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A WEB-BASED HL7 VALIDATION SYSTEM ARCHITECTURE

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This paper describes the design for HL7 validations; although the electronic data exchange standard of Health Level Seven(HL7) has been presented more than a decade, health organizations apply the standard of data transfer only in these few years with little experience. Because the quality of the hospital information system (HIS) varies in each institution that whether the transmitted data match with the standards completely or not. If there is any mistake in the exchanged data in hospitals, it will cause problems to the whole information system as well as to patient records for management. As computer technologies are using rapid processing to speed up the electronic medical records (EMR) and increasing the use of electronic data exchange (EDI) in health organizations. To fulfill the requirement it is necessary to have a validation mechanism to verify the integrity of the data before data exchange. In this paper, we introduce the method of designing a web-based validation system. This method may accept and parse HL7 messages and warn the errors in segments, sequences, required fields, field length, components, data types and valid values.

Keywords: HL7, Validation, EMR, EDI, HIS.

1. Introduction

The fast growth of the information and communication technology has speeded up the innovation of clinical information systems. More and more patient records, laboratory reports, pharmacy drugs, financial and health insurance data are transferred through computer networks [1][2]. Electronic data exchange among systems may save time and reduce cost by eliminating redundant data and typing errors. HL7 was founded in 1987 to develop standards for the electronic data interchange in the health care domain. The term "level 7" refers to the seventh layer of the Open System Interconnection (OSI) model. HL7, which is an abbreviation of Health Level Seven, is a standard for exchanging information between medical applications. This standard defines a format for the transmission of health-related information. Information sent using the HL7 standard is sent as a collection of one or more messages, each of which transmits one record or item of health-related information [3]. The application level addresses the definition of the data to be exchanged, the timing of the interchange, and the communication of certain errors to the application [4][5].

The computer network systems must meet to allow for standard-based communication between heterogeneous health care applications [6]. The correction and integration of data exchange is very concerned by healthcare organizations. Should there be an interchange of error information, it will make the whole information system unreliable. A validation mechanism to verify health information over network is needed. However it is difficult to find any similar service for HL7.

The goal of this system is to check the electronic healthcare data transfer in the network, and see if they are valid and compliant to the standard. The prototype of the web-based system is ready for accepting and parsing the HL7 message to perform the validation service. The results may be viewed from browsers via Internet. In this paper, we report our work on the system design.

System Architecture

The architecture of the HL7 validation system includes four Modules that are message parser module, database module, data validation module, and I/O interface module.

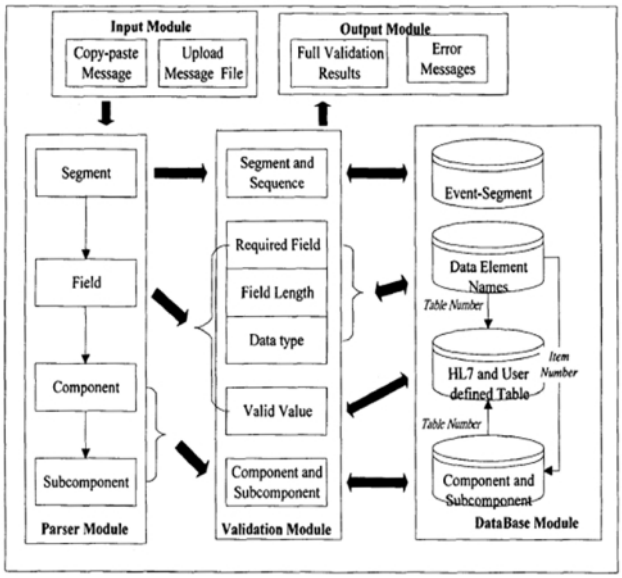

Fig. 1: Validation System Architecture

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The system diagram is shown in Fig.1. Each module has different functions and is introduced in the following.

2. HL7 Message Parser Module

A HL7 message is the atomic unit of the data transfer between two systems. It is comprised of a group of segments in a defined sequence. The segment terminator is a carriage return (Hex OD). A segment in the HL7 is a logical grouping of data fields. Each field is separate by a "|". Some of the fields can be broken into components or sub-components. The delimiters "^" and "&"" are used as the separators between components or sub-components [7]. To parse the HL7 message, the system reads the message text character by character, judges whether it is a datum or a separator, and distinguishes the value of each datum element.

3. Database Module

In order to simplify the validation program design, a database system has been used to manage the HL7 definition data. There are four tables in the database, including event-segment table, data-element-name table, HL7user-defined table, and component table.

A. Event-Segment Table

This table saves all of the information of segments used in each message, detailing the segment sequences, the required segments, the optional segments, and the repeatable segments.

For example, the ADT Event A01 is expressed as

MSH, EVN, PID, [PD1], [{NKI}], PV1, [PV2], [{DB1}], [{OBX}], [{AL1}], [{DG1}], [DRG], [{PR1, [{ROL}]}], [{GT1}], [{IN1, [IN2], [IN3]}], [ACC], [UBI] , [UB2].

Segments between square brackets [ ] are optional, and those between braces {} are repeatable segments. There are about 380 records of events, acknowledges and responses in the HL7 the table.

B. Data-Element-Name Table

The data-element-name table contains the field information for each segment. The field information includes the data element name, its affiliation to a particular segment, the sequence number in the segment, field required or optional in the segment, data types, maximum field length, and the relation table number that the field value is defined. There are about 1500 data elements in this table. Each data element is assigned an item number.

C. HL7 and User Defined Table

HL7 defines codes or values for some special fields, like sex and marriage status, and presents them in tables. There are around 1400 records in 280 tables. The database collects the table number, table name and value information. In case that the table value is different from institution to institution, HL7 notes No suggested values I' and reserves the space for on-site definitions.

D. Component Table

In order to make component and sub-component check, we create a component table. It contains the component name, data type, sequence in the data element, table number of each component and sub-component, and the connection between the data-element-name table and the item number. There are more than 6000 records in this table.

All the tables are established by following the definition of the HL7 document. Among them, the data-element-name table and HL7 User defined table are collected in the appendix of the document and can be incorporated into a database directly.

4. Data Validation Module

A data validation module is the kernel of the system. It compares parsed data with those in the database, including required segments and its sequence, required fields, field length, data types. It also checks the validity of the data values [8]. We describe each function in the following:

A. Segments Validation

In the HL7 message, the first three characters of each segment string are the segment ID. Segments of a message may be required or optional. They may occur only once or may repeat several times.

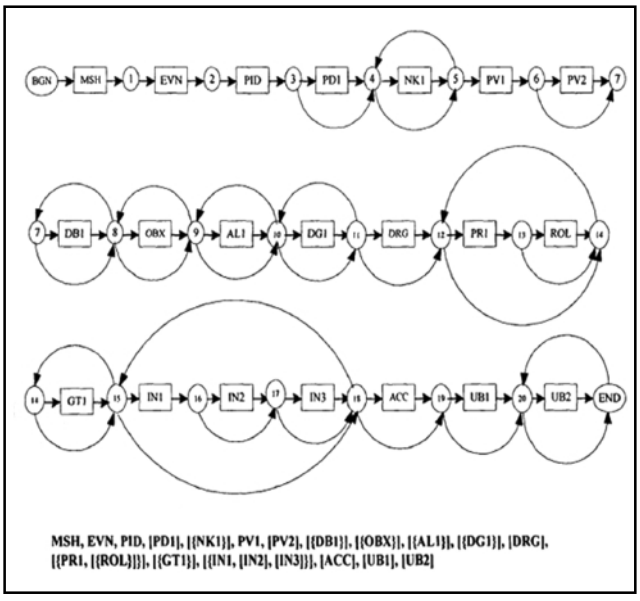


Fig. 2: The HL7 State Transitions Diagram of ADT-A01

For each event, the system will read the message definition from the database and generate a state transition table as shown in Fig. 2 and Table I. Then it traces segment IDs with the table step by step. The absent and out-of-sequence segments will be checked.

B. Required Field Check

Some of the fields are required and others are optional in the segment. The value in the optional fields may be omitted and only retain separate delimiter between adjacent fields. A separator can also be omitted if no field is behind it. The data-element-name table in the database has a column record that determines if the field is required or optional. The system checks for each required field and shows error messages if the value is a null or the fields are absent.

C. Field Length Check

HL7 has defined maximum length for each field. The information is saved in the data element table. The system checks the character number for each field and gives a warning message if the character number exceeds the saved value. The HL7 document emphasizes that the maximum length is not of conceptual importance in the abstract message or the HL7 coding rules [7].

Table 1
State Transition Table

State	Option 1	Option 2	Option 3	Option 4
0	MSH			
1	EVN			
2	PID			
3	PDI	4		
4	NK1	5		
5	– 4	PV1		
6	PV2	7		
7	DB1	8		
8	–7	OBX	9	
9	–8	AL1	10	
10	–9	DG1	11	
11	–10	DRG	12	
12	PR1	14		
13	ROL	14		
14	–13	– 12	GT1	15
15	–14	IN1	18	
16	IN2	17		
17	IN3	18		
18	–15	ACC	19	
19	UB1	20		
20	UB2	21		
21	END			

D. Data Type Check

HL7 defined the data type for each field. There are more than 30 data types. For example, ST is string, NM is numerical, and DT is date. Some fields composed by many components also have their data types. The numerical data type can only contain an optional leading sign (+ or –), the digits, and an optional decimal point. The system checks each character and ensures that it is digital and its field length must be 4, 6 or 8. The system does not check the field data type and only checks its component data type if components exist in a field.

E. Data Value Check

HL7 defines a table of values for some fields, such as sex field. The code in the sex field must be M(male), F(Female) or U(unknown). The system will check the content of fields from corresponding tables in the database by connection through the table number. If other values are present in this field, the system will show an error message for the invalid values [9].

F. Component and Sub-component Check

Some fields consist of many components or sub-components. The system separates these fields into fundamental elements and checks their data type and valid values. The methods are similar to the field validations.

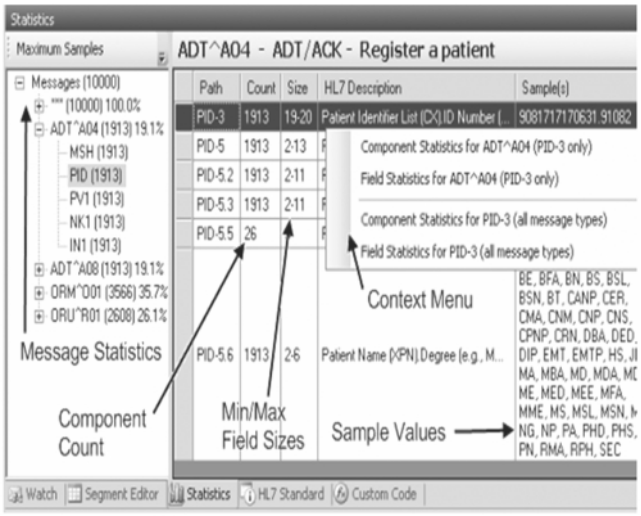
5. SYSTEM INTERFACE

The system user interface is applied to a web browser. The HL7 message can be sent to a server by using.

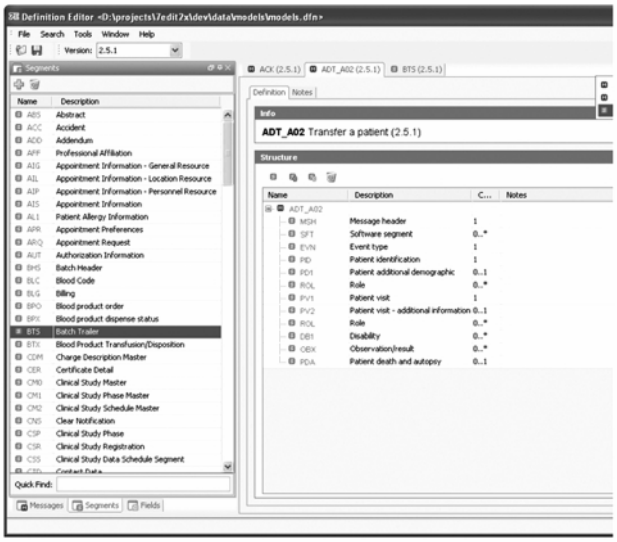
Copy-paste functions to a text box in a computer screen or be treated as a text file [9]. The processing results are displayed in the screen. Users may select only error messages or all of the validation results in the output. When all result is selected, it displays all of the information including segments and fields names, sequences number, values and field length in the screen with a table format. The system can distinguish the following data: error, warning, checked and correct, checked with no error.

Tools

1. HL7Spy: One of the most complex aspects of configuring, and maintaining, healthcare applications is interpreting the semantics of the data being exchanged. HL7Spy has been designed to help HL7 analysts and programmers quickly interpret, and characterize very large HL7 message streams [10].



2. 7Edit: It is productivity Tool for browsing, editing and validating HL7 messages and exchanging data with HL& applications [11].



6. DISCUSSION AND CONCLUSION

The requirement of developing a validation system is stricter than a general application system. The system should be capable of monitoring any interrupt from improper input data, exchange between information systems and listing all of the possible errors. The system compares the user input data with HL7 standards in the database. It is very important in database correction. There are a lot of character comparison works in the validation system. Sometimes, the system has to take care of the lowercase and uppercase problem. For example, the segment ID is defined with uppercase letters. Once the segment ID is keyed in with lowercase letters in the input data, the system sends out an alarm with a warning message and makes special treatments to continue other validation works. The system is ready to provide HL7 version 2.3 validation services in the Internet. Besides supporting the electronic medical record data interchange, the system may be used to educate the students in medical informatics to understand and get familiar with the HL7 standard. This can also be used to share HL7 techniques with other hospitals to design and implement the HIS system for further use.

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