Improving the Interoperability of Healthcare Information Systems through HL7 CDA and CCD Standards

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Abstract—The interoperability of healthcare information system is an important issue in medical informatics field. It is important to increase the life expectancy, reduce medical errors and provide more medical information for medical personal. For achieving the interoperability of healthcare information systems is important to have a standardized communication. This paper presents a control for Visual Studio .NET 2010 toolbox; it can be used for ASP.NET pages and in the final it will be used to improve interoperability issues. It has the possibility to show the tables and fields from different database and it can be integrated with a cloud application. Further is revealed the use of this control in a Pediatrics application on Azure platform. CC (cloud computing) is a technology that supports flexibility, seamless care, and can reduced costs of the medical act.

I. INTRODUCTION

It is important to increase life expectancy and this can be achieved with the help of a good management of medical informatics systems, a standardized communication which will lead to interoperability of healthcare information systems.

Interoperability between medical informatics systems is the ability of interchange information that will be interpreted and understood in the same way for all the interconnected systems. Interoperability in healthcare refers to the possibility of exchanging medical data between two or more interconnected systems and understanding the transmitted data in the same way by all physicians and healthcare professionals using those systems [1], [2].

Cloud computing is a technology that allows full access and uses shared resources for storing, developing and running computer applications in various fields. Using cloud computing technology health providers would benefit of; reduced costs, payment being made on time and use of resources; data storage, medical data can be stored in data centers as needed and can be scaled at any time; availability, cloud computing services are available at any time; accessing data from different locations, online applications can be accessed from anywhere in the world via the Internet.

If the interoperability is improved that one of the major benefits it will be that medical personal will have more information about the patient in EHR (Electronic Health Record), which is a longitudinal electronic record of patient health information generated by one or more encounters in any care delivery setting, including information about: patient demographics, progress notes, problems, medications, vital signs, medical history, immunizations, laboratory data and radiology reports [3].

In this paper is presented a Pediatrics application which is integrated in a network. The network is composed by different healthcare information systems (application for obstetrics-gynecology department, application for pediatrics department and application for general practitioner office) which communicate using standards HL7 CDA (Clinical Document Architecture) and CCD (Continuity of Care Document)). The standards must be configured for different applications; this will be performed using a control which has the capability to show the database tables and fields, in a unique way for all the applications. After these in the paper is presented the possibility to put the application on the cloud; and the interoperability between them.

II. MEDICAL INFORMATICS SYSTEMS USING STANDARDS

A. System architecture for Romanian healthcare

In Figure 1 is presented the system architecture for Romanian healthcare system, which is composed by an application for obstetrics and gynecology department, an application for pediatrics department, and an application for general practitioner office. These applications communicate using standardized communication, in our case using HL7 CDA standard and CCD standard. This healthcare system is presented in Figure 1.
Each application has a database configuration control (DB configuration control) which has the possibility to show the database tables and fields. This control allows to extract the needed data in a standardized manner and to send the information to other applications.

In Figure 1 is presented two types of components: CDA/CCD Component and CCD Component. The CDA/CCD Component can send data as XML in CDA format and in CCD format. The CDA is used for transmitting the data between the hospital information systems (HIS), and the CCD is used for transmitting the data between HIS and General Practitioner office. The CCD Component sends the data in XML CCD format from General Practitioner office to HIS departments. The communication is based on web services, in this case using WCF (Windows Communication Foundation).

B. HL7 CDA (Clinical Document Architecture) standard

This standard is used by HIS departments to communicate in a standardized way, being implemented into CDA/CCD Component, using Visual Studio .NET 2008, using C# language, and in this moment can support only SQL Server database, but in the future will can extract data from other databases.

The definition for HL7 CDA standard after [4] is that: the HL7 CDA is a document markup standard that specifies the structure and semantics of clinical documents. It is represented as a XML document and consists of a header and a body. This standard is derived from HL7 Reference Information Model (RIM). The common architecture can be adapted for progress note, radiology reports, discharged summaries, transfer notes, medications, laboratory results and patient summaries. The CDA standard is adapted for Romanian healthcare and also, uses two types of codes: LOINC (Logical Observation Identifiers Names and Codes) and ICD-10-am.

C. CCD (Continuity of Care Document) standard

The CCD/CDA Component and CCD Component use the CCD standard to transmit data for HIS department and for General Practitioner office.

The Continuity of Care Document (CCD) standard is a combination between two standards: CDA and ASTM CCR (Continuity of Care Record), and the definition after [5] is that: an electronic document exchange standard for sharing patient summary information among providers and within personal healthcare records. It summarizes the most commonly needed pertinent information about current and past health status in a form that can be shared by all computer applications, it respects a set of constrains on CDA that define how to use the HL7 CDA to communicate clinical summaries and it is built using HL7 CDA elements.

CCD templates include: header, purpose, problems, procedures, family history, social history, payers, advance directives, alerts, medications, immunizations, medical equipment, vital signs, functional states, results, encounters and plan of care [5].

III. DATABASE CONFIGURATION CONTROL FOR TOOLBOX

A web custom server control developed for Visual Studio .net 2010 toolbox, which can be used in ASP.NET pages, is presented. This control has the possibility to show the databases tables and fields and it can be applied in this stage to SQL Server, Access and Oracle databases, but in the future will be extended the functionality for other databases (e.g., MySQL) and can work with the CDA and CCD standard to transfer the medical information in other application.

Web Custom controls are compiled code which can facilitate different user actions, but on the other hand is more difficult to create. It is possible to add it to the toolbox and display it in a visual designer with full Properties window support and all the other design-time features of ASP.Net server controls. Other important feature is that it is suitable for creating dynamic layout [6].

In Figure 2 are shown the steps that a user has to cover to access the database tables and fields, and finally this will result in selecting the needed fields for HL7 CDA and CCD standards format.

This control can access different database, for example SQL Server, Access and Oracle database. In Figure 3 is shown the interface where the user can select the database he needs.

In Figure 4 is shown how the user can access the Microsoft Access database.
Microsoft Windows Azure is a Platform as a Service (PaaS) solution offered by Microsoft [7]. Windows Azure is an operating system with development environment, service hosting and service management. Applications for cloud can be developed in Visual Studio.NET by adding additional packages for cloud services. Code for cloud applications is largely similar to the applications developed locally. Windows Azure also has a set of storage services that can be used to store and manage persistent and transient data [8].

Currently, a medium Azure instance cost $0.24 per CPU compute hour and an large instance per CPU compute cost $0.48 per hour. The storage is $0.14 per GB stored per month and $0.01 per 10000 storage transactions. The data transfer under Zone 1 (North America and Europe) is $0.12 per GB and under Zone 2 (Asia Pacific) is $0.19 per GB [9].

Currently, it is very important to try to develop applications and offer platforms and infrastructures cheaper and more complex to each medical unit. Doctors and patients need data transfer in real time and storage of this data in safe locations, which provide simple access to information. For this, it can be used cloud computing. It is a technology that provides a comprehensive infrastructure for development of medical applications and data storage required for each medical unit. Payment is made based on use of the resources (pay-per-use). In this way, healthcare units can use complex tools at low prices. Prices offered by cloud computing are much lower than buying the physical infrastructure of each unit. Another benefit of the technology is the resource management that is provided by the cloud computing provider; medical units network administrators being no longer needed, which again reduce the cost.

Currently, it can be migrated to the cloud all applications developed for the web. For example the application in which we demonstrated the use of the control created was originally developed as a website with local database. The application is designed for a Pediatric hospital, and the created control is used to exchange medical data between Pediatric hospital and Obstetrics and Gynecology hospital.

As the application was created as a website, first we turned the application in web application and so it can be migrated to the cloud. Once converted, we created an Azure project and integrated the application. After the integration of the application in Azure project, in the data exchange module between two units, the developed control was integrated. To demonstrate the functionality of the application we chose a Microsoft demo environment to port the application on the cloud. In Figure 8 it can be see the first step of the migration, which is the choice of the data center in which will be store our application and our databases.

After choosing the data center it will be able to load the desired application, which previously was packed for the cloud. In Figure 9 it can be seen steps 2 and 3 to loud our application on the Azure cloud.
Once the application has been loaded, it can be accessed at the link provided in the final step of loading it on the cloud.

Figure 10 illustrate the principal structure of the pediatrics application. The pediatrics application was started in [10] with a simple communication throw HL7 CDA Standard and now we integrated in the pediatrics application the toolbox control. In that way we demonstrated the functionality of the toolbox control developed.

Accessing data exchange between the two medical units it will load a form that was developed using the created control (Figure 11).

The user can choose its own database format and after that it must enter specific data to each format of database (Figure 12).

The developed module is useful for doctors, as they can access information from different medical units, regardless the database format. In this way, doctors can access medical data of the patients when they need, in real time, at different critical moments.

V. CONCLUSIONS

The paper presents a way to improve the interoperability between healthcare information systems which is a very sensible issue in medical informatics field. This control has the possibility to indicate the database tables and fields. As future work the user (medical staff or hospital administrator) will can indicate for each HL7 CDA and CCD section where the needed data are located to be sent in standardized communication; it can be localized the data for HL7 CDA and CCD header which consists in demographic data. All the actions are developing without interference in the application source code. Usually, after a medical unit buys the information system the medical staff and hospital manager don’t have easy access to the associated. This can lead to some problems in transmitting the data to other units, because not all the
healthcare information systems have a module which can send messages in standardized format. Using this control it can ensure a better interoperability between healthcare information systems.

The steps needed for putting on the cloud an application, in our case the application for pediatrics department, are presented.

The benefits of the presented solution consist in helping the medical staff and hospital administrators to configure the local information systems in order to communicate with other information systems, leading in the end to a better patient care, reducing medical errors, supporting easy access to patient information when and where is needed and adding more information to patient EHR.

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