Flexible Solution for Interoperable Cloud Healthcare Systems

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Abstract. It is extremely important for the healthcare domain to have a standardized communication because will improve the quality of information and in the end the resulting benefits will improve the quality of patients' life. The standards proposed to be used are: HL7 CDA and CCD. For a better access to the medical data a solution based on cloud computing (CC) is investigated. CC is a technology that supports flexibility, seamless care, and reduced costs of the medical act. To ensure interoperability between healthcare information systems a solution creating a Web Custom Control is presented. The control shows the database tables and fields used to configure the two standards. This control will facilitate the work of the medical staff and hospital administrators, because they can configure the local system easily and prepare it for communication with other systems. The resulted information will have a higher quality and will provide knowledge that will support better patient management and diagnosis.

Keywords. interoperability, cloud computing, HL7 CDA, CCD, information healthcare systems

Introduction

Cloud computing is a technology that allows full access and uses shared resources for storing, developing and running computer applications in various fields. Physical resources required for data storage in the cloud are always available and can be increased or decreased depending on the needs of applications and databases and payment is made accordingly (pay-per-use).

Cloud computing includes three types of services: Infrastructure as a Service (IaaS) - hardware, Platform as a Service (PaaS) – development platforms and Software as a Service (SaaS) – applications and four models of development: Private cloud – allow access to a certain group or institution, Public cloud – allow access to general public, Community cloud – allow access to several institutions that are common issues and Hybrid cloud – are public and private cloud too.

Currently, several healthcare providers have adopted the electronic medical records systems for storing medical records of patients in their central database.

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Nowadays, in many cases physicians have switched to electronic medical records, giving up handwritten medical records. The problem that arises now is the access to those records from other locations or by other physicians. Usually, a patient during his/her life has to visit many healthcare providers: family physician office, dentist office, hospitals, clinics, etc. [1]. For these reason the full medical data and medical history of patients are needed in more places.

Several medical applications are available "on the cloud": Microsoft HealthVault, Google Health, Salt Lake City-based Spearstone's healthcare data storage application, MedCommons, HealthURL and others that are public available thought cloud services provided by Amazon's Web Service, Google of Microsoft [2].

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.

Cloud computing can prove great benefits to healthcare providers, but adopting this new technology will require a great amount of time and work in which specialists must demonstrate the safety and privacy of health data required by HIPAA standard.

1. Interoperability in the cloud computing architecture

Interoperability between medical systems is the ability of these systems to 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 [3].

To reduce costs and improve quality of care cooperation and collaboration of medical units from different locations is required [4]. Showing the needs existing in healthcare data flow processing, we describe several scenarios. First, is the high number of family physicians (e.g. in Romania in early 2011 worked approximately 11.000 of family physicians and 4800 residents have chosen this specialization [5]). A patient can change their family physician at any time for various reasons like: going to another city/country, dissatisfaction with services provided by physicians, changing jobs, etc. Any of these situations require the transfer of medical information (medical history) of the person concerned to the physician that will continue monitoring the patient. Another reason for the existence of interoperability is the multitude of departments within a hospital such as: cardiology, pediatrics, neonatology, gynecology, internal medicine, neurology infectious diseases, surgery, ophthalmology, etc. A patient may be sent by the family physician, and not only, at any of the above departments for further investigation. Each department or specialist physician need the patient's history to can give an accurate diagnosis and as well as family physician needs the data provided by specialists to maintain continuity of medical records. Another need is to access medical information from another country. When a patient is leaving in another country for a short period of time, for business or holiday, it may need to access certain health information in special cases in the country where it is.

Currently the exchange of information in the above cases is solved via fax, email or phone. In addition, this exchange of information violates the privacy of patients, or it

may be misunderstood by the person who receives this information, either because the writing is unreadable or the person receiving the information loses data considered unimportant.

In this paper we proposed a web custom control that can be used to configure the databases and tables from the medical applications and can work with the CDA and CCD to transfer the medical information in other applications. To demonstrate the functionality of the control that we propose, we realized the connection of two departments in the hospital (Obstetrics and Gynecology and Pediatrics) that need data from each other (Figure 1) [6], [7]. For the proposed system there are currently two applications developed in private clouds by our group, one for the department of Obstetrics and Gynecology and another one for Pediatrics department. After birth, the child is given to the care of pediatrician, so he/she needs all medical data with the child at birth. For this reason we chose these two medical units as a starting point for a complex system with more medical units. In the application for Obstetrics and Gynecology or for Pediatrics the physician can access its own database. When one of them needs data from other units, he/she will connect to the database required by the control developed. The functionality of our control will be described in the followings.

This control will help configure the information related with the two standards: HL7 CDA and CCD. The HL7 CDA standard is used to transmit the data between hospitals and the CCD standard is used to send data from hospital to general practitioner. HL7 CDA standard is a document markup standard that specifies the structure and semantics of "clinical documents" for the purpose of data exchange. It is encoded in XML format and contains two parts: a header and a body [8]. CCD standard is an electronic document exchange standard for sharing patient summary information among providers and within personal health records. It summarizes the most commonly need pertinent information about current and past health status in a form that can be shared by all computer applications, from web browsers to electronic medical records and is encoded in XML format [9].

According HIPAA Standard in our applications we secure the information changed throw HTTPS and cryptographic algorithms.
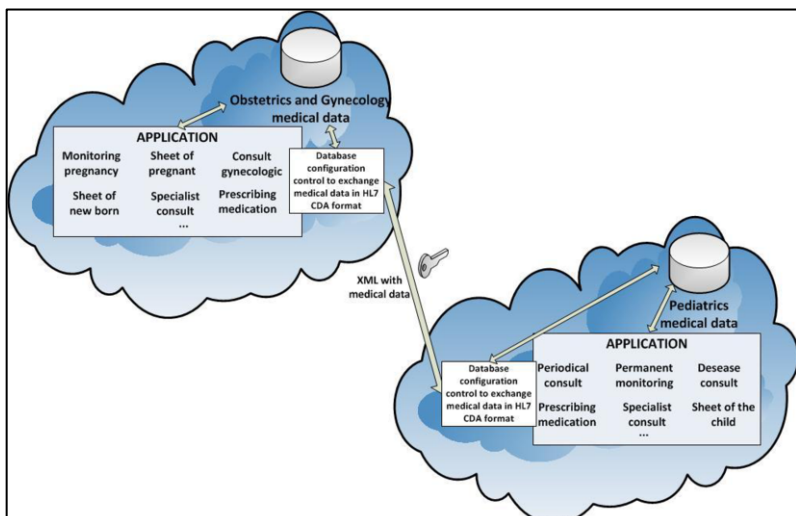

Figure 1. Interoperability with configuration control

2.   Control toolbox for healthcare information systems

In the healthcare domain it is important for the user (medical staff and hospital manager) to have access to local databases. To create an XML file in HL7 CDA or CCD format there is a need to indicate the path where the database is situated, also for the XML header one has to indicate the tables where it is possible to retrieve patient demographic data and for the XML body the tables for each section for HL7 CDA and CCD (e.g. for laboratory section – it is shown in which tables are stored the patient laboratory results in the database). This can be done with the help of a control for toolbox which has the functionality to see the tables and the fields of the database. In the following a control for ASP.NET is described, which in the end can be added to the Visual Studio .NET 2010 in the toolbox.

It is possible to create two types of controls for ASP.NET: one is Web User Control and the second is Web Custom Control. The first difference between them is that the Web User Control cannot be added in the toolbox and the Web Custom Control has this capability and the second difference is that the Web User Control can be developed more easily than the Web Custom Control.

Web Custom controls are compiled code which the user can use it easier, but on the other hand is more difficult to create. After it is created, 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 [10].

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.
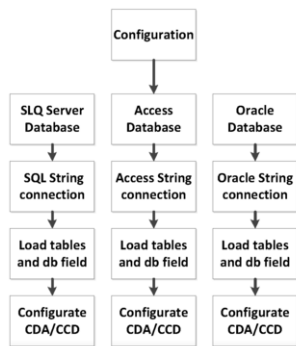

Figure 2. Control functionality

The advantages which result from using this type of control are: supporting the medical staff in configuring the standardized communication and also being used on other application which is ASP.NET based.

This control has the advantage to increase the quality of information because the medical units will have more information about the health status of the patients and also this solution can support improvement of treatments and in emergency situations the physicians will have the information in time and at the right location, which, in the end will increase the quality of patients' life.

A restriction of the solution is represented by the fact that the Web Custom Controls can be used only for ASP.NET applications.

Conclusions

The paper presents the interoperability in a cloud computing solution, a very sensible issue in medical informatics field. This control has the possibility to indicate the database tables and fields, and after this step the user (medical staff or hospital administrator) can indicate for each HL7 CDA and CCD section where the needed data are located to be sent in standardized communication. Also 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 one can ensure a better interoperability between healthcare information systems. 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, and supporting easy access to patient information when and where is needed.

Acknowledgment

References

[1]   R. Zhang and L. Liu. Security Models and Requirements for Healthcare Application Cloud. IEEE CLOUD 2010 : The Third IEEE International Conference on Cloud Computing (CLOUD 2010). 2010 Aug; Miami, FL; 268-275.
[2]   M.-H. Kuo, A. Kushniruk, E. Borycki. Can Cloud Computing Benefit Health Services? – A SWOT Analysis. Studies in Health Technology and Informatics. 2011. Volume 169: 379 – 383.
[3]   A.K. Soman. Cloud-based Solutions for Healthcare IT. USA: CRC Press; 2011
[4]   D. Papakonstantinou, M. Poulymenopoulou, F. Malamateniou, G. Vassilacopoulos. A cloud-based semantic wiki for user training in healthcare process management. MIE 2011. 169 :93-7
[5]   www.avocatnet.ro (Accessed in 10.01.2012)
[6]   M. Vida, O. Lupșe, L. Stoicu-Tivadar, V. Stoicu-Tivadar, ICT Solution Supporting Continuity of Care in Children Healthcare Services, Proceedings: 6th IEEE International Symposium on Applied Computational Intelligence and Informatics, SACI 2011, Timisoara, România, 635-639
[7]   Lupse, O.; Vida, M.; Stoicu-Tivadar, L.; Stoicu-Tivadar, V.; , Using HL7 CDA and CCD standards to improve communication between healthcare information systems, Intelligent Systems and Informatics (SISY), 2011 IEEE 9th International Symposium on , vol., no., pp.453-457, 8-10 Sept. 2011
[8]   HL7 version 3 Interoperability Standards Normative Edition 2009, Based on HL7 v3 Data Types, Release 1, Disk 1 – Standards Publication
[9]   Healthcare Information and Management Systems Society Electronic Health Record Vendor Association (EHRVA), Quick Start Guide, HL7 Implementation Guide: CDA Release 2 – Continuity of Care Document (CCD), 2007
[10] Recommendations for Web User Controls vs. Web Custom Controls, www.msdn.microsoft.com, Accessed in 10.01.2012.