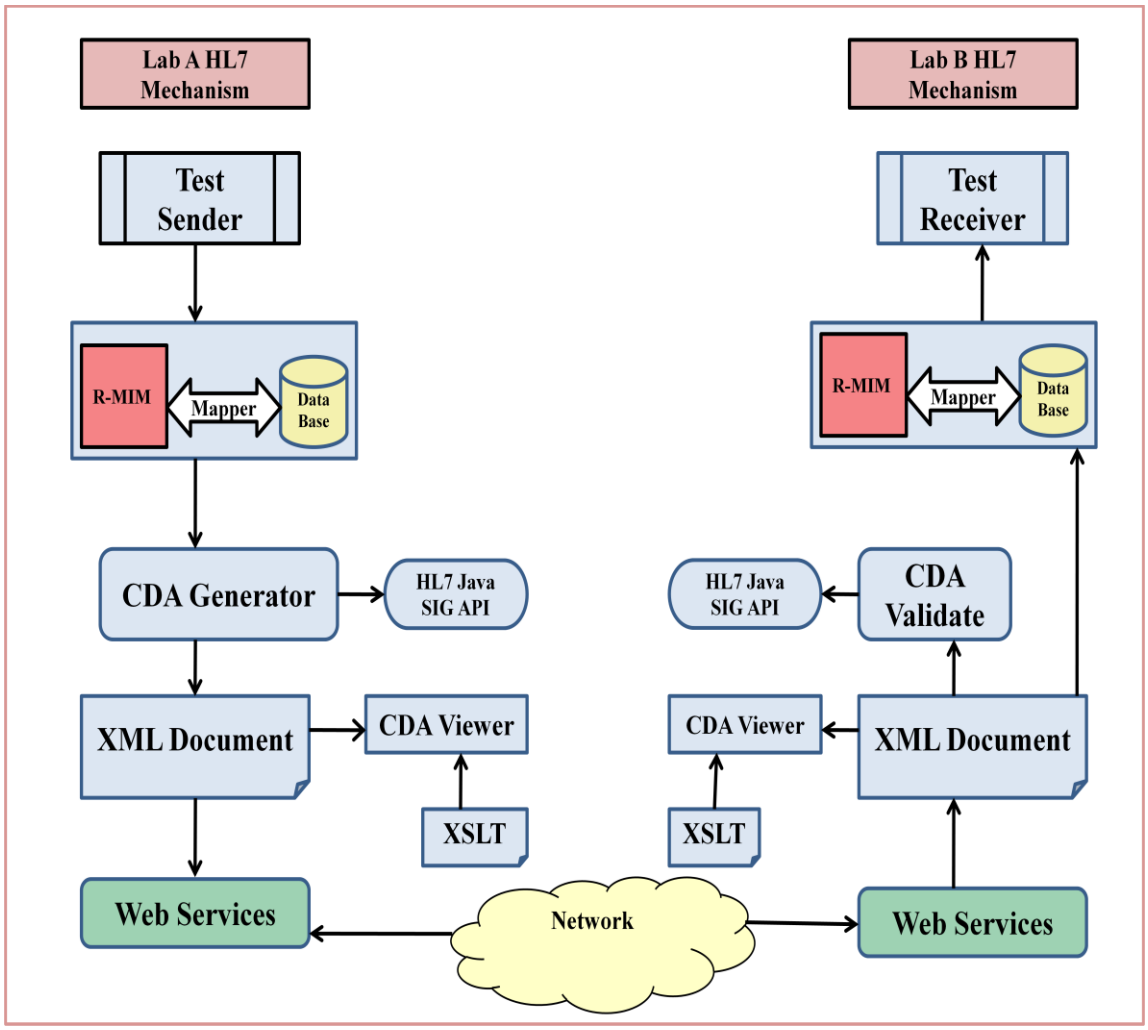

Figure 2: Test Report Scenario

In order to display this CDA XML document in human readable form a special XSLT is designed which is transfer along with this document. Multiple XSLTs are design to display a single document in different formats depending upon the requirements. We have defined tables in database to store xml documents and XSLTs.

A table having two columns the cdaid as a primary key and cdadoc, id column stores the id of document and cdadoc column stores the xml document. another table having three columns *cdaid* as a foreign key, its own *id* as a primary key and *XSLT* to store the XSLT document.

VI. Conclusion and Future Work

In this paper, we presented our proposed architecture of an application based on HL7 CDA for clinical laboratory reports. We have explained its different components their functionalities and implementation techniques. CDA mapper is used to map the data from database to CDA RMIM. CDA generator generates the document and web services are used for the transportation of documents which gives us the platform and language independency. The most important is that documents are stored natively in xml format in the database due to which we can use these documents in future. Our system assures the generation, persistency and exchange of documents.

The proposed architecture is extensible with minimal efforts so our vision is to extend our work to the other domains of healthcare like patient administration and pharmacy. We aim to make it open source so that it can be available for the whole community.

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