

A Health Cloud Framework to Present a Comprehensive EHR Integrated System

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To cite this article:

Sahar A. El_Rahman. A Health Cloud Framework to Present a Comprehensive EHR Integrated System. *Software Engineering*. Vol. 5, No. 1, 2017, pp. 1-7. doi: 10.11648/j.se.20170501.11

Received: October 31, 2016; **Accepted:** January 6, 2017; **Published:** February 22, 2017

Abstract: Information Technology is a significant portion of the healthcare system. Availability, integrity, security, and accuracy of the data in every healthcare process are vital. So, such data should be updated to fulfil continued improvement of the services in each healthcare providers and especially in healthcare. Thus, several information systems must be integrated with the healthcare systems. Healthcare record includes some information such as specific allergies and medications, medical history, the status of immunization, radiology images, results of lab and examination, everyone stat such as weight and age, appointments, order tests, and diagnoses. This record is identified by patient ID. The authorized hospital employees and the doctors will use their password and ID to login the application for privacy and security. Then a request for that patient record will be sent by using the patient ID, that will be received by the doctor, the recording ought to be recent since the patient final visitation to any Health Care (HC) organization in Kingdom of Saudi Arabia (KSA). So, the patient has a single Electronic Health Record (EHR), and this will reduce the cost and time of patient, and support doctors to obtain proper and recent information of any patient from the recordings from any HC organization in KSA. Also, EHR gives a better healthcare of patients that averts some medical errors due to the information lack and health records unavailability. A small number of HC organizations have more advanced EHR adoption, where the most of them has no EHR at all. So, we proposed a Health Cloud Framework (HCF) to offer a comprehensive EHR unified system, by applying the cloud computing technology on EHR system. Where, the paradigm of cloud computing is a latest appearing technology utilized in industries and achieved a considerable gaining. Regardless of the large characteristics of cloud computing, they haven't been used rightly so far, in the medical industries. HCF proposed to get better the normal process of acquiring all patient health recordings distributed in each HC organization any time using portable devices, based on cloud computing technology oriented architecture.

Keywords: Cloud Computing, Bioinformatics, E-Health, EHR Integration, Electronic Health Record, Healthcare

1. Introduction

A clinical history information of patients in a health records system, managed and accessible by health care organizations. Sick persons recorded in the separate health record system in various HC organizations suffering from waiting until carrying their portfolios to other health organizations. That hardness could be overcome by HCF system integration in health care organizations. However HCF integration that means sharing patient data process

between HC organizations and exchanging them with other HC organizations over the internet, still a serious issue and a big challenge because it is insecure to stealing, security violations, laws and standard problems [1].

With the expense of health care, HC organizations are still searching for a mechanism to continue competitive and provide medical services with quality to the patients. The healthcare industry has traditionally concentrated on difficulties in managing procedures and information technology to remain competitive. However, healthcare organizations have established to understand that cloud

computing paradigm could be a preferable solution to attain a competitive advantage. Cloud computing enables healthcare organizations to evaluate their involved processes, determining efficiency and redundancy that can be removed [2].

In the later years, the health care industry has faced important challenges related to limited budgets, service demands that comply with new ordinances and legislation, as well as engineering-savvy consumers that need a higher layer of interaction, e.g., instant access through portable devices. Moreover, as healthcare enterprises expand, their IT infrastructure is becoming more complicated, so needs more IT staff for maintenance [3].

To address these challenges, some forward thinking health systems are transitioning towards Cloud offerings. Cloud reduces the complexity of keeping up a dedicated infrastructure, brings down the capital expense of bringing out new services, and allows experienced entities to manage their applications. At the same time, Cloud offerings allow HC organizations to deliver higher business agility. The HC institutions are capable of identifying related services and products in an effective environment. They can rapidly provision applications, present new services and products to the market, and develop the user experience [3].

In today's fast paced global economy, people are busier now than ever before. The financial stress has forced people to manage more with less. Thus, they are regressing back to an old technology made new again in cloud computing. The concept behind cloud computing is the ability to store ones data on a server in the datacenter "The Cloud" and retrieve it via users digital devices (PC, laptops, tablets, and smart phone). Cloud computing demand for mobile technology has increased dramatically as more and more people have started to propel out from traditional desktops to using mobile devices and cloud services. Recent improvements in computer communications technology and particularly Cloud computing are forcing some of these varieties. A 2010 report by Gartner Consulting shows that cloud revenue will increase from 58.6 billion in 2009 to nearly 150 billion in 2014. Cloud computing is a transformative paradigm which offers; ubiquitous network access, on demand services, location independent resource pooling, pay per usage, and rapid elasticity [4].

2. Cloud Computing

Cloud computing is the digital variant of Internet based computing. It delivers access to the applications, platforms, and hardware over the Internet (see Figure 1) [5]. Nevertheless, there are even several stories as that is completely concerned with clouding computing. More specifically, NIST (National Institute of Standards and Technology) defines "Cloud computing as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. Networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal

management effort or service provider interaction" [3] [4]. Some of the central elements of cloud computing include [4]:

- Admittance to the cloud is offered through a participation base utilizing a request resilient cost type in it the clients pay further if they use further resources on the swarm.
- The infrastructures are maintained and owned by the cloud services Providers as a third party.
- The cloud computing service models (see Figure 2) are brought through the internet making them location and platform agnostic [6].

In different concepts, the end client demands to preserve their web connections and the whole desired services could be obtained via the web. Service Types On Demand Self Service Having on demand services requires less human interaction as well as network storage from a service provider. The central characteristic of this service is the ability for the cloud customer to take and release service capacity without human intervention from the avail supplier. This procedure enables the cloud customer to manage their computing needs for processing every bit well as storage on demand. Broad Network Access This allows information to be accessed via thin or thick client platforms and cloud based software application helps. In most cases the cloud customer needs only a thin client, which they accept. Because of this the benefits of cloud service are within reach of a very large section of the business community globally. Resource pooling the third party provider essentially serves multiple organizations by using pooled resources depending on the organization's need. Traditionally the server utilization rates have been quite low, approximately 10% of the server capacity in most shells. The cloud service provider is able to use virtualization technique and hit their server capacity used by multiple clients. In this face the cloud service has significantly increased the server utilization rate at the cloud service provider level [4].

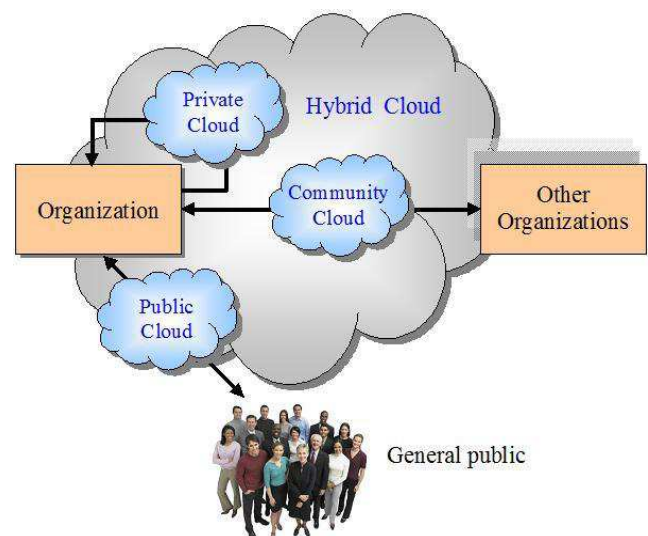


Figure 1. The cloud computing deployment models [5].

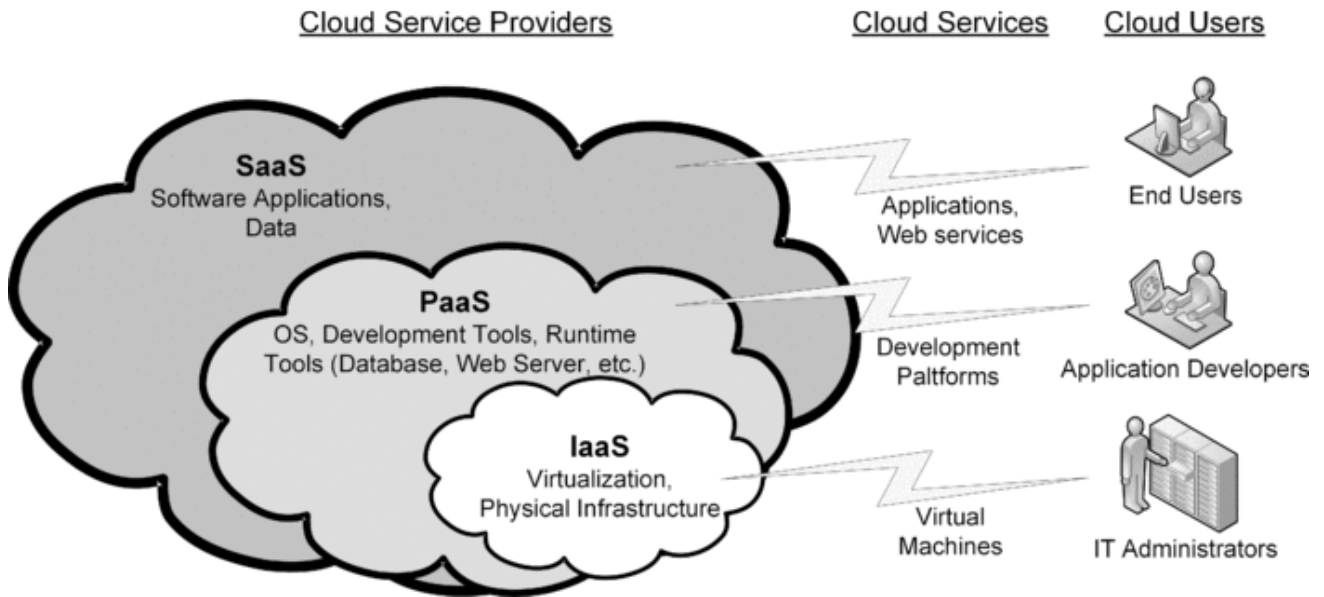


Figure 2. Different types of cloud services [6].

2.1. Cloud Computing Characteristics

Cloud computing appears as usable solutions to accomplish the clients needs. Trade suppliers like Microsoft and Amazon assure to create thousands of Virtual Machines ready instantly and just they are indeed desired. The vantage of that offering is, the resources exclusive should be paid for the time, size and configuration, the clients are really utilized [7]. Cloud computing Opportunities and challenges (See Table 1 and Table 2) [5][8].

Table 1. Cloud computing opportunity and challenge summary [5] [8].

Aspects	Opportunities	Challenges
Security	More resources available for data protection	Unpredictable performance
	Replication of data in multiple locations, increasing data security	Data lock-in
Technology	Dynamically scaled defensive resources, strengthening resilience	Data transfer bottlenecks and international data transfers
	Reduction of IT maintenance burdens	Bugs in large-scale distributed cloud systems
	Scalability and flexibility of infrastructure	Separation failure
Management	Advantage of green computing	Public management interface issues
	Lower cost of new information Technology (IT) infrastructure	Poor encryption key management
	Computing resources available on demand	Privilege abuse
	Payment of usage on a short-term basis as needed	Data jurisdiction issues
Legal	Provider's commitments to protect customer's data and privacy	Privacy issues
	Development of guidelines and technologies to enable	Lack of trust of health care professionals

the construction of trusted platforms by not-for-profit organizations	Organizational inertia
Fostering of regulations by government for data and privacy protection	Loss of governance
	Uncertain provider's compliance
	Resource exhaustion issues

Table 2. Possible solutions to the cloud computing challenges [5].

Challenges	Solution Summary
Management and technical issues	Ten solutions to handle technical, policy, and business issues Further references to handle cloud-federated management issues XML-based mediator to handle data lock-in (interoperability) problems
Security and legal issues	Solutions to handle cloud governance and operationa issues (12 domains) Precaution recommendations to deal with security and privacy issues Five strategies for handling data jurisdiction issues

2.2. Main Domains of Cloud Computing in Healthcare

An increase in the cloud application number in HC is unavoidable. Clinical research, digital images, and EHR are just the source of wherever the HC clouds are leading [9]. The most domains of the cloud computing applications in HC, sharing information and providing communication between the stakeholders in HC. The main important domains are:

1. Tele-consultation and Telemedicine [7].
2. Patients' self-management and public health.
3. Medical and magnetic resonance imaging.
4. Clinical data systems and HC management.
5. Data secondary purpose.
6. Medication.

2.3. Classification of Healthcare Cloud Services

A cloud services variation is convenient to HC establishments that include [3]:

- Electronic wellness and health tools.
- Information and image warehousing.
- Information and image sharing.

Cloud computing services offer healthcare providers, health plans, and other healthcare organizations significant information technology savings and increased scalability. Nevertheless, not all cloud providers are created alike -- risks need to be managed and functional integrity, as well as data security, needs to be maintained [10].

2.4. Cloud Computing Benefits to Healthcare

Many HC institution services have been transferred into a cloud paradigm, mainly since:

- The interchange of patient information located in different HC organizations.
- Facilitating the insurance process by linking the data of insurance with the records of the patients.
- Automation of the medication order procedure which is actually paper based in most HC organizations [11].
- Raising the quality of care offered.
- Cost Reduction (to pay simply for the service user consume) [2] [3].
- Management Simplification [3].
- Improved Service Delivery [3].

Cost decrease is accomplished by removing great principle expenditure of IT infrastructure as well as operational expenditures. The capability to shrink and grow IT capacities related to needs is another characteristic which voids over resources provisioning and therefore cuts down the price. For a healthcare governance, understanding the Cloud computing characteristics is critical to secure the program conforms to all in-house IT requirements [3] [12]. The benefits of cloud computing are the financial, business continuity, and performance [10]. The challenges, barriers and successes of cloud computing are considerations for healthcare organizations [10] [13].

Cloud computing provides many advantages for healthcare providers, but there are some drawbacks to the technology as well. Cloud computing has quickly made inroads into the health IT space. It is an efficient data storage method and helps ease the exchange between healthcare systems. The concealment and security considerations of cloud computing in health care might be the primary cause why some healthcare organizations are not taking this paradigm [10] [14].

2.5. Considerations When Evaluating Cloud Services Providers

Health care systems are getting a wide change of constituents into consideration when evaluating cloud service providers, advising that these healthcare systems are taking due diligence prior to putting applications and information in a cloud environment. Despite this high stage of preparation,

health care systems have involved relatively few steps with respect to staffing. Among current users of cloud services, respondents were least likely to suggest that their healthcare organizations undertook initiatives related to staffing in preparation for going through and using cloud services. This indicates that they expect their cloud service providers to deliver a "turnkey" solution that does not involve special training of their staff [13].

Computing in health care and life skills are rapidly adapting to opportunities created by new technologies for scalable data storage, elastic compute service resources, and data analytics. Passed on the powerful forces changing the political economy of the overall wellness care marketplace, technologies that can address security and compliance at reduced cost are getting a great deal of attention [15].

Specialty service providers are targeting the unique needs of life sciences and wellness care with computing solutions for virtualization, high performance computing, application development and disaster recovery. To construct a standards-compliant, high-reliability platform for wellness care and life sciences, computing, Multiscale set out to find cloud technology suited to optimized, high-availability data storage and computing for clinical and research customers [15].

Healthcare organizations evaluate multiple commercial and open-source cloud and virtualization options. Avoiding vendor lock-in was a key requirement behind the selection, along with support for on premise and remote data center deployments. In increase, the flexibility of open source simplified development of specialized compliance, protection, privacy and audit approaches [15].

3. A Framework of Health Cloud

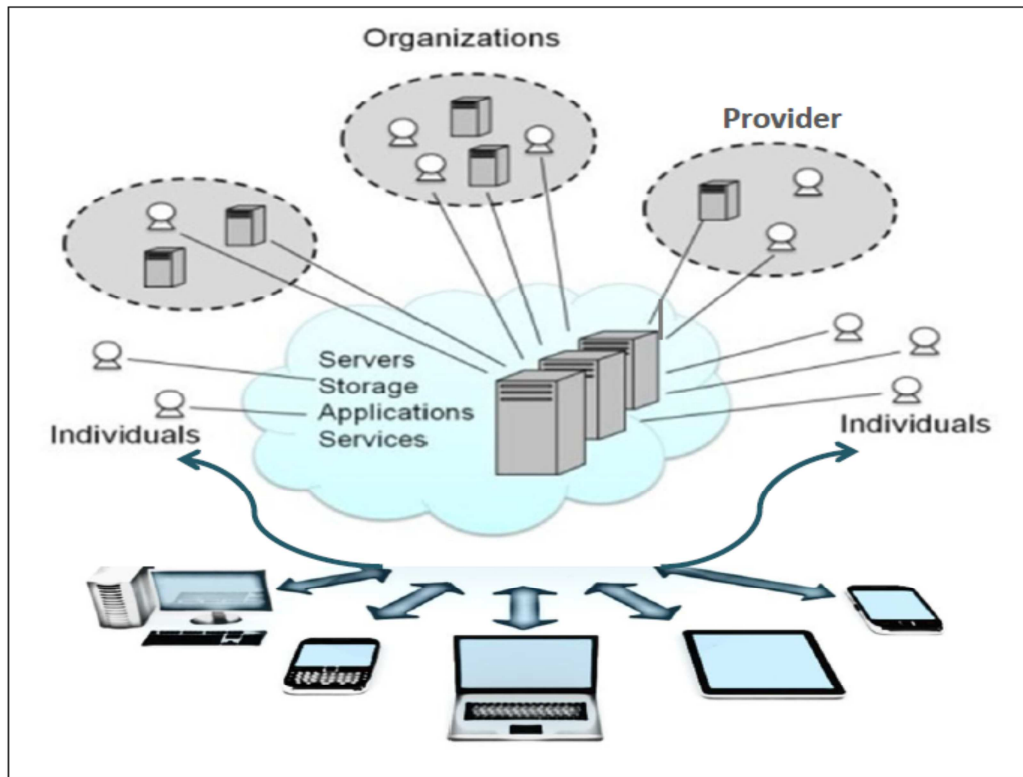
The competition in healthcare area is extended worldwide, it has become definitely necessary for the healthcare organizations to transform and integrate technology enabled processes for the management of healthcare record. Then, the doctor patient collaboration is enhanced and effective patient records management. Cost reduction for services that handled and hosted is one of the key cloud computing features.

HC institutions have thirstily taken in emerging paradigms to decrease IT expense, however, still seeking to encounter the patient demands. The generation of EHRs, for instance, has made better data sharing and cooperation for medical practitioners, also providing enhanced gain access to sick persons. This growth in acceptance of modern technologies has as well built the cloud worthy assets for controlling the cost of information storage and regulating the management of IT. Nevertheless, extremely organized industry faces distinctive challenges in title of deference.

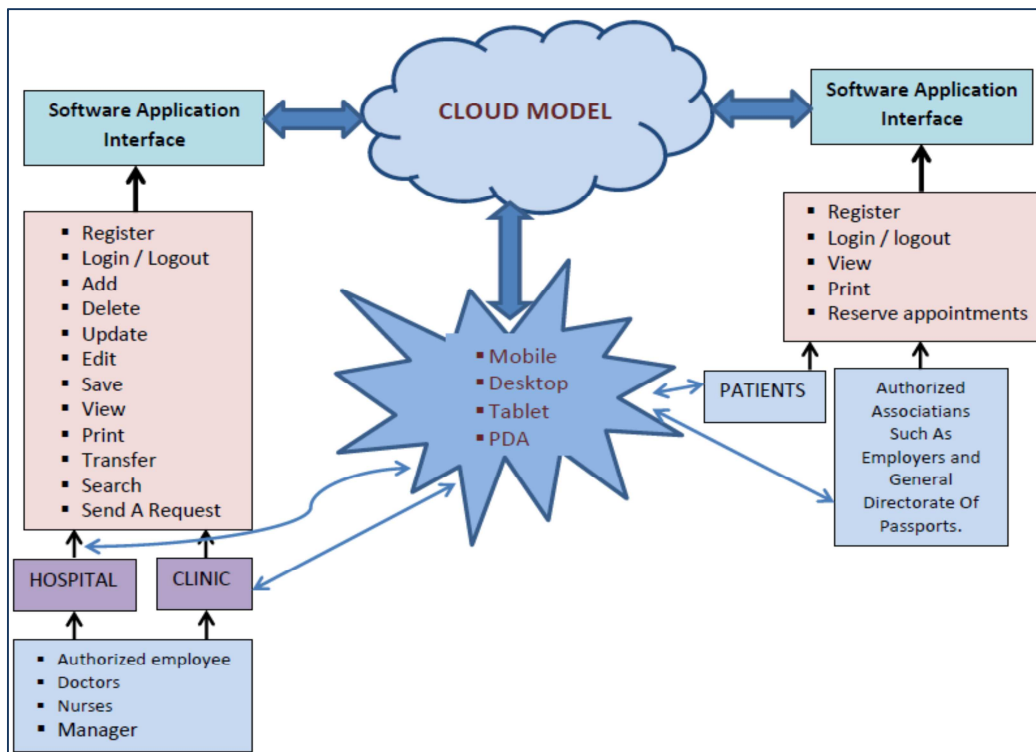
A health cloud is the interconnection of a vast number of hosts and computers set up to supply the essentials of the health care industry. The services of health care are rendered to the stakeholders who can be employees, nurses, doctors or patients through the internet using portable devices. The cloud services allow stakeholders to access the software and hardware controlled by the third party at distant locations. As

a result, Cloud computing changes how information is accessed and stored. Today, the whole paradigm has changed over to document the centric context from desktop centric, while the HCF encourages the utilization of cloud computing

capabilities in the healthcare industry. HCF has different characteristics referred to each stakeholder as indicated in (see Figure 3).



(a)



(b)

Figure 3. A Framework of Health Cloud.

4. Results and Discussion

The proposed framework supplies a standardized, integrated context of various EHR systems to freely connect in the absence of any obstacles. The proposed framework gets the better of the obstacles of integrating EHR systems for several HC organizations like as the complexities of maintenance, staff development and rising prices. In whole cases, the proposed system presents effective and comprehensive HC services. It permits several HC organizations to connect and readily sharing EHR information of patients via the HC cloud system. Furthermore, it surmounts the EHR system integration challenges like as the web security worries and the hardness of information standard and it introduces a scalable and configurable EHR system in the paradigm of cloud computing for health maintenance suppliers. The system also maximizes health care service quality results by releasing them from technology problems. Ultimately, the proposed system facilitates the HC allocation procedures and also, offers patients more comfortable, dependable and cooperative HC lifetime. Protection is one of the major events and concerns patients have about EHR and integration. The cloud system uses the latest security technology and the secrecy of the patient data is guaranteed by a patient authorizing mechanism.

HCF Features

Health cloud system provides an efficient and effective system to decrease the clinical and administrative transaction costs. The benefits of the Health Service include:

- Improved data center availability ensures better service for patients and all users.
- Time savings through single interface monitoring and Administrative time savings through performance reports.
- Reduced time to provision new servers, provides greater responsiveness and scalability.
- High level of patient satisfaction.
- Control and supervise execution of store inventory and pharmacy.
- Easy and fast healthcare insurance claim processing.
- Laboratory reagent tracking.
- Improves service quality and increases productivity.
- Maximizes resources utilization across all health organizations.
- Just pay as you use.
- Lowered the capital cost of IT infrastructure, allowing budgets to be redirected to the tending of patients.
- Saving the cost of maintenance and upgrades.
- From anywhere, access to EHR for patients.
- Provided a long-term strategy for IT operations, insuring an effective and cohesive method of management.

5. Conclusion

Through the last century IT has functioned a critical part in reinventing, driving, and defining processes, systems, and medicine in HC. Cloud computing has been ushered in just lately. Many doctors and researchers pay attention for supplying of a comprehensive, readily approachable, and re-configurable resources like as platforms, applications and virtual systems with small services pricing. A health cloud framework has been proposed for integration and unification of EHR. The proposed framework makes use of cloud computing features integrating them with the characteristics of the EHRs system to achieve an integrated centric system that manages EHRs in the cloud architecture. HCF presents a scheme for health care providers in the Arab states, to take the chance to share and utilize EHRs.

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