# HL7 Messaging Engine with Customizable Translation System

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***Abstract* — This paper introduces a new client-server messaging engine used to exchange clinical data between various medical software applications. Our portal uses the HL7 (Health Level Seven) messaging standard to provide translated clinical data to HL7 and non-HL7 client applications. We used HL7 because this standard is worldwide used to facilitate the communication between clinical applications.**

***Index Terms* — Medical services, HL7, Client-server systems, Data communication, RFID**

## I. INTRODUCTION

Many errors in health care relate to lack of availability of important patient information. The use of information technology (IT) and electronic medical records (EMR) holds promise in improving the quality of information transfer and is key to patient safety [2].

Let's suppose the following scenarios: somebody that has a chronic disease travels overseas and has an unexpected crisis or somebody else has a serious accident and is unable to communicate with people around him. Both of them will get hospitalized and the medical staff will quickly need essential data about them, like: blood type, chronic diseases status, allergies and so on. Because the first patient doesn't know the foreign language of the country he traveled to, language barriers can obstruct access to health care. Because of his condition, the second patient cannot provide the information required by emergency doctors that are trying to help him. Our research lead to one solution to these problems that uses two modern technologies: HL7 messaging standard and RFID tags [5].

Our system architecture includes some server applications (HL7, WEB and SQL) that can be used by medical software applications to exchange clinical data. We used HL7 because "is the most widely used standard to facilitate the communication between two or more clinical applications" [1].

Also, the system uses RFID technology that can provide a number of benefits to the healthcare industry. By attaching RFID tags to different entities in healthcare industry (people and objects), RFID technology can provide some capabilities, such as: identification, tracking, location and security. These capabilities directly affect the major issues currently experienced by healthcare organizations while helping to drive down costs [6].

This paper is organized as follows. In this first section we justify our choice of our HL7 portal development. In Section II we introduce the major concepts of HL7 Standard. Section III presents an overview of our HL7 portal. In Section IV we describe the major HL7 portal facilities. The next section describes how HL7 data is interpreted and translated. Section VI focuses on different testing methods for our HL7 portal and its impact on the quality factors of the integrated system. Finally, we end with some conclusions and future developments.

## II. THE HL7 STANDARD

What is HL7? HL7 (Health Level Seven) is a non-profit organization that is a global authority when talking about interoperability of health information technology. HL7's more than 2,300 members represent approximately 500 corporate members, which includes more than 90 percent of the information systems vendors serving healthcare [3]. Besides this HL7 "is a standard series of predefined logical formats for packaging healthcare data in the form of messages to be transmitted among computer systems" [4].

Why HL7? Because "HL7 is the most widely used standard that facilitates the communication between two or more clinical applications. The prime benefit of HL7 is that it simplifies the implementation of interfaces and reduces the need for custom interfaces. Since its inception in the late 1980's, HL7 has evolved as a very flexible standard with a documented framework for negotiation between applications. The inherent flexibility makes deploying HL7 interfaces a little more challenging at times." [1].

The HL7 messages are in fact clinical information and not only collections of data used to send information about some events in some healthcare enterprise.

Originally developed in 1987, HL7 Version 2.x is now in use in more than twenty countries around the world. It contains messages for almost every conceivable healthcare application area, including the following: registration, orders (clinical and other), results and observations, queries, finance, master files and indexes, document control, scheduling and logistics, personnel administration, patient care planning, network synchronization, laboratory automation [4].

In order to acquire all these, the HL7 standard includes: conceptual standards: RIM (Reference Information Model), document format standards: CDA (Clinical Document Architecture), clinical application standards: CCOW: (Clinical Context Object Workgroup) and messaging standard.

## III. HL7 PORTAL OVERVIEW

Our research team developed a distributed RFID-based system for patients' identification and monitoring, called SIMOPAC ([8][10]).

We consider a Personal Electronic Identity Card (CIP) as an RFID tag which stores relevant medical information related to the person who wears it. This CIP is used to allow the timely patient identification and expedite access to his relevant medical information.

Thus, in conjunction with SIMOPAC, this card may facilitate access to more detailed patient records visualization. We consider agents [9] that cooperate with each other in order to manage the information flow between local EMR database applications and HL7 message templates. As a result, SIMOPAC can improve the continuity and quality of healthcare with significant decrease of adverse drug events or other medical errors.

The main objective of the HL7 portal is safe and standardized communication between aware and non-aware HL7 applications and SIMOPAC system modules (Fig. 1). Other objectives that we had to accomplish are:

- easy integration with other modules of the system like: plug-ins, PDA software, software agents;
- compatibility with Linux, Windows 7/XP/2000 and Windows Mobile operating systems;
- safe data exchange using HL7 CCOW standard authentication and encryption algorithms.

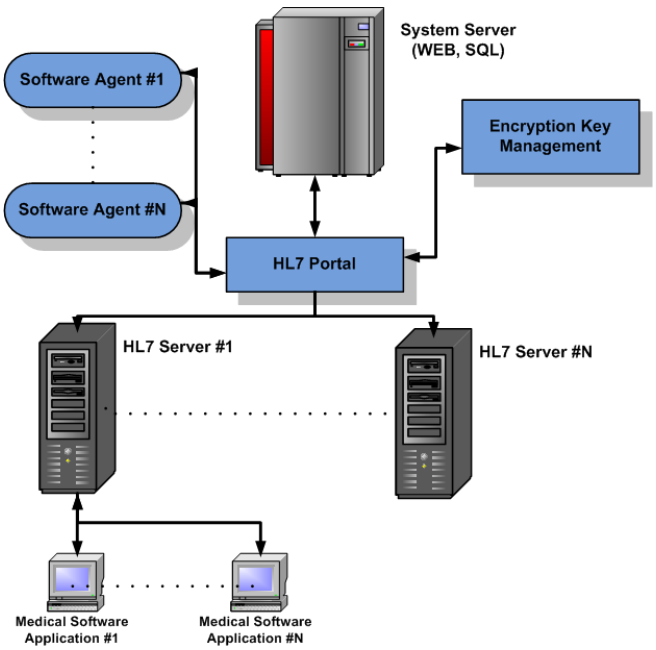


**Figure 1.** HL7 Portal integration.

The HL7 Portal should provide a secure and sustained flow of medical data between various modules of the system even if they support or not the messaging standard. The modules we developed for this portal are (Fig. 2):

- Medical Data serving module: HL7 V2/3 messaging which provides standardized communication between system's modules and also with external medical software applications. This module can be integrated anywhere HL7 data messaging is used. The design and the implementation of this sub-module are compatible with Windows 7/XP/2000, Linux and Windows Mobile operating systems. Also it will provide, at request, additional clinical data, other than what the RFID tag contains, when needed;
- Authentication and data encryption according with HL7 CCOW, and so providing the necessary confidentiality elements regarding the flow of medical data. This sub-module works only with HL7 aware applications;
- Login and transfer module that uses HL7 V2 messaging in order to transfer clinical data between external HL7 servers and SIMOPAC applications. Operation of this method involves creating a TCP/IP socket connection that will connect to another socket (IP address: port) on a server, and so providing the medical data flow. Typical connection used is HL7 LLP (Low Layer Protocol);
- Data interpretation and translation module which is the heart of the portal;
- Encryption key management which keeps and distribute all the keys inside our software system and also provides safe exchange of keys between the system's modules. Also this sub-module keeps and distributes authentication and encryption algorithms types used by every module by each partner module/external application.

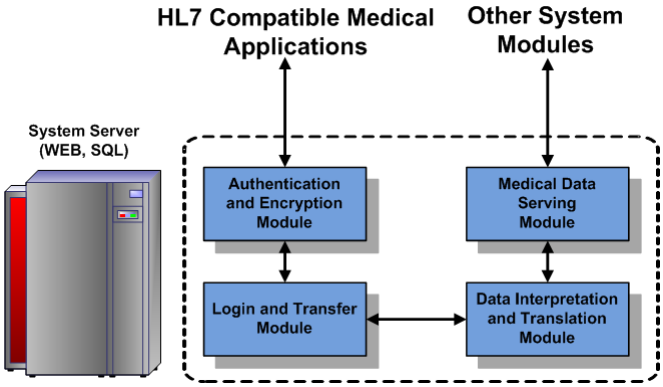


**Figure 2**. HL7 Portal Architecture.

## IV. HL7 PORTAL FACILITIES

The main requests covered by the HL7 Portal are:

- compatibility with Windows 7/XP/2000 and Linux operating systems;
- use of HL7 connection and authentication standards;
- acquiring clinical data regarding patients using safe HL7 connections;
- encrypted exchange of data in all cases;
- translation of HL7 formatted data as close as possible to the natural language;
- the system architecture allows an unlimited set of languages, as long as they use standard ASCII characters;
- ensuring connection and authentication of an unlimited number of concurrent client applications that can request data about patients from HL7 medical data servers;
- supported command set designed to provide complete support for obtaining relevant medical data;
- storing all connections, received commands and answers in an encrypted log file.

## V. DATA INTERPRETATION AND TRANSLATION MODULE

This module provides the following features:

- allows the interpretation of clinical data in different languages;
- allows users to customize interpreted messages;
- new languages can be dynamically added and then used for data interpretation;
- execute commands received from client applications and returns the corresponding clinical data if any;
- allows connections from an unlimited number of clients.

The operation of this module involves completion of the following steps:

- read the *languages.txt* file that contains all supported languages;
- read all the files used in data interpretation in different spoken languages and data initialization for each of them (Fig. 3);
- create a TCP/IP server socket where potential external application can connect;
- wait for connections and create one server socket for each client;
- reply to received messages from each client and returns requested data using the appropriate foreign language;
- disconnect the client at his request and destroys the corresponding thread/socket pair.

The *languages.txt* file is used in order to find out the available interpretation languages. Thus, this file contains each available interpretation language identified by its name and indicates the associated language abbreviation used to find the specific files. For example the *languages.txt* file can contain: English (en), Francais (fr), Romana (ro).

The files needed to interpret clinical data in English are:

1. HL7 specific messages files: EVN.en, MRG.en, MSA.en, MSH.en, MSH-EventType.en, MSH-MessageType.en, OBR.en, OBX.en, ORC.en, PID.en, PV1.en, QAK.en, QPD.en, RCP.en, ZDS.en.
   We choose these files because we needed to interpret the most used HL7 messages:
   - MSH (Message header);
   - MSA (Message Acknowledgement);
   - OBX (Observation);
   - OBR (Observation Request);
   - EVN (Event Type);
   - PID (Patient Identification);
   - PV1 (Patient Visit),
   - etc.
2. Files with translated error messages: -none-.en, -files not found-.en, -not present-.en.

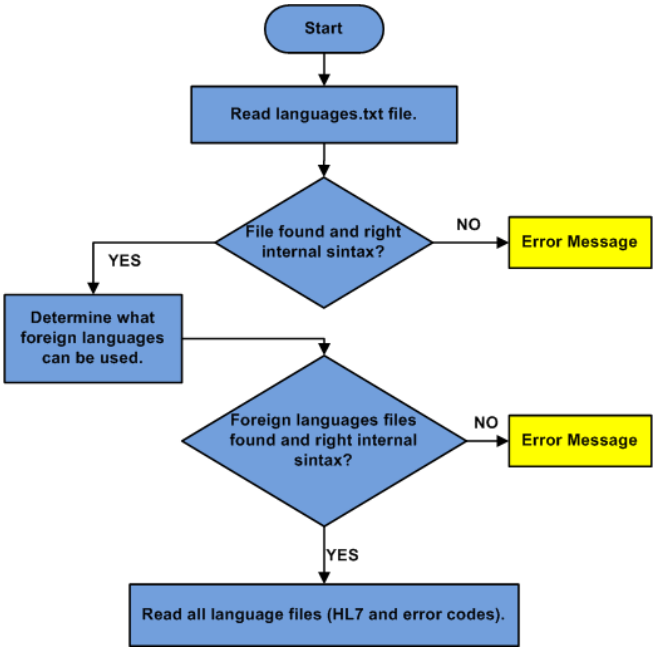


**Figure 3.** Module initialization by reading languages files.

Table I presents command set for English and Romanian languages.

TABLE I. COMMAND SET

| English Language | Romanian Language |
|---|---|
| login(IP, port, user, password); | conectare(IP, port, utilizator, parola); |
| usePatient(SSN,language); | utilizarePacient(CNP, limba); |
| getExternalID(); | idExternPacient(); |
| getInternalID(); | idInternPacient(); |
| getAlternateID(); | idAlternativPacient(); |
| getName(); | nume(); |
| getMotherMaidenName(); | numeFataMama(); |
| getDateOfBirth(); | dataNasterii(); |
| getSex(); | sex(); |
| getRace(); | rasa(); |
| getAddress(); | adresa(); |
| getCountryCode(); | codulTarii(); |
| getHomePhoneNumber(); | numarTelefon(); |
| getBusinessPhoneNumber(); | numarTelefonServici(); |
| getPrimaryLanguage(); | limbaNatala(); |
| getMaritalStatus(); | stareCivila(); |
| getReligion(); | religie(); |
| getAccountNumber(); | numarContBancar(); |
| getCNP(); | codNumericPersonal(); |
| getDriversLicenseNumber(); | serieCarteIdentitate(); |
| getEthnicGroup(); | minoritateaEtnica(); |
| getBirthPlace(); | loculNasterii(); |
| getCitizenship(); | cetatenie(); |
| getNationality(); | nationalitate(); |
| getLastError(); | ultimaEroare(); |

We can make some observations on command set and returned values:

- login(IP, port, user, password)
  - command sent by the client in order to connect through the portal to a HL7 server;
  - returns ***OK*** if successful or ***NOK*** if the connection failed;
- usePatient(SSN, language)
  - command that will set the current patient; all subsequent commands from the current client will receive data on this patient;
  - returns ***OK*** if successful or ***NOK*** if the connection failed;

- getExternalID()
  - external identifier associated with the current patient (external to HL7 application questioned);
  - returns ***none*** if there is no external ID;
- getInternalID()
  - internal identifier associated with the current patient (internal on HL7 application questioned);
  - returns ***none*** if there is no internal ID;
- getAlternateID()
  - alternates identifier associated with the current patient (alternate to HL7 application questioned), etc.
  - returns ***none*** if there is no alternate ID.
- name()
  - returns the name of current patient;
- getMotherMaidenName()
  - returns the patient's mother maiden name, this may be important in order to get all information about family health history. Also may be used to distinguish between patients with the same last name.

Considering this solution is easy to add a new language. To add support for a new language the interpreter must follow the steps:

1. adding a new line in the *languages.txt* file (e.g. Espanol (es));
2. creating the following files:
   a. *–files not found-.es,* file with the following content: "*!Archivos no encontrados! !Elija por favor otra lengua!*",
   b. *-none-.es* file with the following content: "*Ningunos*",
   c. *-not present-.es* file with the following content: "*No presente*";
3. translation into Spanish of all HL7 specific files.

Interpretation of data will be done when some commands are received from external applications.

## VI. TESTING

To test the module we developed a prototype for a generic client that executes all the commands described in the previous section. HL7 portal runs on a Linux machine, the client is using the Windows platform. In order to test the HL7 portal we used three different applications compatible with the HL7 standard: PatientOS, AccuMed EMR and the Mirth HL7 messaging server.

All tests proved that our system complies the specified requirements and can be successfully used to provide accurate health information in different spoken languages.

From the performance point of view, our design and implementation meets all requirements of typical client/server software systems. Performance testing proves that there are no significant delays and the server response time is more than acceptable.

## VII. CONCLUSIONS

A language barrier between patients and healthcare providers is a major obstacle to the provision of quality care according to [7].

Elements of originality of the HL7 portal are:

1. Translation of some parts of HL7 messaging in some foreign languages;
2. Enabling partial interpretation and translation of data from HL7 segments in any language;
3. Providing a simple mechanism to add new languages for data interpretation;
4. Providing means to obtain and process data that was initially in HL7 format to non-HL7 applications;
5. There is no other portal that has the same functionalities as the one we designed and developed.

Even if our main goal was to provide a solution for healthcare languages issues there are some aspects our system, as it is now, cannot solve: translation of descriptive fields, translation of doctors observations, etc. More research needs to be done on EMR translation systems.

## VIII. ACKNOWLEDGMENTS

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