Impact of Cloud Computing on Health Care

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Abstract - *The term "Cloud Computing" is a recent buzzword in the IT world and has been a major topic of conversation as of late and is emerging as one of the most important technologies of this decade. Large technology companies are already investing millions of dollars in building infrastructure, services and applications to make cloud computing easily accessible to consumers, organizations and businesses. It remains to be seen how cloud computing will impact the healthcare business since it is very diverse and complex, it presents several challenges such as protecting members health records in addition to following HIPAA guidelines set by federal compliance regulations Efforts are being made to decrease the costs for consumers and it will play a big role in achieving it and also improving clinical and quality outcomes for patients. It will be very interesting to see how cloud computing will address and contribute towards these issues in the healthcare industry. Cloud computing field has an immense potential in it to be used in the field of healthcare especially developing countries like India. This article will discuss briefly on the inception of cloud computing and what it exactly is.*

Key Words: Cloud, Cloud Computing, HealthCare, Electronic Records, Security, Mobile Health, HIPAA.

1.INTRODUCTION

Cloud computing is one of the most recent revolutionary technologies in world. The applications of Cloud computing is rapidly increasing in day to day life. Today the application of cloud computing is so widespread that it is being used even in the health care industry. 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 healthcare 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.

Despite of a common belief that certain boundaries and security issues of the cloud would hinder the shift, the healthcare industry is taking an initiative to move to these cloud based platforms. Today many doctors and hospitals are moving to-wards these clouds in order to provide better healthcare services to their patients.

According to the research firm Markets and Markets, The cloud computing market in the health care sector is expected to grow by 2017 to $5.4 billion. Hence from this survey it can be interpreted that the applications of cloud in healthcare is going to be a huge industry in the near future.

2. CLOUD COMPUTING BASIC

Cloud computing has freshly come out as a new sculpt for delivering and hosting Information Technology (IT) services over the internet. It provides services that are on-demand, scalable, and multi-tenant on the pay-per-use basis.

Several definitions have been given for cloud computing model but no one is standard definition that describes it completely. However, National Institute of Standards and Technology (NIST) defines it as "Cloud computing is a model for facilitating well-situated, on-demand network access to a shared band of configurable computing resources like networks, servers, storage, applications, and services that can be rapidly provisioned and released with minimal management effort or service provider interaction".

NIST cloud framework also defines five key attributes, three service models, and four deployment models. These essential service attributes include on demand self service, broad network access, resource pooling, rapid elasticity and measured service.
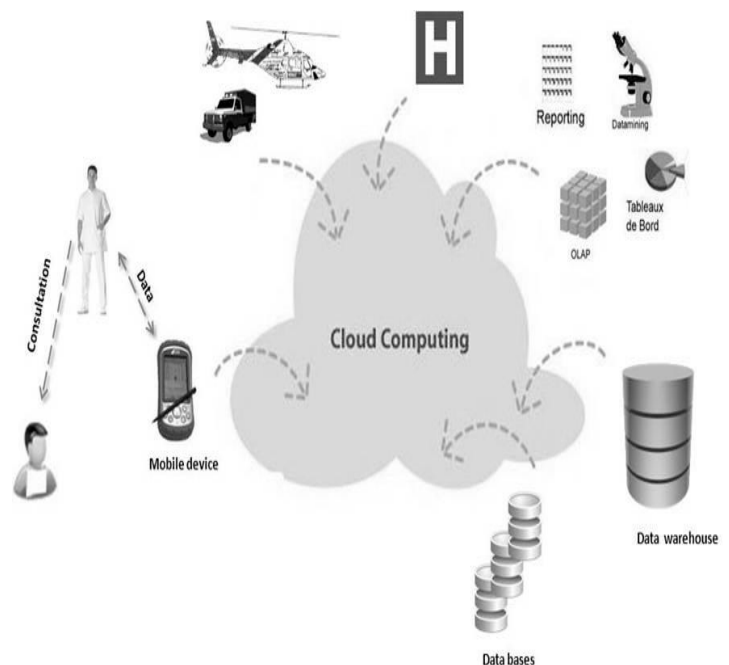

Fig-1:-

2.1 Service Moedels

Following are the service models of cloud computing:

Software-as-service (SaaS): SaaS provides various software applications which clients can use without having to install them on their machines. These services like e-mail, facebook, and google docs are accessible from any device having a web browser.

Platform-as-a-service (PaaS): It comprises a set of software development and deployment technologies e.g. operating systems, application development environment, databases, and web servers. People can use these services either to host or to develop and test their applications. Microsoft Azure, Google AppEngine and Amazon SimpleDB/S3 are some examples of PaaS.

Infrastructure as a service (IaaS): This model offers an organization with services like processing, storage and network bandwidth. Businesses and institutions can purchase these compute and I/O services to meet their application demands. Examples include GoGrid, FlexiScale, AmazonEC2 etc.

2.2 Development Models

Four deployment models of cloud computing are as follows:

Public cloud: Public cloud as its name suggests 'Public' is available to general public. It is economical cloud that is stand-alone, proprietary based and off-premises. In house and small businesses use public cloud mostly to meet their requirements.

Private cloud: Big organizations use private cloud to serve their business needs internally. Private cloud is more secure, well configured and expensive as it is not shared. Private cloud is usually on-premises.

Community cloud: Organizations that have similar requirements and business targets they use community cloud. It is just like public cloud but only for the participating groups with enhanced security and privacy control. It can be located on-premises or off-premises.

Hybrid cloud: Hybrid Cloud is a combination of two or more clouds (private, community or public). Hybrid cloud is a single cloud that provides blend of shared services. The major issue of hybrid cloud is its security and control. Hybrid cloud can be on user or on provider's premises.

3. CLOUD COMPUTING BASED HEALTHCARE SERVICES

Healthcare industry has been using new technologies to streamline processes, deliver novel patient care applications and ultimately to provide improved healthcare services. Despite the use of IT solutions, healthcare organizations face

the challenges such as high infrastructure management costs, dynamic needs for computational resources, scalability of human resources, ubiquitous access, multi-tenancy and increased demand for collaboration. These key challenges vouch for the introduction of cloud computing in healthcare organizations. The five essential characteristics of the cloud adequately address these challenges.

- *On-demand service:* resources can be provisioned immediately without any human intervention.
- *Broad network access:* services can be accessed from any location at any time.
- *Resource pooling:* several users may utilize the services simultaneously.
- *Elasticity:* resources can be added or removed to suit the organizational needs.
- *Measured service:* clients only pay for what they have used.

Using cloud it is quite easy to get healthcare services over the internet using a web browser on a range of devices.

Figure 1, presents cloud driven healthcare service model. Model could be used as a reference to provide various services to the healthcare industry. Following is the description of these cloud services to the medical industry that can improve the traditional healthcare procedures and reduce management overhead and cost of IT procurement.
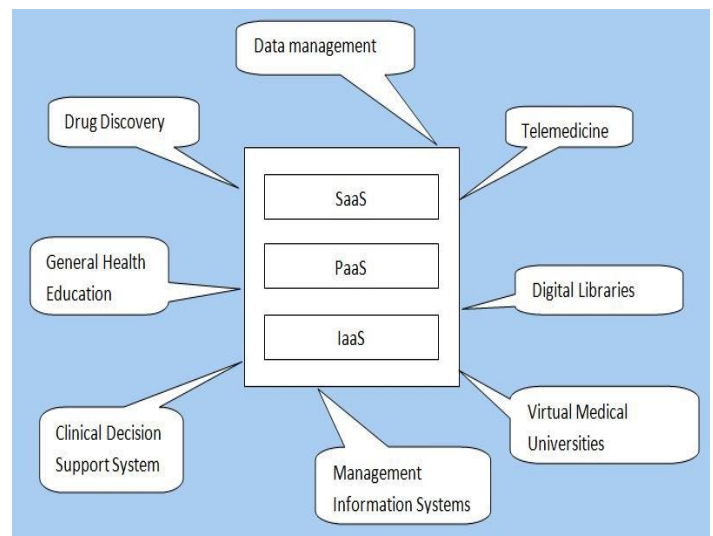

Fig-2:- Cloud Driven Helathcare services

3.1 Data Management

Data management is a prime issue in healthcare industry. Point of care centers, particularly, have to store and maintain pica bytes of data about human resource, account files and patient medical records including patient history, diagnosis, treatment, dietary information etc. Traditional approach of in-house data maintenance incurs a big investment on IT staff and storage infrastructure. Furthermore, issues like

data loss, data theft, data availability and data integrity remain common to the data center.

Cloud data storage and maintenance frameworks like HDFS, Hive, HBase etc offer a cost effective solution to the problem with increased security and ease of management. In addition to this, cloud storage benefits include:

- It increases the data availability. Clinicians can access the data 24/7 from any place they want.
- Physicians can share the data with other specialists around the world for decision making.
- Hundreds of simultaneous data access can be made using any device having a web browser.

Cloud data storage is distributed in nature, so there is fast storage and retrieval procedure

3.2 Telemedicine

Recently information and communication technologies have been surged to support and provide patient care services beyond the medical centers. Telemedicine technologies like telesurgery, audio/video conferencing, and teleradiology bring a new model for collaboration and communication between various healthcare stakeholders. Telehealth care services not only allow patients to get clinical treatment without leaving their place but also help medical specialists to share their expert opinion to deal with complex medical cases.

Cloud based software could be developed to make possible the doctor-patient and doctor-doctor interaction as well as to facilitate the transmission and archiving of medical images. proposed such a system to provide the treatment for distant dermatology patients. Cloud driven telemedicine services offers the following advantages:

- It offers live interaction between the participants without being at the same site.
- Patient medical data can be shared in real time across the geographical boundaries.
- It is flexible model as patients don't need to visit the doctor for getting a medical advice. Moreover, surgeons can retrieve the archived patient files at their own time and place.
- It saves on the patients' traveling cost and time. Medical specialists can adopt this model to reduce the unnecessary visits of patients thus saving their time.

3.3 Drug Discovery

Drug discovery is a process of discovering new medicines while ensuring its efficacy and any side effects. The process requires massive computing resources to identify the potential compounds for drug from a trillion possible chemical structures. Clouds against Disease, a joint venture of Molplex; Newcastle University; and Microsoft Research,

introduce the cloud technology in drug discovery process. Thanks to the IaaS cloud, pharmacist can now borrow the computational infrastructure to analyze the huge biological. This revolutionary technology has drastically decreased the cost and time for drug discovery.

3.4 Digital Libraries

Libraries are the prime source for knowledge improvement among medical students, researchers and practitioners. However, paper based medical libraries, particularly in developing countries, are not able to meet the demand of community due to the financial barriers. Cloud based digital libraries have been seen as an opportunity. Cloud providers can offer range of services to the libraries like file storage, indexing service, query languages, hosting service and library management systems. Cloud library services bring the following advantages to the community:

- Institutions and individuals can avail the facility on demand.
- Several information seekers can read the literature, simultaneously.
- Information is readily available, as researchers don't have to sift through the pile of files.
- Semantic based query makes the searching process hassle-free.
- Physicians could get aware of current progress in medical domain and hence improve their work practice

3.5 Virtual Medical Universities

Cloud computing has taken its roots in academia too due to its flexible and pay-as-you-go model. IT companies like Amazon, Google, Microsoft, IBM, and HP have been developing applications for both on-campus and off-campus support. Medical universities can use this model to deliver online lectures, conduct seminars and to increase collaboration among academia around the globe. It can help medical institutions, particularly in developing countries, to reach a greater number of learners at low cost and less effort. Cloud computing service models can be effectively used for academic purpose as shown in Table I.

Cloud Service	Users	Applications
SaaS	Student, Faculty and Admin staff	Collaboration tools, teaching and learning software etc
PaaS	Developers	Software development, deployment and testing
IaaS	Researcher, Faculty, Admin staff, Students	Storage, computations, I/O, network etc

Table-1:- Cloud computing for Academia

3.6 Management Information System

Healthcare industry has started using management information systems to streamline the information flow within and outside the organization. Physicians use the system to provide better patient care; customers use it for querying service; administrators use this to manage the human resource, billing and finance; top management use this system for decision making and forecasting purpose. These are the proprietary systems which contain the mission critical data about the organization. Due to the confidentiality of the information, developers can use PaaS cloud to develop, test and deploy this system. PaaS ensure the rapid collaborative development, cross-platform compatibility, and integration of the system with other legacy systems.

4. CURRENT MARKET DYNAMICS

Compared to other industries, the healthcare industry has significantly underutilized technology to improve operational efficiency. Most healthcare systems still rely on paper medical records. Information that is digitized is typically not portable, inhibiting information sharing amongst the different healthcare actors. Use of technology to facilitate collaboration and to coordinate care between patients and physicians, and amongst the medical community is limited.

Around the globe, healthcare reform has mandated that it is time for healthcare information technology (HIT) to be modernized and cloud computing is at the center of this transformation. The healthcare industry is shifting toward an information-centric care delivery model, enabled in part by open standards that support cooperation, collaborative workflows and information sharing. Cloud computing provides an infrastructure that allows hospitals, medical practices, insurance companies, and research facilities to tap improved computing resources at lower initial capital outlays. Additionally, cloud environments will lower the barriers for innovation and modernization of HIT systems and applications. Cloud computing caters to the key technology requirements of the healthcare industry:

- Enables on-demand access to computing and large storage facilities which are not provided in traditional IT environments.

- Supports big data sets for electronic health records (EHR), radiology images and genomic data offloading, a burdensome task, from hospital IT departments.

- Facilitates the sharing of EHRs among authorized physicians and hospitals in various geographic areas, providing more timely access to life-saving information and reducing the need for duplicate testing.

- Improves the ability to analyze and track information (with the proper information governance) so that data on treatments, costs, performance, and effectiveness studies can be analyzed and acted upon.

Healthcare data has stringent requirements for security, confidentiality, availability to authorized users, traceability of access, reversibility of data, and long-term preservation. Hence, cloud vendors need to account for all these while conforming to government and industry regulations. Problems in making IT systems interoperable have delayed cloud computing growth in the health care industry.

When considering a move to cloud computing, healthcare actors (medical practices, hospitals, research facilities, etc.) need to carefully consider the type of application moving to the cloud (clinical and nonclinical applications). Clinical applications consist of EHRs, physician order entry and software for imaging and pharmacy use. Nonclinical applications include revenue cycle management, automatic patient billing, cost accounting, payroll management, and claims management.

In many cases, the type of application moving to the cloud will dictate the cloud deployment model that's utilized (*private*, *public*, and *hybrid*), addressing the specific security, privacy and availability requirements for that application. Initially, cloud deployments for clinical applications will take root in private or hybrid clouds given that these applications require the highest level of security, privacy and availability. Nonclinical applications are a better fit for public deployments but still must be carefully assessed. For example, an appointment with the psychiatry department may imply potential mental issues and, as such, must be protected as sensitive data.

Healthcare actors must also consider the cloud service model (IaaS, PaaS, or SaaS) that best addresses their business requirements. In many cases, SaaS, with its pay-per-use business model will be the most attractive economic option, especially for small physician practices, since the need for full-time IT personnel is eliminated along with capital expenses associated with system hardware, operating systems and software. PaaS is a viable option for larger healthcare institutions that have the resources to develop their own cloud based solutions. For healthcare institutions seeking a more scalable infrastructure, IaaS offers a cost-effective turn-key solution that provides scalability with security, flexibility, defined service level agreements, built-in backup and data protection.

Though still in its early stages, there are clear signs around the world that cloud computing is emerging as a critical technology for the healthcare industry. A large and growing percentage of hospital executives are storing data, including clinical applications and email, in the cloud (Terry, 2012). An increasing number of health care providers are deploying or are planning to deploy cloud technology. A large percentage of IT decision makers currently have budget assigned to cloud computing and most expect to spend more on cloud in the next three years. While there's still a ways to go, cloud computing may end up being one of the most important IT advances to impact the healthcare industry.

5. ISSUES OF CLIUD COMPUTING IN HEALTH CARE

The slow adoption of the Cloud Computing model in the health field is mostly due to two important concerns associated with security and interoperability. Those issues need to be addressed in order to overcome doubts when moving to cloud and taking advantage of all the solutions and improvements it brings.

5.1 Security Concerns

Healthcare data unlike other kind of data has strict confidential, privacy and security concerns (Muir, 2011). HIPAA compliance is the most fundamental requirement when moving medical records to the cloud. Migrating entire data storages to a third party organization is not an easy task to do, especially when moving sensitive information such as healthcare data. Even more robust security should be assured because more concerns will arise with access controls, audit controls, authentication, authorization, transmission security and storage security in order to avoid exposing the information to unauthorized entities. These issues are an obstacle that have slowed the cloud adoption and should be addressed in order to enable the trustworthiness of cloud systems. Fortunately, many of the biggest cloud providers in the market such as Microsoft, Google, and Amazon have commitments to develop the best policies and practices to secure a customer's data and privacy (Kuo, 2011).

5.2 Interoperability

Interoperability is one of the biggest challenges when moving healthcare systems to the cloud. It is due to the vast existence of different protocols, O.S, programming languages, platforms, data formats, databases and approaches that different healthcare organization have been using. Healthcare systems are not currently designed using common data modelling constructs resulting in different database designs (Myers, 2012) and incompatible systems. Healthcare systems interoperability must occur in several different ways: at the provider, software, computer, data levels and system integration (Myers, 2012). Providers have generally maintained their own independent data and the incompatibility of healthcare systems largely prohibits its cross-institutional use (Myers, 2012). To embrace the cloud, health organizations must integrate their existing systems with modern web and cloud based systems (Muir, 2011). In addition, they should standardize processes such as the process of getting patients information and saving it to the cloud storage.

Computer software developers must not only cooperate but also share a common data model and design products that can interact with each other (Myers, 2012). Moreover, they must meet legal frameworks and standards in order to comply with law related with HIPAA requirements.

Data integration is fundamental and a necessary prerequisite to systems integration (Myers, 2012). In addition data standardization and formatting is another obstacle when designing cloud applications. For example, something as innocuous as a phone number may be formatted in one system as 1234567890 whereas another system will need (123) 456-7890, requiring software engineers to write custom code--costing time and money (Muir, 2011). Moreover, currently there is nothing that ties healthcare data together in a coherent and uniform way, which is expensive, redundant and insufficient (Myers, 2012). Therefore, integration and inter-operability can be reached by using universal standards, which makes version control, updating and maintenance easier.

A new approach to developing healthcare systems should be taken in order to design more interoperable systems. This change will result in numerous and substantial benefits to the health community. Integrating current healthcare systems and making them interoperable with the newest cloud-based development looks to be a challenging task. Although, by designing flexible and scalable standards and by integrating medical data will greatly benefit and assist the various caregivers.

6. ADVANTAGES OF ADOPTING CLOUD FOR HEALTHCARE ORGANIZATION

Cloud computing brings a new business model which enables several advantages that would benefit the general healthcare community. By adopting the cloud in medical services both patients and healthcare organizations would obtain a huge benefit in patient's quality of service, collaboration between healthcare organizations as well as reductions in IT cost in healthcare companies.

This collaborative approach enables healthcare services to interoperate between them in order to offer a faster and efficient response helping to improve the patient quality of service through sharing information across healthcare organizations. Therefore, hospitals, clinics, imaging centers, pharmacies and insurance companies can efficiently share patient's medical records, prescription information, X rays, test results, physician's references, physicians availability,

etc. that can be accessed anywhere and everywhere by authorized entities. All this information would be used for making decisions, obtaining better diagnosis and treatments to yield better results, scheduling physician's appointments, speeding insurance approval, etc. which highly improves patient's quality of service.

When moving to the cloud, there is also a very important beneficial factor for healthcare organizations, which is the IT costs. By adopting the cloud model, all the IT processes will be migrated to the remote cloud-computing infrastructure where all the processes will be performed and stored. The new "pay-as-you-go" model allows organizations to pay only for what they use; therefore, there is no reason for acquiring expensive hardware infrastructure, software licenses or to keep/train in-site staff for maintenance, security, replications because the cloud computing providers takes care of them.

Human life is priceless, and medical resources are limited (Wang, 2010) therefore, healthcare services adopted in cloud providers match a cost-effective concept where patients and health organizations take advantages of this new technology by improving patients quality of service through a distributed high-integrated platform (Wang, 2010), coordinating of medical process as well as reducing IT infrastructure investment or maintenance costs which leads to a better healthcare environment.

CONCLUSION

The current trend of adopting cloud computing in the medical field can improve and solve several collaborative information issues in healthcare organizations as well as cost optimizations. Standardized cloud-based applications will bring obvious advantages to patients, physicians, insurance companies, pharmacies, imagining centers, etc. when sharing information across medical organizations yielding better results. Challenges such as security concerns and interoperability will rise due to the cloud-computing model. Therefore, the adoption of the cloud is progressing slowly. Through the implementation of best practices in the design, deployment and use of it will hopefully generate a future growth of the cloud-based systems adoption, despite all of the obstacles.

REFERENCES

[1]. Cloud Computing in Health Care to Reach $5.4 Billion by 2017: http://www.eweek.com/c/a/Health-Care-IT/Cloud-Computing-in-Health-Care-to-Reach-54-Billion-by-2017-Report-512295/

[2]. K. Bakshi, "Considerations for cloud data centers: Framework, architecture and adoption," presented at Aerospace conference, Big Sky, MT: IEEE, 2011

[3].P. Mell, & Grance, T.,, "NIST definition of cloud computing," presented at National Institute of Standards and Technology, US department of Commerce, 2011.

[4].S. Ahmed, & Abdullah, A.,, "E-healthcare and data management services in a cloud," IEEE, 2011.

[5].A. M. Burney, Mahmood, N., & Abbas, Z.,, "Information and communication technology in healthcare management systems: Prospects for developing countries," International journal of computer applications, vol. 4, pp. 27-32, 2010.

[6].D. Leahy, Watson, P., Sykora, V. J., & Gagliardi, F., (n.d.), "Case study: Aiming to deliver new drugs faster at less cost in the cloud."

[7].A. Mahapatra, & Dash, M.,, "Design and implementation of a cloud based teledermatology system," International journal of engineering research and technology, vol. 2, 2013.

[8].A. F. Alshuwaier, Alshwaier, A. A., & Areshey, M. E.,, "Applications of cloud computing in education," presented at 8th International conference on computing and networking technology, Gueongju, 2012.

[9].H. Marwaha, & Singh, R.,, "Deploying cloud applications in educational organizations," International journal of advanced research in computer science and software engineering, vol. 3, pp. 227-29, 2013.

[10].S. Mathew, "Implementation of cloud computing in education- a revolution," International journal of computer theory and engineering, vol. 4, pp. 473-75, 2012.

[11].P. Mell, & Grance, T.,, "NIST definition of cloud computing," presented at National Institute of Standards and Technology, US department of Commerce, 2011.

[12].E. Mitchell, "Using cloud services for library IT infrastructure," 2010.

[13].K. Siau, "Health care informatics," IEEE transactions on information technology in biomedicine, vol. 7, 2003.

[14].marketsandmarkets.com Healthcare Cloud Computing (Clinical, EMR, SaaS, Private, Public, Hybrid) Market - Global Trends, Challenges, Opportunities & Forecasts (2012 – 2017): http://www.marketsandmarkets.com/Market-Reports/cloud-computing-healthcare-market-347.html

[15].Kuo, A. M. (2011). Opportunities and Challenges of Cloud Computing to Improve Health Care Services. *Journal of Medical Internet Research, 13*(3), e67. http://dx.doi.org/10.2196/jmir.1867

[16].Allen, S. (2011). Cloud Computing and Health Care Security. *Cloud Computing Journal*. Retrieved from http://cloudcomputing.sys-con.com/node/1796151

[17].Blaisdell, R. (2012). *Cloud benefits in the health Industry.* Retrieved from http://www.cloudtweaks.com/2012/02/cloud-benefits-in-the-health-industry/

[18].Cloud Security Alliance. (2010). Top Threats to Cloud Computing V1.0. Retrieved from https://cloudsecurityalliance.org/topthreats/csathreats.v1.0.pdf

[19].Horowitz, B. (2011). *Cloud Computing Brings Challenges for Health Care Data Storage, Privacy.* Retrieved From http://www.eweek.com/c/a/Health-Care-IT/Cloud-Computing-Brings-Challenges-for-Health-Care-Data-Storage-Privacy-851608/

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