CLOUD-POWERED e-HEALTH

Logica BĂNICĂ[1], Liviu Cristian ŞTEFAN[2]

[1] Faculty of Economics, University of Pitesti, olga.banica@upit.ro
[2] Faculty of Computer Science, University of Pitesti, lcstefan@yahoo.com

Abstract. *During the last years, the global economic crisis has affected all domains, including the health sector. Many governments have considered that the solution to this problem is to reduce public expenses on healthcare, to decrease the budgets for health services, to rationalize the medical plans for the population, to increase the share of health expenditure paid by patients and to select the products on the pharmaceutical market.*
In order to improve the medical service whilst maintaining reduced infrastructure costs, the new digital technologies offer the solution of cloud-based services for the e-health systems.
In this paper we present the cloud-hosted healthcare applications concept, the advantages of using e-Health on distributed platforms and some considerations about the security levels. Also, we further present an experiment based on the free OpenEMR solution, which has also a cloud version, ZH-Services OpenEMR.

Keywords: e-Health, Cloud computing, Healthcare services, Security.

JEL Codes: I10, C88, D83.

1. INTRODUCTION

During the last years, the global economic crisis has affected all domains, including the health sector. Many governments have considered that the solution to this problem is to reduce public expenses on healthcare, to decrease the budgets for health services, to rationalize the medical plans for the population, to increase the share of health expenditure paid by patients and to select the products on the pharmaceutical market.

Romania holds one of the smallest GDP shares allocated for public health (3,9% in 2012, 4,4% in 2013), much less than the European average of 9%. This sub-financing has led to a continuous leakage of trained professionals from the medical system.

In 2012, the budget for public health was almost four times smaller than the one in France or Belgium, which had a rate of 11%, as indicated by the British magazine *"The Economist"*.
Also, Switzerland, Canada, Germany and Austria have all similar values, floating around 10-11% per year from their GDP. The biggest rate is present in the USA, which allocates 16% for health problems. In Romania, the total amount raised to 8,67 billion in local currency in 2013 [6]. The Euro Health Consumer Index (EHCI) 2012 Report analyzes the European healthcare systems, offering "reality checks for policy makers, empowerment to patients and consumers and an opportunity for stakeholders to highlight weak and strong aspects of healthcare".

Figure 1 presents the EHCI scores and it may be noticed that Romania holds the 32-rd place from 34 countries evaluated. The ranking is influenced by the introduction from 2008 of the e-health indicators.
According to Gunter Eysenbach, "*e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an*

attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology."[7]

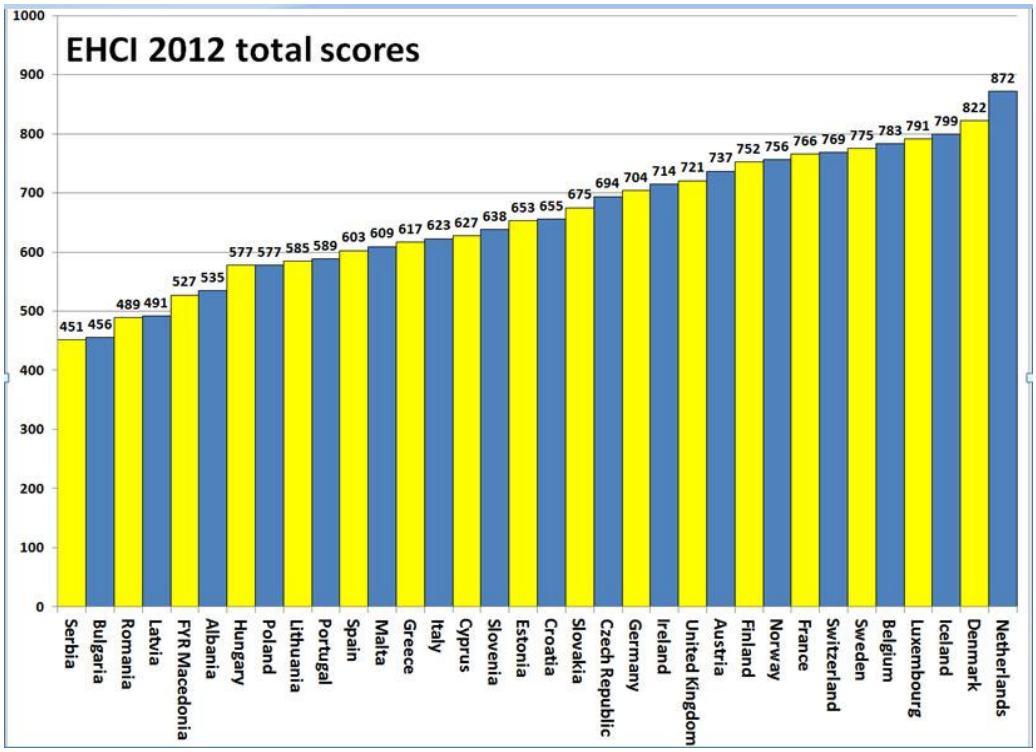

Figure 1 - Results of the Euro Health Consumer Index 2012

Source: http://www.healthpowerhouse.com/files/Report-EHCI-2012.pdf

Starting with 1997, in Romania has been introduced the health insurance system, being inspired by the German model.

This represents the main funding source for the health system, through which the insured people pay 5.5% and the employers pay 5.2%, the rates at Jan 1, 2013.

The administration of the system is carried by the National Health Insurance House (rom.: *CNAS*), a public institution established in 1999 as a juridical person.

To fulfill its mission, the CNAS has introduced a series of advanced IT&C systems that led to a better management of the Social Health Insurance Fund and the control of insured persons, and to the more efficient reporting of the medical services. In order to improve the medical service whilst maintaining reduced infrastructure costs, the new digital technologies offer the solution of cloud-based services for the e-health systems.

The e-Health in the cloud is a relatively new concept that provides the possibility to enhance healthcare management and decrease expenses in an integrated environment.

In this paper we present the cloud-hosted healthcare applications concept, the advantages of using e-Health on distributed platforms and some considerations about the security levels. Also, we further present the current level of the Romanian e-Health implementation and our proposal about the migration of e-Health on Cloud Computing. Finally, we present an experiment, based on the free OpenEMR solution, which has also a cloud version, ZH-Services OpenEMR in order to test some of the facilities of this technology.

2. LITERATURE REVIEW

Since the start of the global financial and economic crisis in 2008, all sectors of the national economy were affected, including the health system. The government had to take some unpopular austerity measures in order to reduce the expenses, measures that had an impact on the nation health status. After a short presentation of health policies in various states, we will argue that a major shift in strategy, like the migration to cloud-based e-health, will help keeping the costs down while providing an increased reliability for the end users.

The European countries decreased their current level of public expenditure on health during the last years. With any of these options they could also reallocate funds within the health system to enhance efficiency [18].All European governments made efforts to implement e-Health solutions to ensure optimal healthcare services to their citizens (E-Medical records, e-Prescriptions, Health card) with a reasonable financial effort. E-Health solutions became popular at the beginning in the European Union, by offering the medical services to the European citizens wherever they are in the EU.

From the EU members, France and Germany were among the first to use IT&C solutions for the health sector.

According to Liberman [19], in France, the "SESAM-Vitale" program, widely deployed from 1998, currently links more than 300,000 healthcare professionals and processes around 1 billion electronic claim forms for reimbursement per year.

The *CPS* (Carte de Professionnel de Santé – Healthcare Professional Card) functionalities include identification, authentication and electronic signature of healthcare professionals.

Patient card (carte Vitale - *CV*) contains health insurance data for the insured person. Also, the e-Prescription service is running, and the pharmaceutical record contains all information related to the consumption of pharmaceuticals to a patient.

The *DMP* (Dossier Medical Personnel – personal medical record) is an electronic secure personal medical record, accessible over the internet. The DMP may contain medical history of a patient, previous medicine prescriptions, hospital care reports and results of medical examinations. Each insured citizen may have a DMP but this is not mandatory, and having a DMP is the patient's decision, according to the law. The patient keeps control over his DMP: he authorizes access of the healthcare professionals to his DMP.

In the same work, Liberman [19] shows that in Germany, the *KVK* (Krankenversichertenkarte – health insurance card) launched in 1995. Due to the fact the KVK did not bear any picture of the cardholder, and its content was just plain memory without security, it had to be replaced by a more secure and efficient system.

The German government is introducing electronic Health Cards (eGK) for all insured citizens. The card contains personal data, insurance details and medical history records and it is used by the cardholders, when they require health care services, which are covered by the insurance.

Bittschi and Markus [20] affirm that since 2005, the electronic health card (EHC) was introduced by the Austrian social health insurance system and the actual goal is to develop the electronic health record (*EHR*) by ELGA project. Within ELGA, the e-card should take on the role of an electronic key providing access to electronically stored patient information.

In other countries, like Canada and Australia, projects are in development for the migration the public health services to the cloud. Thus, Neil McEvoy [21] provides information about the strategy document of Canada Health Infoway, entitled *Cloud Computing in Healthcare*. This provides a reference model for important aspects of a Cloud strategy, especially for Healthcare but also in a broader sense.

Marcoullier [22] says that in 2013, the challenge is run by Health and Human Services (HHS) Office of the National Coordinator for Health Information Technology. Statistic, the

current implementation status and the public opinion of the American public about electronic health records (EHRs) could be summarized as follows:

- 80% of Americans who have access to their health information in EHRs use it;
- Two out of three people would consider switching to a doctor who offers secure access to medical records;
- 65% of Americans who don't have access to EHRs say it's important to have it;
- 17 million consumers used their mobile device to access health information in 2011.

Colley, in its paper *Telstra cloud pilot in e-health system*, refers to a web-application delivery service for medical practitioners [23]. It inked a memorandum of understanding with the Royal Australian College of General Practitioners to build an e-Health Cloud. It will host healthcare applications including clinical software, decision support tools for diagnosis and management, prescriptions, training and other administrative and clinical services.

3. THE CONCEPT OF CLOUD-BASED E-HEALTH

This new concept results by reuniting two technologies: cloud computing and healthcare services supported by electronic processes and communication. Thus, we will briefly discuss the meaning of each component, how did the cooperation between them occur and which are the advantages of accessing healthcare services in the Cloud.

3.1 Defining Cloud Computing

Cloud Computing can be defined as "A computing paradigm which is a pool of abstracted, virtualized, dynamically scalable, managing, computing, power storage platforms and services for on demand delivery over the Internet." [8]

The National Institute of Standards and Technology (NIST) defines cloud computing as „a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [1].

Cloud systems introduce many opportunities for e-health: sharing data with medical organizations, health research institutes, insurance companies, governmental institutions.

On the other side, using Cloud computing is a method to reduce the costs with hardware and software platforms and technical personnel for IT solutions.

Cloud computing is a new computing model that lets different healthcare organizations pay only for the resources they need, when they are needed. With cloud computing, shared resources are allocated dynamically to create a highly flexible environment. This enables organizations to treat the infrastructure as a service, rather than an expensive capital expenditure.

The main features of cloud computing solutions can be summarized as follows [1][2] [10]:

- use of Internet technologies to offer scalable and flexible services; this feature refers to the capacity of dynamically acquiring resources which support variable-size tasks, that can be measured and are cost-effective;
- full maintenance and security are offered by providers; they have more efficiency, extended know-how and the possibilities to periodically update the hardware and software resources.
- data storage strategy takes into account the physical distance to the site where resources are used in a location-independent manner; this leads to increases in reliability, security and lowers communication costs.
- by dynamically provisioning valuable resources, cloud computing platforms can reassign the unused resources and move them to where consumer demand is the highest.

A characteristic of cloud computing is the possibility to be accessed anywhere from an Internet connection and to promote on-demand self-service, by helping the end users to have computing resources at their disposal without the need of permanent interaction with the service provider. Data may be accessed from any network, regardless of the client platform (laptop, tablet, mobile phone) that is used. This leads to the final purpose of location-independent resource pooling.

Cloud computing consists of multiple levels, starting from the physical layer (servers, storage equipment) through the application layer, according to three fundamental models [3][4][5]:

- Infrastructure as a Service (IaaS) – layer capable to provision processing, storage, networks, and other fundamental computing resources (operating systems and applications) for medical data processing and storage resources.
- Platform as a Service (PaaS) – layer offering an integrated environment to design, build, deploy consumer-created or acquired healthcare applications onto the cloud infrastructure.
- Software as a Service (SaaS) – layer providing healthcare service-based applications in the cloud; in this model cloud providers install and operate application software on their platform and users access the services remotely. The cloud users do not manage the cloud infrastructure on which their application is running. The application is not installed and does not run on client computers; in this manner the customer is not responsible for maintenance and support for the software.

An implementation of computing clouds covers infrastructures of different sizes, with different levels of management, and different user numbers. There are four types of cloud strategies:

- Public Cloud - the infrastructure is owned by a third-party organization providing cloud services and is available to the general public or large groups of users; their services are free or offered on a pay-per-use model.
- Private Cloud - the infrastructure is owned, operated and managed by a private organization for its internal use only;
- Community Cloud - the infrastructure is shared by several organizations and supports a specific community that has similar approaches about policy, objectives, and security requirements.
- Hybrid Cloud - the infrastructure is a joint solution of two or more clouds (private, community, or public) that are bound together by standardized rules that enable data and application portability.

3.2 Defining e-Health

The term e-Health refers to “the use of emerging information and communication technology, especially the Internet, to improve or enable health and healthcare thereby enabling stronger and more effective connections among patients, doctors, hospitals, payers, laboratories, pharmacies, and suppliers” [11].

E-Health offers important medical/healthcare services, including [12]:

- Electronic health records: enabling the communication of patient data between different healthcare professionals;
- Telemedicine: physical and psychological treatments at a distance;
- Consumer health informatics: use of electronic resources on medical topics by healthy individuals or patients;
- Health knowledge management: *e.g.* in an overview of latest medical journals, best practice guidelines or epidemiological tracking;

- Virtual healthcare teams: healthcare professionals who collaborate and share information on patients through digital equipment;
- Medical research using Grids: powerful computing and data management capabilities to handle large amounts of heterogeneous data.

E-Health is not a solution for different healthcare organizations due to some limitations and weaknesses, such as: high cost of implementing and maintaining information systems, fragmentation of patient data in many separate healthcare systems, clinics or other areas of the healthcare institutions, lack of a general law to protect the privacy of patients and the interchanges of their medical records between healthcare organizations from many countries, lack of support for collaborative work among different healthcare organizations and the integration of the high volume of medical information.

3.3 Moving e-Health to Cloud Computing

Cloud computing is the technology that many small and medium healthcare organizations have chosen, and it has a powerful financial impact on the health industry also.

Being a newly introduced paradigm, both pro and con discussions about deploying cloud-based e-Health solutions exist, as follows [9][10]:

a). Advantages

- Scalability – the main feature of cloud-based services is that they are incredibly flexible in adapting to the size of the client, and thus even small-scale companies can benefit from them.
- Simplified deployment – the company does not have to support the high expenses for maintaining a complex IT infrastructure anymore, as the solution runs in the datacenter of the cloud hosting company.
- Cost – there is the option to lease the service and use a pay-as-you-grow model, avoiding the elevated costs implied by acquiring a site license from the beginning.

In this context, moving e-Health to the Cloud computing platforms solves these problems and offers important benefits to patients and healthcare institutions [13]:

- Better patient care: an unique patient medical folder, available for all the medical units;
- Reduced cost: a feature for small and medium sized healthcare providers to use advanced IT infrastructures and high performance software services without high operational costs; also, there is another aspect of cost decreases by having medical records available globally for all Cloud participants.
- Improved quality: having the clinical data stored in the Cloud, the healthcare operators will facilitate supplying data to governmental concerned entities such as the Ministry of Health or the World Health Organization with information on patient safety and the quality of care provided.

At national and inter-regional level, there are important positive effects [13]:

- Support research: the huge information repository about millions of patients' cases which can be uniformly and globally accessed can be easily used to develop medical research, to discover new medical facts and to conduct medical research to enhance medications, treatments and healthcare services.
- Support national security: an increased capability to detect and monitor the spread of infectious diseases and/or other disease outbreaks.
- Support strategic planning**:** decision makers can use data for planning and budgeting for healthcare services, the requirements for doctors, medical labs and equipments, operating

rooms, patient beds, and other medical facilities. It can also be integrated with other Cloud services to help in forecasting future healthcare services needs.

b). Draw-backs of the solution:

- data security risks – accessing patient data by unauthorized users; the systems include credentials to verify identity, but also a recording of every access attempt;
- the risk of loss of data – database management systems such as Oracle, IBM DB2, SQL Server include hot and cold backups, mirroring and database restores as solutions that minimize this risk;
- the risk of systems unavailability – losing an e-Health service is a major issue and must be solved by increasing the reliability of the software applications.

Figure 2 shows a generic architecture of e-Health Cloud, as a layered structure.

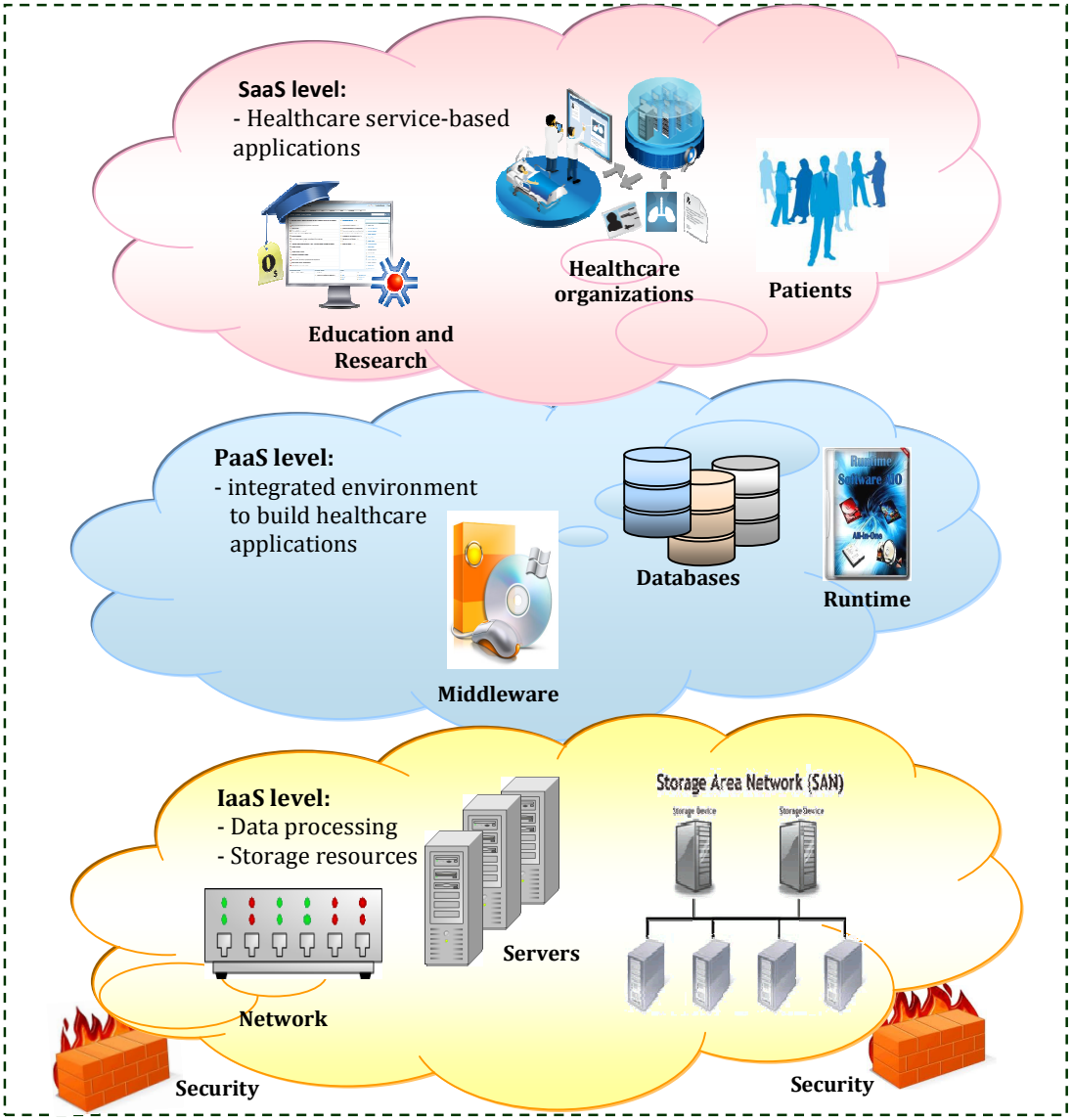

Figure 2. The e-Health Cloud Computing architecture

We choose OpenEMR as e-Health platform for our experiment, taking into account the popularity of this software and it user base spread all over the world.
OpenEMR is free and open source software for Practice management and Electronic Medical Records (EMR) software application. It features fully integrated electronic medical records, practice management, scheduling, electronic billing etc. It can run on Windows servers, UNIX-like and Mac OS X machines, and of course Linux based environments.
OpenEMR was originally developed by Synitech and version 1.0 was released in June 2001 as MP Pro (MedicalPractice Professional). It became an open source project and was registered on SourceForge.net on August 13, 2002. The project evolved through version 2.0 and the Pennington Firm (Pennfirm) took over as its primary maintainer in 2003. Walt Pennington transferred the OpenEMR software repository to SourceForge in March 2005, where it remains today [15].
The following paragraph will synthesize some of strengths of OpenEMR software, according to the results of research studies in 2012 [16]:

- First of all, it is a free and open source platform;
- Secondly, it was built as a LAMP-type of web based application that uses a web server such as Apache, MySQL as the database and PHP as the programming language;
- Electronic Medical Records;
- A compact and flexible appointment calendar;
- Advanced reporting capabilities;
- Prescription writing capability with ability to email or print prescriptions;
- Patient statements and collection letters;
- Browser-based for flexibility, security, easy maintenance and platform independence for remote access (including tablets);
- Patient Demographics;
- Patient Scheduling;
- Medical Billing;
- Clinical Decision Rules;
- Patient Portal;
- Security.

Various application migrations to cloud computing are the most difficult aspect because there are some rules and principles that should be adopted in this shared environment. For this purpose, more providers such as VMware have teamed up to offer a joint solutions package that delivers e-Health in the cloud, according to Agency for Healthcare Research Quality [14].

So, the Open Healthcare Cloud (OHC) is a VMware implementation that provides a platform on which open source EMR applications can be deployed, run, and administered remotely and for which hardware usage is securely shared to improve affordability.

Another implementation Cloud based solution is ZH OpenEMR. Its popularity is largely due to economic reasons, namely the personnel and resources required to stay on top of the new technologies and ever-changing threat landscape [17]. The ZH OpenEMR cloud-based solution enables companies to focus on their core business of caring for patients by leaving the technical aspects of the EMR application to the experts who really understand the latest technologies and are able to keep the system running efficiently, taking into account the changes in user behavior that introduce security vulnerabilities.

Using a cloud-based application, in our example Hosted OpenEMR, we access the system via Internet to the application hosted in shared resource environment, as opposed to being

deployed on private servers. Cloud services are designed to provide easy, scalable access to the applications resources and services, which are managed by a provider.
A cloud service can dynamically scale to meet the needs of its users, and because the service provider supplies the hardware and software necessary for the service, there's no need for a company to provision or deploy its own resources or allocate IT staff to manage the service. Currently ZH Healthcare utilizes Amazon's AWS Cloud as their data center infrastructure provider [17]. Amazon is the pioneer in the field and has developed a reliable and flexible infrastructure that easily supports healthcare applications.

Why use a Cloud-based OpenEMR solution?
The answer is complex and must take into account the following considerations [17]:

a. Using the system as a better business strategy: the medical personnel will spend time working with patients, not with patient healthcare software. With the software installed in the cloud, the provider upgrades the software, makes the backups and is responsible with security. The cloud infrastructure is built on redundancy, meaning that the system is always available and so are the services.

b. Considering its scalability: in time, EMR system will grow due to the increasing amount of patient data and additional improvements in the application software that may require more computing power. This will require additional computing resources in order to keep performing efficiently. On the cloud platform, the provider can expand as required, and this operation is transparent for users.

c. Considering its security measures: patient information in the cloud became a target for hackers and are harder to secure. By using a cloud-based solution, the advantages are related to an infrastructure that is already in place, providing both security benefits such as private IP network isolation, encryption, server load balancing and automated backups.
Server load balancing means that there are two or more servers for every piece of the application software. If one of the servers experiences a malfunction due to hardware or software problems, it is automatically removed from production to prevent it from causing impact to the service. When the issue is resolved, it's automatically placed back into service.

4. ROMANIAN E-HEALTH PROGRESS

In Romania, e-Health implementation has begun by introducing, starting with 2012, of the Integrated Health Information System *(SIUI)*, developed by the local software company SIVECO, and it is designed to interface with the components of the Health Insurance Informatics Platform *(PIAS):* SIVMED represents a complex software solution, addressed to health units like hospitals, groups of hospitals or large clinics, and is relies on the national health card and the electronic health file (record) for patients.

Today the *SIUI* is implemented at all levels of the health system, from the primary medicine to the ambulatory and specialty medicine and hospitals, with the following functions:

- checking the insurance state of a patient
- checking the prescriptions against the approved drugs list
- warning on double prescriptions
- monthly reporting of medical services

For the primary medicine, all population has been distributed by territorial criteria, by allocating an average of 1800 patients per family doctor.
The electronic prescription module (rom.: *SIPE*) allows for a better management of drug funds and avoiding the most part of the frauds from the system.

The doctor enters the prescription data for each patient and validates it in the health insurance system. Then, the patient receives a printed form that contains a 2D barcode that acts as an access key that any drug store (pharmacy) registered in the system can read and authenticate.
The Health Ministry has announced that, in the second half of 2013, the project for the Electronic health Insurance Card (rom. *CEAS*) will be implemented in order to identify the patient and ensure quicker access to medical services. Once this will be available, there will be no need for the printed prescription, as the card will be scanned directly by each entity.

In a future development phase, the Romanian health system will use an electronic patient record, which will store the medical history of each patient and will allow doctors to offer the right treatment for each case.

Implementing the Electronic Patient Record will lead to reduced infrastructure costs, as the new digital technologies offer the solution of cloud-based services for the e-health systems.

4.1 Using OpenEMR as an e-Health Cloud testing tool

For this experiment, we have downloaded the OpenEMR package (available at *http://open-emr.org/wiki/index.php/OpenEMR_Downloads)* and used the installation guide for the WAMP platform (Windows, Apache, MySQL and PhP) – OpenEMR Setup [16].
After the successful installation, the user may launch the application by pointing the browser to the server (in this case, local machine): *http://localhost/openemr*.
A successful login (figure 3) will bring up the main screen of OpenEMR. The user is presented with two windows, the Calendar and, below that, the Messages page.
OpenEMR can be used with one of the three navigation schemes: Sliding Menu, Tree View, or Radio Buttons. The Sliding Menu option is the default navigation scheme for OpenEMR 4.1. This expanding menu-style navigation scheme presents a hierarchical list of page links on the left side of the screen, which can be directed to load in either in the top or bottom widow of the main screen.

Figure 3. The access to the Cloud OpenEMR

To introduce a new patient, simply click on the name of the clinic, and edit the details.

Now that the clinic and all its practitioners are set up, we can begin scheduling appointments for the patients (figure 4).

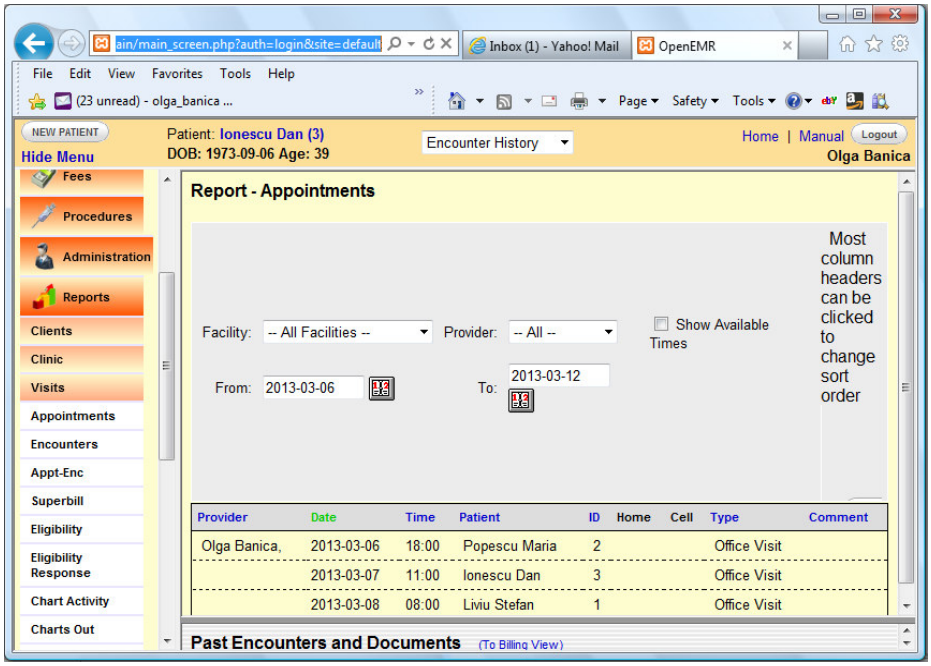

Figure 4. Report of all patient appointments

To locate a patient in the system, we must introduce all or part of their name into the search field and click 'Name' (Figure 5).

OpenEMR Software is relative simple to install on a local station, in a LAMP or WAMP configuration, or accessed in the Cloud, hosted by a dedicated provider, such as ZH Healthcare.

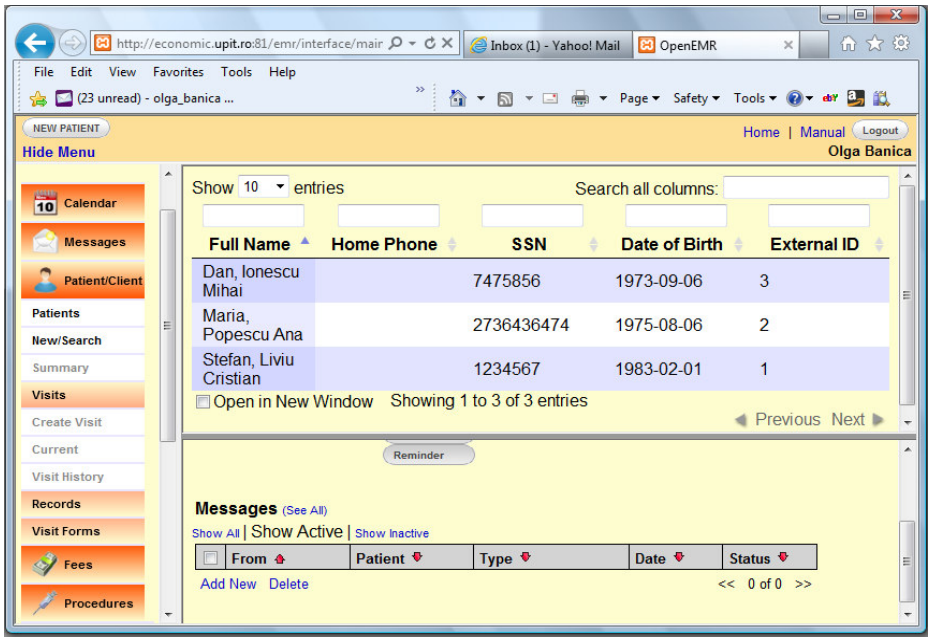

Figure 5. The list of patients

The experiment was dedicated to adding new patients and the appointments for a time period, introduce recommended prescriptions and generate miscellaneous reports.

The software responded to all technical requests of the mono-station experiment, next level being the evaluation of scalable performance on several servers.

5. CONCLUSIONS

The paper emphasizes the four main highlights for the future of the health environment that cloud-powered integration can offer:

- the advantage for the patients, healthcare organizations, pharmaceutics companies, insurance companies, governmental agencies;
- helping the patients to better care of their health and don't spend their time for medical record redundant operations.
- by migrating to the Cloud computing, healthcare professionals across the globe can collaborate in real time and share information without the need to invest in expensive infrastructure. So, they work with a centralized platform allowing to access reports, scans, electronic medical records (EMRs), prescriptions and patient information and medical history such as insurance claims, prescriptions, and lab reports from anywhere in the world.
- having a central repository for patient information will decrease the risks of misdiagnosis or the prescription of the wrong medication, as well as eliminating chances of conflicting treatments where multiple healthcare professionals are involved.

Today Romania takes important steps in the direction of upgrading the health system, with visible advantages for both the patients and the medical service providers. Though, the financial effort to implement all these technologies from the *CNAS* will be substantial. Therefore, the design, development and implementation of the Integrated Information System for Social Insurance (*SIUI*) required an amount of EUR 119.540.000 (excl. VAT) and a 15 years period to become fully operational.

Thus, our view on moving e-Health on Cloud refers to the implementation of a solution meant to reduce infrastructure costs both in public and private sectors, while keeping the same performance.

Running software such as OpenEMR in Romania involves two main components:

- firstly, a powerful provider for the hardware and software of the cloud system;
- secondly, conformance testing of the available software solutions, in order to assess if they are capable to meet the requirements of healthcare providers, respecting the laws for implementing the framework contract that rules the public health services.

It is not only a *technological challenge*, but also a *strategy decision one*, regarding the following factors: government regulations, budget, available technologies, organizational culture, and these may affect the capacity to reach the desired goal.

Also, we suggest that building an e-Health on Cloud is a process that must evolve through at least four phases: determine the e-Health Cloud model, compare the offers of cloud providers, migrate the information to the data center, run and evaluate a pilot implementation.

REFERENCES

1. Mell, P. and Grance, T. "NIST Definition of Cloud Computing V15." http://csrc.nist.gov/groups/SNS/cloudcomputing/index.html
2. C. Cacciari, F. D'Andria, M. Gonzalo, B. Hagemeier, D. Mallmann, et al. "elasticLM: A novel approach for software licensing in distributed computing infrastructures.", Proc. IEEE 2nd Int. Conf. on Cloud Computing Technology and Science, pp. 67–74, 2010
3. Gray, M. "Cloud Computing: Demystifying IaaS, PaaS and SaaS.", http://www.zdnet.com/news/cloud-computingdemystifying-iaas-paas-and-saas/477238, 2010
4. M. O'Neill. "SaaS, PaaS, and IaaS: A security checklist for cloud models." http://www.csoonline.com/article/660065/saas-paas-and-iaas-a-securitychecklist-for-cloud-models, 2011
5. Williams, A., "The Feds, not Forrester, Are Developing Better Definitions for Cloud Computing." http://www.readwriteweb.com/enterprise/2009/10/forrrester-says-we-need-better.php, 2009
6. http://www.gov.ro - Legea bugetului de stat nr. 5/2013
7. Eysenbach G, What is e-health?, J Med Internet Res 2001;3(2):e20, http://www.jmir.org/2001/2/e20/, doi: 10.2196/jmir.3.2.e20, PMID: 11720962
8. Foster, I.; Zhao, Y.; Raicu, L.; Lu, S. Cloud Computing and Grid Computing 360-Degree Compared. In *Proceedings of the Grid Computing Environments Workshop (GCE)*, Austin, TX, USA, 12–16 November 2008; pp. 1–10
9. Bharat Chadha, Meena Iyer, „BI in a Cloud: Defining the Architecture for Quick Wins", SETLabs Briefing, Vol 8, No.1, pp 39-44, 2010
10. Chris Hagans, "Business Intelligence in the Cloud", http://cloudcomputingtopics.com/2011/09/business-intelligence-in-the-cloud/, 2011
11. eHealth Technologies, authors. *What is eHealth?*, http://www.ehealthtechnologies.com/what%20is%20ehealth.htm, 2004
12. http://en.wikipedia.org/wiki/EHealth
13. Eman AbuKhousa, Nader Mohamed and Jameela Al-Jaroodi, *e-Health Cloud: Opportunities and Challenges,* Future Internet 2012, *4*, 621-645; doi:10.3390/fi4030621, ISSN 1999-5903**,** http://www.mdpi.com/journal/futureinternet
14. http://realsearchgroup.com/ohc/
15. "Sourceforge OpenEMR Project", http://sourceforge.net/projects/openemr/
16. "OEMR Organization Website", http://www.oemr.org/.
17. http://www.zhservices.com/zh-openemr-cloud-based-architecture
18. Mladovsky, P., Srivastava, D., Cylus, J., Karanikolos et al., Health Policy in the Financial Crisis, Eurohealth incorporating Euro Observer, Vol.18, No.1, 2012, http://www.euro.who.int/__data/assets/pdf_file/0005/162959/Eurohealth_Vol-18_No-1_web.pdf
19. Georges Liberman, e-Health in Europe, http://www.ingenico.com/ru4fef.pdf?t=/documentManager/sfdoc.file.supply&fileID=1341391556104
20. Bittschi, B. and Markus, K., Implementation and development of the E-card, 2007, http://hpm.org/en/Surveys/IHS Austria/10/Implementation_and_development_of_the_E-card.html
21. McEvoy, N., Cloud 2.0 integrations in eHealth Canada, 2012, http://canadacloud.net/2012/06/16/cloud-20-ehealth/
22. Tammi Marcoullier, Trending in 2013: Electronic Health Records, 2013, http://blog.howto.gov/2013/01/03/trending-in-2013-electronic-health-records/
23. Colley, A., Telstra cloud pilot in e-health system, 2010, http://www.itnews.com.au/News/219433,telstra-to-build-e-health-cloud.aspx