Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2018, 5(9):202-205**

Review Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Cloud Computing in Healthcare

M. N. O. Sadiku[1], S. R. Nelatury[2], S.M. Musa[1]

[1]College of Engineering, Prairie View A&M University, Prairie View, TX 77446
[2]School of Engineering and Engineering Technology, Pennsylvania State University, Erie, PA 16563-1701

Abstract Cloud computing refers to an on-demand, self-service Internet infrastructure that enables the user to access computing resources and services anytime from anywhere. It is widely adopted by healthcare organizations worldwide. It is becoming a vital tool for healthcare professionals everywhere. It is changing the way physicians, nurses, clinics, insurance companies, pharmacists, laboratory staff, and hospital staff deliver cost-effective patient care. The paper briefly discusses the concept of cloud computing, its impact on health care, it benefits and challenges.

Keywords cloud computing, healthcare organizations, electronic health records

Introduction

Cloud computing is a new means of providing computing resources and services. It is an on-demand and self-service Internet infrastructure [1]. It offers large scalable computing and storage, data sharing, on-demand anytime and anywhere access to resources. Organizations with not enough resources to build their own infrastructure can now take advantage of the cloud services to suit their specific needs. The adoption of cloud services is increasingly evolving so that the number of cloud providers is also increasing. Popular, established providers of cloud services include Amazon AWS, Google Cloud, IBM Cloud, and Microsoft Azure. They have heavily invested in building large data centers to support cloud computing. They are responsible for providing computing resources such as hardware and software installation, upgrades, maintenance, backup, data storage, and security.

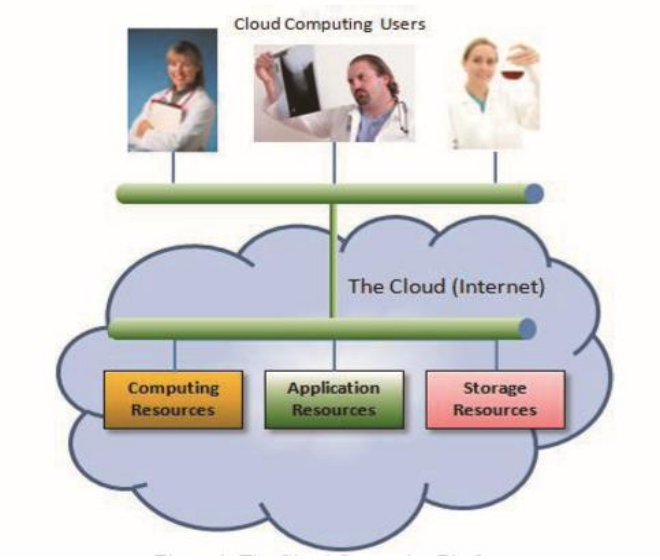

Figure 1: A typical cloud computing platform [2].

Cloud computing (or cloud) is an emerging new technology that can be integrated with healthcare. The term "cloud" is used as a metaphor for Internet. A typical cloud computing platform is shown in Figure 1 [2].
The healthcare industry has been hesitant in embracing the cloud computing because of the concern of data privacy and integrity. It lags behind other industries. Experts claim that cloud computing can improve health care services and benefit health care research. For example, cloud computing can reduce electronic health record (EHR) startup expenses and therefore encourage its adoption. Several world-class software companies have heavily invested in the cloud, extending their offerings for medical records services and promising an explosion in the storage of personal health information online [3].
The healthcare industry is entering an IT period with mobile and cloud computing technologies at the heart of the healthcare transformation.

Cloud Characteristics

In order to understand cloud computing in the healthcare industry, we need to understand the basic characteristics of cloud computing. Cloud computing presents several characteristics such as [4]:

- The pooling of resources
- Better use of resources
- Elasticity
- Dynamic (Distributed)
- Scalability
- Virtualized

From a service point of view, cloud computing includes three models: software, platform, and infrastructure [5].
(1) *Software as a service* (SaaS): The applications (e.g. EHRs) are hosted by a cloud service provider and made available to customers over the Internet. As a SaaS, the cloud can offer healthcare organizations on-demand hosted services. It is a means of providing the electronic medical record (EMR) or electronic health record (EHR) as a service.
(2) *Platform as a service* (PaaS): The development tools (e.g. operation systems) are hosted in the cloud and accessed through a browser. Using a PaaS environment, Microsoft provides a service to supply providers with networks, servers, and storage.
(3) *Infrastructure as a service* (IaaS): Cloud service providers set up huge infrastructure like servers, storage devices, hardware, etc. to be used by potential clients. Cloud solutions can offer on-demand computing and large storage for medical facilities.

There are four cloud computing deployment models [6].
(1) *Public cloud*: A public cloud is a publicly accessible cloud environment owned by a third-party cloud provider. The service provider makes resources available to the general public over the Internet on a pay-as-you-go basis.
(2) *Private cloud:* A cloud infrastructure is owned and operated solely for a single organization. Organizations build their own cloud infrastructure for use by their business units. Healthcare organizations can also choose between private cloud or public cloud.
(3) *Community cloud*: A community cloud is similar to a public cloud except that its access is limited to a specific community of cloud consumer. The cloud infrastructure is shared by several organizations with common concerns.
(4) *Hybrid cloud*: A hybrid cloud is a combination of a public and private cloud.

Cloud in Healthcare Setting

Healthcare is an increasingly becoming data-intensive and collaborative endeavor. Cloud computing is changing the way healthcare providers (doctors, clinics, and hospitals) deliver services to their patients. Healthcare providers are increasingly facing keen competition and are compelled do more for less. They are rapidly turning to the cloud to address the business and patient needs. On the patient side, people are accustomed with managing their own healthcare needs.

Cloud computing is a cost effective method that facilitates data collection, data storage and exchange between healthcare organizations. The cloud has opened several opportunities in healthcare which lower costs and create better care. Cloud-based EHRs are becoming popular as a potential answer to the problem of interoperability. Cloud computing has network access and resource pooling to support big data sets from EHR.

It is the solution for the "big data" challenge because cloud infrastructure is characterized with a high throughput and high volume storage [7].

Application areas include emergency healthcare, home healthcare, assistive healthcare, telemedicine, storage, sharing and processing of large medical resources. Cloud computing can support healthcare organizations to share information such as EHR, prescriptions, insurance information, and test results. The cloud makes it easier to archive and use patient records and medical images. The cloud also makes it easier to collaborate and offer care as a team. Cloud solutions can offer on-demand computing and large storage for medical facilities.

Benefits and Challenges

Compared with conventional computing, cloud computing provides three main advantages: massive computing resources available on demand, elimination of an up-front commitment by users, and payment for use on a short-term basis as needed [7].

The major benefit of cloud computing are its low cost and computing resources available on demand. Other compelling benefits include flexibility, risk reduction, increased security, faster deployment, agile development, elasticity, and increased scalability. Some of these benefits are illustrated in Figure 2 [4]. The range of services offered through the cloud is expanding rapidly.

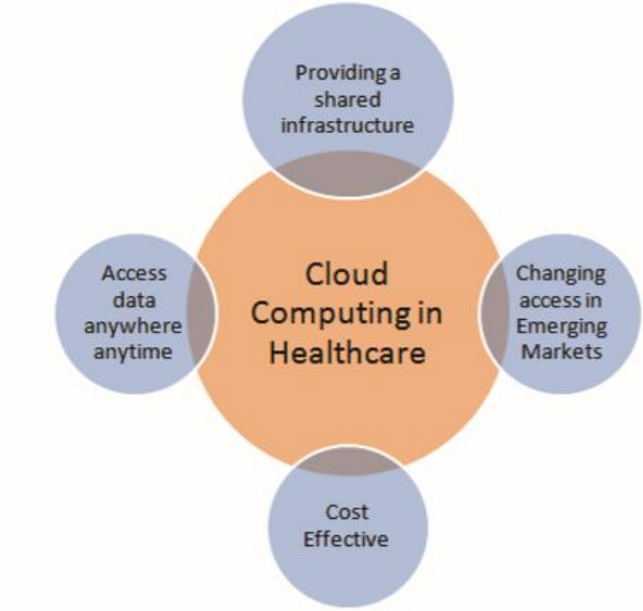

Figure 2: Some benefits of cloud computing in healthcare [4].

While the cloud presents several benefits for healthcare organizations, it also presents some challenges. The major challenge with cloud computing is lack of trust in data security and privacy by users. This is perhaps the strongest resistance to the adoption of cloud computing in healthcare. Concerns on trust arise when their sensitive data move to a cloud computing paradigm where providers cannot guarantee their security and privacy controls. When you move to a cloud provider, you are handing over control of your IT operations and all of your data. There is the possibility that patient data can be misused or fall into the wrong hands.

Other challenges include cultural resistance to share data, resource exhaustion, unpredictability of performance, interoperability, and data transfer bottlenecks. The use of cloud computing also presents many legal issues such as intellectual property rights, data jurisdiction, and data privacy. These should be addressed in order to enable the trustworthiness of cloud systems. The Health Insurance Portability and Accountability Act (HIPAA) regulates privacy and security of patients' data whether in the cloud or not.

HIPAA compliance is the basic requirement when moving medical records to the cloud [8].

Conclusion

Cloud computing is a relatively recent concept and is on the rise in healthcare. It is quickly becoming a necessity in the healthcare industry. It is used in creating a network between patients, doctors, and healthcare institutions by providing applications, services and keeping all the data in the cloud [9]. By adopting cloud computing solutions, providers pay only for what they use (applications, storage, infrastructure services, etc.). The adoption of cloud computing approach in healthcare brings many compelling benefits but it also raises some challenges. These challenges must be addressed for the healthcare industry to prosper from this modern technology.

References

[1]. S. L. Wang et al., "A study of cloud computing based on context-aware healthcare app," *Applied Mechanics and Materials,* vols. 764-765, 2015, pp. 801-805.

[2]. Y. Guo, M. H. Kuo, and T. Sahama, "Cloud computing for healthcare research information sharing," *Proceedings of the IEEE 4th International Conference on Cloud Computing Technology and Science,* 2012, pp. 889-894.

[3]. H. A. Aziz and A. Guled, "Cloud computing and healthcare services," *Journal of Biosensors & Bioelectronics,* vol. 7, no. 3, 2016.

[4]. H. Jemal et al., "Cloud computing and mobile devices based system for healthcare application," *Proceedings of IEEE International Symposium on Technology in Society*, 2015.

[5]. M. N. O. Sadiku, S. M. Musa, and O.D. Momoh, "Cloud computing: Opportunities and challenges," *IEEE Potentials,* vol. 33, no. 1, Jan/Feb. 2014, pp. 34-36.

[6]. F. Alharbi et al., "Strategic value of cloud computing in healthcare organisations using the balanced scorecard approach: A case study from a Saudi hospital," *Procedia Computer Science*, vol. 98, 2016, pp. 332 – 339.

[7]. G. Eysenbach, "Opportunities and challenges of cloud computing to improve health care services," *Journal of Medical Internet Research,* vol. 13, no. 3, July-September 2011.

[8]. S. P. Ahuja, S. Mani, and J. Zambrano, "A survey of the state of cloud computing in healthcare," *Network and Communication Technologies,* vol. 1, no. 2, 2012, pp. 12-19.

[9]. N. Dubey and S. Vishwakarma, "Cloud computing in healthcare," *International Journal of Current Trends in Engineering & Research,* vol. 2, no. 5, May 2016, pp. 211 – 216.

About the Authors

Matthew N.O. Sadiku is a professor at Prairie View A&M University, Texas. He is the author of several books and papers. He is an IEEE fellow. His research interests include computational electromagnetics and computer networks.

Sudarshan R. Nelatury is an associate professor at Penn State University, The Behrend College, Erie, Pennsylvania. His teaching and research interests lie in electromagnetics and signal processing.

Sarhan M. Musa is a professor in the Department of Engineering Technology at Prairie View A&M University, Texas. He has been the director of Prairie View Networking Academy, Texas, since 2004. He is an LTD Sprint and Boeing Welliver Fellow.