International Journal of Enhanced Research in Science Technology & Engineering, ISSN: 2319-7463
Vol. 3 Issue 10, October-2014, pp: (22-26), Impact Factor: 1.252, Available online at: www.erpublications.com

A Review of Cloud-Based Healthcare System

Veer Lade, Sayali Jaitpal, Ameya Chitnis
Department of Computer Science, Electronics and Telecommunication
St. Francis Institute of Technology, Mumbai, India

Abstract: Cloud computing is one of the most recent revolutionary technologies in the world. Today the application of cloud computing is so widespread that it is being used even in the health care industry. Recently, there has been a remarkable upsurge in activity surrounding the adoption of Personal Health Records (PHRs) on the cloud. The benefits of storing electronically the records of patients have increased the productivity of patient care and easy accessibility and usage. Hospitals, doctors, research clinics, private and public health care institutions are looking for alternatives in order to increase the efficiency of the services economically. If these cloud computing technologies are implemented appropriately, they meet the requirements of majority of the problems faced by the healthcare industry. The major advantages of cloud computing in the Healthcare industry include mobility of records, speed, security and privacy.

A framework from a developing nation's perspective wherein the healthcare institutes and the physicians can be connected with the rural masses who face financial and geographical constraints. A globalized cloud based database will make the patient's medical record and history available at a single click from anywhere at any time. Also the patients' health records that are stored on the cloud will prove beneficial for statistics and research purposes. This will also pave a way for e-prescribing in the near future. We are motivated to work towards a web based application for the above mentioned concept while also incorporating Apache Hadoop for improving the efficiency of data storage, data retrieval and operational overhead . A Barcode printed card would pave a way for improved personal identification and emergency services. As the evolution of cloud computing in health care is occurring at a rapid rate in recent times, we can expect a major part of the health care services to move onto the cloud and thereby more focus is laid on providing a cost effective and efficient healthcare service to the people all around the globe.

Keywords: cloud computing; developing countries; Health care; Web application; Personal Health Records.

I. INTRODUCTION

A thorough literature has been done by studying various international papers. According to the World Health Organization, there is a shortage of 4.3 million doctors and other medical staff in the world [8]. This problem is even more intense in the developing and the under-developed nations who have a significantly lower doctor per patient ratio. The reason being that the physicians find better working environment and a stable financial support in the urban areas. Hence the best healthcare centres and specialists are located in the metro areas. Thus the rural masses are devoid of quality healthcare services. With the help of latest technology, this geographical and financial constraint can be nullified to some extent. Patients can communicate with the doctors via video-conferencing and Personal Health Records (PHR) [4] sharing.

A. Cloud Computing:

Cloud computing is a recent trend in Information Technology that moves computing and data away from desktop and portable Personal Computers into large data centres. The main advantage of cloud computing is that customers do not have to pay for infrastructure, its installation, required man power to handle such infrastructure and maintenance. In a cloud computing system, there's a significant workload shift. Local computers no longer have to do all the heavy lifting when it

comes to running applications. The only thing the user's computer needs to be able to run is the cloud computing system's interface software, which can be as simple as a Web browser, and the cloud's network takes care of the rest [1]. On the back end of the system are the various computers, servers and data storage systems that create the "cloud" of computing services. A central server administers the system, monitoring traffic and client demands to ensure everything runs smoothly. It follows a set of rules called protocols and uses a special kind of software called middleware. Middleware allows networked computers to communicate with each other [2].

B. Personal Health Records (PHRs):

By the term Personal Health Record (PHR) we refer to a collection of information about individual's health and health care that is gathered from different sources such as from health care providers, pharmacies, insurers, the consumer, and third parties such as gyms. A PHR typically includes information about medications, allergies, vaccinations, illnesses, laboratory and other test results, and surgeries and other procedures [4]. By the term PHR system we refer to a software application that manages PHRs. Through the introduction of sophisticated PHR systems we can contribute to preventive medical care and achieve better health and well-being while reducing healthcare cost. PHR's grant patients access to a wide range of health information sources, best medical practices and health knowledge. All of an individual's medical records are stored in one place instead of paper-based files in various doctors' offices. Upon encountering a medical condition, a patient's health information is only a few clicks away. Moreover, PHRs can benefit clinicians. PHRs offer patients the opportunity to submit their data to their clinicians' Electronic Health Records (EHRs). This helps clinicians make better treatment decisions by providing more continuous data. Eliminating communication barriers and allowing documentation flow between patients and clinicians in a timely fashion can save time consumed by face-to-face meetings and telephone communication.The PHR is represented using an extended ontology n a graphical form and in Web Ontology Language (OWL) in which data is imported in Resource Description Framework (RDF) format [3].

II. LITERATURE REVIEW

A. Database Storage:
The massive data gathered from the health care services can be used for research and statistical purposes. The data includes patient centric, resource management and transformed data, hence efficient and secure storage and retrieval of data is required. Online-analytical processing (OLAP) [5], decision trees or artificial neural networks can be used for data mining.

B. Computer Graphics:
Computer graphics collaborated with medical imaging can be brought to use to visualize medical problems through MRI, CT scans and ultrasound technologies. With the use of artificial intelligence and robotics, it has become possible to undergo surgeries remotely in addition to the techniques like computerized diagnosis and automatic prescription [5].

C. System and Scenario:
An ecosystem is proposed through which different health care institutes can be connected together such that all the personal health records will be stored electronically and made available to other institutions. This shall help in building a knowledge base which will prove beneficial for improving the quality of health care services [5]. In-case of an emergency where a patient is rushed into the trauma centre and not much time is available to refer to their case file their medical record can be instantly accessed and the treatment can start with immediate effect. Their record consists of medical history, symptoms and complications faced which will help in providing them with accurate diagnosis. A wireless sensor node [5] is planted externally to the body of the patient for real time vital statistics.

D. Infrastructure:
The infrastructure required at every primary health centre consists of pc, television sets, microscopes, x ray and document scanner and ECG machine. The proposed system has characteristics like digital medical records, ease-of access, data

repository, ease of management, quick referencing, standardization, verification, transparency and prediction of epidemics [5].

E. Mobile Cloud Computing:

Mobile cloud computing has emerged from the amalgamation of mobile and cloud computing, whereby previously infeasible mobile applications are now feasible. Due to the increasing flexibility and agility, the system organizations are increasingly considering migrating to mobile cloud computing [6]. The mobile computing approach provides access to data stored on a cloud infrastructure by means of an android application. The information delivery is performed according to the push messaging model, thus reducing the burden of acquiring data for tasks where time critical data must receive immediate attention. This application has five potential users; ambulance communication operators, ambulance service physician, ambulance paramedics, emergency department physician and emergency department nurse [6].

F. Cloud Application-EMS:

The development of emergency medical services (EMS) [6] system as a cloud computing application which interfaces with a PHR can be accessed by any mobile device. This system is interconnected with the ambulance services for dealing with virtual emergency situations. A prototype implementation of this approach called NefeliEMS [6] is considered here. The NefeliEMS software operates behind a firewall and hence provides an enhanced security. It is an offsite cloud storage system comprising of a number of servers where both PHR and EMS data is stored. It consists of three platforms namely; Business Process Execution Language (BPEL) [6] engine, PHR platform and web/application server. It is accessible either by a web portal or an android client application. The components participating in the notification service are android enabled mobile devices where Nefeli mobile has been installed via google cloud messaging servers.

G. Communication Framework:

The cloud based platform combined with customized text messages over the network, " doctor patient interaction " effectively narrows the distance between doctors and patients in space and time. China mobile will provide a powerful cloud computing and communication framework which will be able to store medical information, statistical analysis and resource reorganization [7]. This results in an effective multi-channel information exchange and improves the efficiency of medical treatments of patients, expanding the audience of medical information. The rehabilitation guide butler service has been approved by the Guangzhou province government and is promoted among patients.

III. GAPS IDENTIFIED FROM LITERATURE REVIEW

On reviewing various international papers it has noticed that although OLAP [5] and decision trees are used for data mining and efficient data storage, none have implemented Apache Hadoop on the backend of the cloud platform. Instead of using an android based application like the NefeliEMS [6], we suggest developing a cloud based web application running on the Google App Engine which will provide environment independence and also implementation of Hadoop on the Google cloud service is convenient. The use of Barcode printed scanners for personal identification can also be implemented for better statistics and security of data.

A. Apache Hadoop:

Apache Hadoop is open source, and explored a innovative new way of storing and processing data. Instead of relying on expensive, proprietary hardware and different systems to store and process data, Hadoop enables distributed parallel processing of huge amounts of data across inexpensive, industry-standard servers that both store and process the data, and can scale without limits. With Hadoop, no data is too big plus to understand how it's possible to scale a Hadoop cluster to hundreds (and even thousands) of nodes, you have to start with the Hadoop Distributed File System (HDFS) [9]. Data in a Hadoop cluster is broken down into smaller pieces (called blocks) and distributed throughout the cluster. In this way, the map and reduce functions can be executed on smaller subsets of your larger data sets, and this provides the scalability that is needed for big data processing. Apache Hadoop can be executed on the Google cloud platform thus providing reduced operational overhead, better query execution, economical approach and efficient storage space utilisation [10]

B. Web Application:

Google App Engine provides easy to build, easy to maintain and scalable data storage as the data stored on the cloud is dynamic in nature with constantly changing traffic and storage needs. Its features include persistent storage with queries, sorting and transactions; automatic scaling and load balancing; integration with other Google cloud services and Application Programming Interface (APIs) and scheduled tasks for triggering events at specified times or regular intervals [11]. Also it supports programming languages such as Java, Python and PHP.

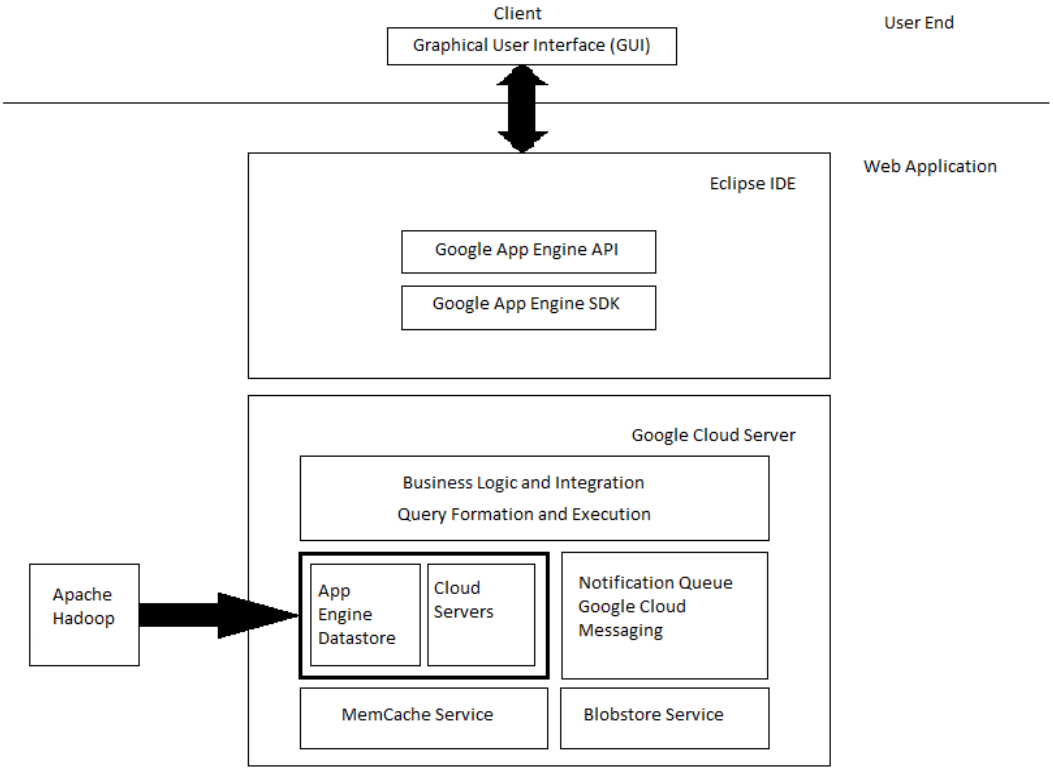

Fig.1: Web Application Architecture

The Fig.1 consists of a Graphical User Interface programmed in java using the Google App Engine Software Development Kit (SDK) in the Eclipse Integrated Development Environment (IDE). The client will only interact with the user interface part of the system. The backend of the system will be handled by the Google Cloud Services. It will handle the business logic, integration and the query formation as well. Google SQL is a MYSQL database and hence it supports MYSQL queries. It also provides a cloud database called the app engine datastore on which we can run Apache Hadoop for efficiency purposes. The cloud web servers will be handled by google based on the traffic demands. The Google Cloud Messaging will be used as a notification queue to send instant messages to the doctors. Memcache services are provided for storing the constantly accessed data in the cache. Blobstore provides a facility to store unstructured as well over-sized data.

C. Personal Identification:

Users will be provided with barcode printed electronic cards to help unique identification. Also in case of emergency situations where the patient is not able to communicate, these cards can be used to easily access the patient's PHR which consists of all the detailed medical history. The ultimate authority of accessing the PHR lies in the hands of the patient with an exception of emergency situations.

IV. CONCLUSION

Considering the grave situation of medical personnel shortage, the suggested system shall prove to be a benison if implemented appropriately. With sufficient government's willingness and support, this framework can be implemented on a national as well as a global scale. The system will help create interactive ecosystem providing quality healthcare to the masses facing financial and geographical constraints. This paper proposes the use of Apache Hadoop as backend for cloud based system which would improve the efficiency and the working of the existing systems.

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