Message Exchanging Model for Hospital Information System

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Abstract

Hospital information system is based on information exchanging. XML provides a means for effective communication to interact between systems. As HL7 v3 is based on RIM and XML ITS, a message from definition of HL7 v3 enables a computer to capture meaning and structure of the documents. We aim to develop effective information exchanging model using XML based on HL7 v3. In this paper we describe (1) how to deal legacy database systems with XML and HL7 messaging format, (2) how to generate messages, (3) how to communicate by exchanging a message, and (4) what is strength and weakness of this approach.

Keywords:

Hospital information system; HL7; XML; Information exchanging model

Introduction

Hospital information system includes office management, finance, scheduling, and materials management. It also allows communication between doctor and other medical personnel, and includes medical and billing information on patients. Hospital information system is based on information exchanging. In this paper we are focusing on effective information exchanging model to improve the system ability. From the technical point of view, we consider XML and XML related technology. Also HL7 version 3 was chosen as prime methodology, because it has several good points to develop healthcare information system. Firstly HL7 v3 has been developed by adopt an object-oriented approach using UML. HL7 v3 messages are modeled using Reference Information Model (RIM) as the methodology and tools. The RIM represents relevant data classes in healthcare for which information must be available for and processed by professional, and the mutual relationships between such data classes. So we can reuse core object (e.g. management for CMET-Common Message Element Type), it makes to increase actual output and to simplify implementation. Secondly HL7 v3 has adopted XML for its ITS (Implementation Technology Specification). As XML is well-formed document format, it can be easy to be parsed and managed. XML can be simply serialized through HTTP, SOAP, TCP/IP etc. Because HL7 v3 is being developed by technical committee, we consider the latest version (committee level 3) ballot format. In this paper we aim to develop effective information exchanging model using XML based on HL7 v3. We describe (1) how to deal legacy database systems with XML and HL7 messaging format, (2) how to generate messages, (3) how to communicate by exchanging a message, and (4) what is strength and weakness of this approach.

This paper is organized as follows. In next section, we shall discuss the related work. Then, the design of message exchanging model and characteristics about our approach will be followed, finally we will conclude.

Related work

Some researchers have already attacked a few problems of XML based healthcare information system [2,3,4]. While examining some existing approaches we have noticed certain differences in solving problems.

- Existing research [2] was focused on referral system, [3] developed a disease specific systems. [2] presented methods to structure and represent patient care records, design mechanisms for interpreting and integrating the XML-based medical record in referral system domain. [3] developed a strategy that should ease the access to the system in the environment of existing systems. They used XML to communicate with API-like services and created a WWW environment to demonstrate the access to these services.
- Another research [4] proposed XML schema representation of DICOM. They described the document type definition (DTD) for representing DICOM SR as XML documents. Then they provided how to create and validate against the schema using the existing DICOM SR specification.

Although existing researchers developed XML based system, they concentrated on one specific domain. To develop a hospital information system, it should be considered a general system model to integrate the entire domain. We consider a strategy that support a standard common communication interface, ease the access to the system in the environment of existing systems, and follow the workflow of the hospital system. In the next section, we describe the design of information exchanging model.

Design of message exchanging model

From the whole system framework, we have extracted the most representative modules : (1) message generation process, (2) transport process, and (3) receiving process. From one process to the other side, it happens to exchange hospital information as XML document format. Internally,

the composed sub-modules interact by following HL7 v3 domain guides. Figure 1 shows the model of message exchanging.

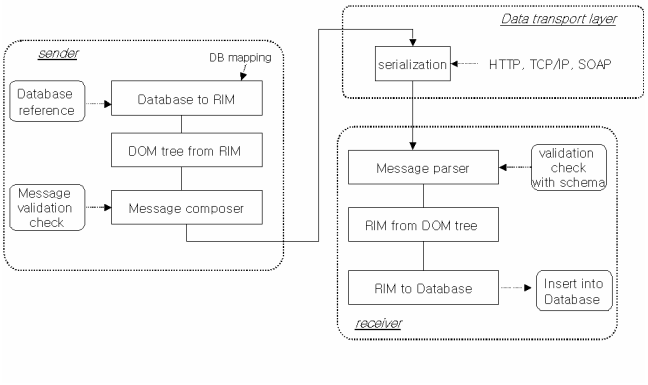

Figure 1. Message exchanging model

The first process is composed of referring a legacy database, converting to RIM, making DOM tree and creating a message. This process aims to create a XML message based on HL7 v3. To start, it references legacy databases and retrieves data. If necessary information is scattered over many databases, it can be possible to look up several databases to generate RIM object. From generated RIM objects we represent it as DOM tree. Data from database is added in this module, then encode with XML tag. To compose a message, it needs to check validation with HL7 v3 message schema. Figure 2 shows the detail process to create a message and results XML document.

Summary is as following.

- Generating a logical RIM object model from legacy databases.
- Creating a DOM tree from the RIM object.
- Composing a message based on RIM object and data, and then checking a message validation.

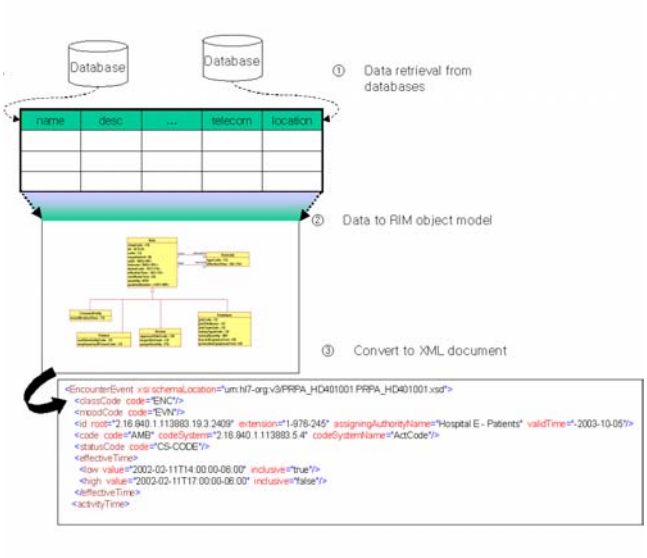

Figure 2. The first process : to create a message

The second process is to transport a message. It aims to send a message to receiver safely. It means that message should not be damaged. And a message should be transmit rapidly and correctly. To send a XML document, it can be used some transport mechanisms, such as e-mail, FTP, HTTP, SOAP, TCP/IP. However, in our system we consider HTTP, SOAP, TCP/IP with the exception of e-mail and FTP. E-mail and FTP are also data transport mechanisms, but it is not fitted with our system. Traditionally to communicate with XML document, SOAP or HTTP is commonly used. SOAP (Simple Object Access Protocol) provides a flexible mechanism for extending a message in a decentralized and modular way without prior knowledge between the communication parties [5]. All SOAP messages are encoded using XML with SOAP envelope structure. The most important point is that SOAP can support to create an instance of platform independent component, RPC (Remote Procedure Call), and use HTTP 80 port regardless of firewall. In the same way, we can transport SOAP package using HTTP POST[6,7]. SOAP naturally follows the HTTP request/response message model providing SOAP request parameters in a HTTP request and SOAP response parameters in a HTTP response. However, that SOAP intermediaries are not the same as HTTP intermediaries. That is, an HTTP intermediary addressed with the HTTP connection header field cannot be expected to inspect or process the SOAP entity body carried in the HTTP request. And HTTP applications must use the media type “text/xml” when including SOAP entity bodies in HTTP messages. TCP/IP is commonly used as peer-to-peer communication. In this case sender and receiver conform to the same port number. Now we describe the data transport process. In order to support an interaction, HL7 v3 provide two kinds of application role, trigger event and message schema. If some trigger event happens, sending application sends a message to receiving application. The message is created by the first process, and then transported through TCP/IP, SOAP or HTTP. Because

the interaction is defined in domain area of HL7 v3 package, both sides (sender and receiver) are built as following it. Figure 3 shows the data transport process.

Figure 3. The second process : to transmit a message

Summary is as following.

- In our system, we consider TCP/IP, SOAP or HTTP as transport protocol, but SOAP and HTTP is more useful when XML messaging. TCP/IP is common protocol to support peer-to-peer.
- HL7 v3 define an interaction, which is composed sending application role, receiving application role, trigger event and message schema. To communicate with v3 message, sender and receiver must follow the interaction.

Next is the final process. When a message is created and transmitted to receiver, it unpacks a message from the transport layer. This is starting point. Message is sent into message queue and handled according to the order. The next step is to parse the message. As this is XML document, we can remove the XML tag and parse the encoded domain content using XML parser to create the DOM tree. Then receiver interprets the DOM tree, builds a RIM object, and retrieves the data from a RIM object. However, in order to store it into database, some information about the databases is needed and reflected. We call this process database mapping, which is to connect data object with database. After database mapping, all dataset is stored in database. Figure 4 shows the receiver process.

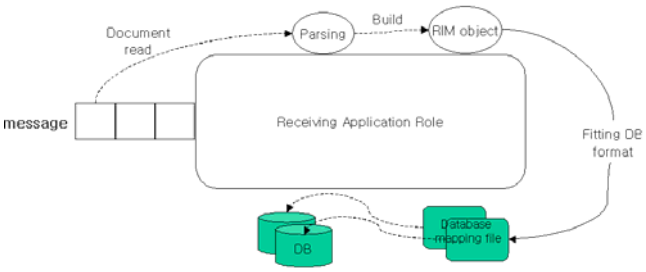

Figure 4. The third process : to parse the message

Summary is as following.

- When a message is arrived to receiver application, it unpacks and parses the message. It means that receiver eliminates the XML tag and creates a logical RIM object.
- To input data into the databases, receiver connect data object with database.

In this section we describe the details of the message exchanging modeling. From the technical point of view, we focus on XML messaging based on HL7 v3. This approach brings some characteristics. In the next section we shall discuss the strength and weakness.

Characteristics of the XML messaging based on HL7 v3

XML and the related techniques make it easy to integrate the different systems, communicate, and build documents. The integration of standard messaging is an important aspect since the degrees of freedom for the application of XML is very high. From the HL7 v3 message development methodology [1,8], the core function can be reuse. Since all domain messages are built with CMETs (Common Message Element Type), they are reused in all domains. Therefore we can reuse the core process module of managing domain messages such as message generation or validation check. Figure shows the messaging structure in HL7 v3.

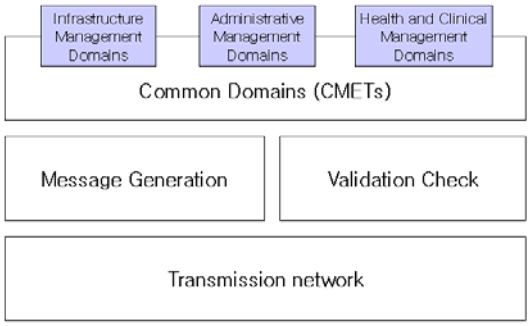

Figure 5. Messaging structure in HL7 v3

In HL7 v2.x, parsing and validation check is not easy, because a message has many optionalities, and it is not well- formed format unlike XML document. Also it is difficult to read and understand what it means. HL7 v3 solve it by using XML messaging. XML documents can be generated, parsed more easily, and transmitted through various protocols.

But it has a problem to access and store in database. Because most of hospital databases are relational database system, in order to store XML document into database, it must be divide document into data and XML tag. If it is native XML or object-relational database system, managing XML document is easy.

Another problem is about XML document size. If many documents are transmitted at a time, network problem can be caused. Therefore we should be considered the XML documents compression to prevent it.

Conclusion

In hospital information system, using XML provides a means for effective communication to interact between systems. As HL7 v3 is based on RIM and XML ITS, a message from definition of HL7 v3 enables a computer to capture meaning and structure of the documents. Currently computer and communication technology advances, and the population of the WWW (World Wide Web) is booming. Therefore, the XML-based messaging can be easily identified, verified and transformed from one system into the other system on the WWW. In this paper we describe how to generate, transport, manage a XML-base HL7 message. For future work, we will develop details of this modeling system and apply it to reality.

Acknowledgments

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