

# Application of Cloud Computing In Healthcare: A Review

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**Abstract-** Cloud computing in the present scenario is a developing and fast growing technology that is widely being adopted around the world. This is quite flexible, mutual, scalable and lucrative computational approach that has entered in various public domains. Cloud computing utilizes the Internet-based computing power and here the information, data, and other resources are provided to the user via a computer or device on-demand and is being charged on the basis of its consumption. This paper categorizes, presents the refined study of recently published articles on cloud computing, especially in the health care sector. It demonstrates an outline of the prime issues and challenges explores resources and discusses practical techniques and tools practiced in this context. It also provides an insight of various cloud computing applications in several scenarios, current enhancements and describes the possible future directions for a deeper understanding of cloud computing in healthcare. It proposes the recent state of the art used in cloud computing for healthcare.

**Keywords**—Health, Medical, Hospital, Healthcare, Care Computing.

## I. INTRODUCTION

IT resources are used in the healthcare sector as it provides an easy and faster way of storing information. It has been used in the areas of medical, research and services. There are several publications relevant to this topic but there is no organized review provided yet [9]. Based on some observations, the following questions arise.

1. The context of cloud computing in healthcare?
2. What are the findings based on the research topics?
3. What is the further scope of this research?

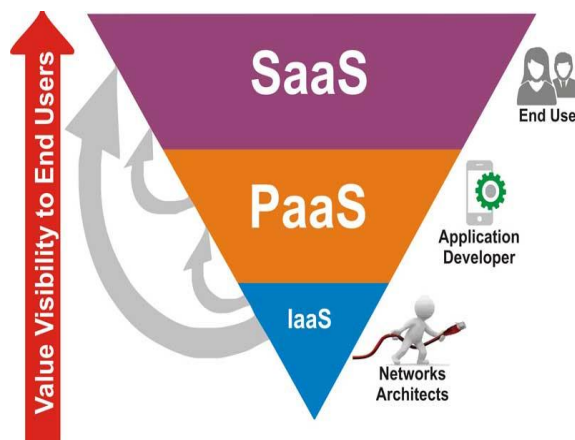
We will review publications published till date with reference to cloud computing for healthcare. While writing these, following steps are included in this paper:

- a. Review scope
- b. Literature search process
- c. Synthesize and analyze the collected literature
- d. Note the findings that derive the conclusion
- e. And in last, Summarizing the result

### Conceptualization of the topic:

Cloud computing is broadly categorized into three types based on the services, firstly, software as a service, secondly, platform as a service, and lastly infrastructure as a service (Fig.1), [11]. It represents a model which provides shared computing resources and storage units. Cloud computing is further divided into three categories: Public, Private and Hybrid cloud [2]. It provides numerous advantages over the

in-house solution. People have given their own definition of cloud computing. In 2014, NIST defined Cloud Computing as a model for preventing the universal, comfortable, on-demand access to a common pool of design resources of computing which can be immediately run and released with least possible management effort or interaction with the service provider [13].



**Fig.1** Categorization of cloud computing based on services

In this paper, section I contains the introduction of cloud computing and its application in healthcare, section II discusses about the background containing literature review and the State of Art and Section III encompasses discussion and conclusion along with the future scope.

**II. BACKGROUND**

**a. Literature search process**

We studied various papers and divided it into four phases, like keyword search, database search, forward/backward search, and journal search. The aim is to check all the relative data of conferences, papers, and journals which are included namely IEEE Xplore, Springer, and ScienceDirect etc. Through the support of key variables from the given context, we derived the keywords and the main synonyms, i.e. cloud, PaaS, IaaS, and the medical, health, hospital and the combination of all possible search phases are formulated.

**Table 1:** Results of various searches based on keyword hits from various resources

Keyword	CLOUD			PAAS+			IAAS+			SAAS+			Sum hits
	Medical	Health	Hospital	Medical	Health	Hospital	Medical	Health	Hospital	Medical	Health	Hospital	
Database	12	27	1	0	0	0	0	0	0	0	2	0	42
AISeL	(0)	(2)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(2)
Springer	61	96	15	0	1	0	3	3	1	3	1	1	185
	(2)	(4)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(6)
Proquest	165	381	129	5	6	2	0	0	0	6	5	3	702
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
IEEE Xplore	456	250	67	5	6	3	7	7	2	21	16	8	828
	(2)	(13)	(1)	(0)	(0)	(0)	(0)	(1)	(0)	(0)	(1)	(0)	(18)
ScienceDirect	60	161	22	1	4	5	4	2	3	8	3	5	278
	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(1)
Emerald	2	3	0	0	0	0	0	0	0	0	0	0	5
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
EBSCOhost	626	924	288	21	18	5	10	17	2	48	109	37	2105
	(0)	(2)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(3)
ACM	22	30	4	0	0	0	0	0	0	0	0	0	71
	(3)	(3)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(6)
Sum hits	1384	1872	526	33	34	15	22	30	24	84	138	54	4216
	(24)	(24)	(2)	(0)	(0)	(0)	(0)	(1)	(0)	(0)	(1)	(0)	(36)

**b. Literature Analysis and Synthesis**

The research is made on five major areas namely, cloud-based applications, security, platforms, privacy issues, and benefits of cloud computing in healthcare. The papers were evaluated based on the proposals and their application areas. At last, our recommendations based on the literature review results are presented and discussed.

**c. Review Scope**

To define the review score on cloud computing in healthcare for a literature view, we establish taxonomy (Table 2)

**➤ Cloud computing in healthcare**

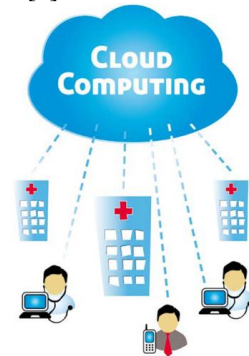
Today, many hospitals and doctors are preferring cloud computing for better services to patients. As we know healthcare is a service which is delivered to individuals by Healthcare providers for maintenance, monitoring and restoring physical and mental fitness. The patient's data is very sensitive that's why the privacy and the security of patient's data are required. If any steps are misleading it can

cause severe implications and at times may lead to life and death [7].

**Table 2:** Taxonomy for predicting the review score

Characteristic		Categories
a	Focus	Research method and Research outcome
b	Goal	Identification of issues
c	Organization	Conceptual
d	Perspective	Neutral Representation
e	Audience	General Public
f	Coverage	Selective

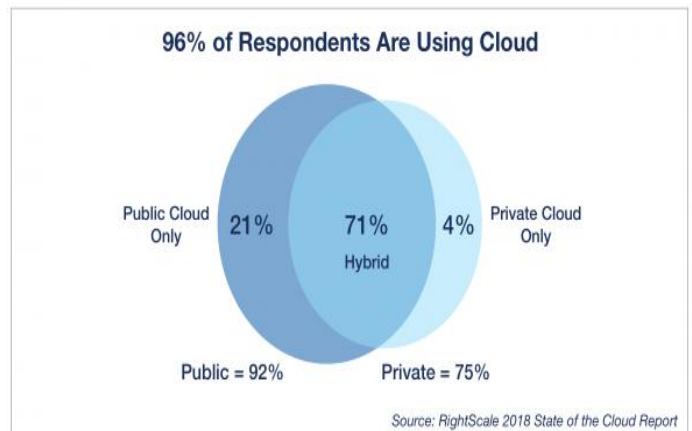
Hence, new technologies are adopted for handling sensitive data. Cloud computing provides us a suitable infrastructure that gives permissions to hospitals, insurance company, research facilities to use cloud computing resources at minor of initial capital cost [3].



**Fig 2:** Technologies for communicating over cloud

**➤ Cloud computing concept adopted in healthcare**

Traditionally, the healthcare sector utilizes fewer technologies, especially in the improvement provided for patient care. In healthcare, the adoption and implementation of cloud computing are not similar to other industries.



**Fig 3:** Percentage of cloud users

It has several barriers, by which the implementation of computing is not possible in various hospital and health institute. There will be an additional burden imposed every year for implementing and assessing, and the resultant will be duplication and waste [8].

➤ **Role of cloud computing in healthcare**

As the technology is being widely accepted everywhere, still, most of the health sector keep their records in paper, and the digitized information is not portable. In the previous few years, the surprising data breaches have to squeeze the healthcare sector to a larger extent. The associated risk and issues in performance have been growing high. That has proved to be a contributing factor for moving from paper records and adopting electronic health record (EHR) in hospital, clinic, labs, etc [8].

The discovery of the right thing can create a big impact which has become the vital need. This is the stage where cloud computing came in to existence. The government has made it mandatory to use cloud computing in the healthcare sector. Some of the advantages of cloud computing in healthcare are:

- With the support of the cloud, the patients and doctors can access their documents from anywhere and at anytime. Cloud computing is more secure and takes less time to transfer the data between the hospital, organization, clinic, etc.
- Cloud computing in healthcare has become useful and corroborates the data better. Without delay, doctors use the patient data and the objective is better patient care. We can access years of data within a minute, with having updated patient and hospitals records.
- In the healthcare sector, cloud computing is gaining dominance in research area too. Data can be exchanged by a doctor and patient with accurate information. The cost incurred is very less using cloud.

However there are certain disadvantages associated with cloud computing in healthcare, which are:

- Cloud-based hosting is a major problem in the healthcare sector. Another critical issue is disaster backup, data availability, and the limitations of error.
- One has to trust their cloud providers. In healthcare, security and privacy issues, these must be shielded from hackers.
- When the security of data is controlled by the third party that reflects that the cloud provider doesn't have control over where its data is actually being stored.

➤ **CLOUD COMPUTING BASED HEALTHCARE SERVICES**

Using cloud it is too easy to get your healthcare services through the internet on your device using any web browser. There has been a swift seen in healthcare industries switching to newer technologies in order to improve the services. Healthcare organizations are facing the challenges like high infrastructure, cost of managing, resources need for computation multi-users and increasing demand for collaboration etc. For the implementation of cloud computing in healthcare organizations, these key challenges are verified [6].

a) **Data Management:**

Data management is the primary case. Traditionally the data management was done on paper. This was not secure and could not be retrieved fast. In healthcare, the organization has to store pica byte of human resource, account records, and medical reports of patients (including the treatments, diagnosis, patient history etc.). For in-house data maintenance brings a big investment in IT staffs and the storage infrastructure [4]. If the data are managed on the cloud then it has several benefits-

- Doctors can access the data anytime from any place. It makes the availability of data faster.
- For decision-making with any expert/ specialists regarding patient health the physician cannot share the data across the world for better treatment.
- Using web browser we can access hundreds of simultaneous data, using any device. Storage in the cloud is distributed in nature, that's why the procedure of storage and retrieval is fast.

b) **Telemedicine**

Telemedicine is a technology by which the patients can communicate with the doctor without moving from their place using computational devices, it monitors and diagnosis remotely [5]. Telemedicine is used to overcome the distance barriers to improve healthcare services across the worlds. Technologies involved in telemedicine like audio/video conferencing, telesurgery, and teleradiology are new models for providing health services [1]. The software's which are based on the cloud acts as an interface between patient-doctors and doctor-doctor interaction and supports doctors to share their experience with complex medical cases. Telemedicine is proposed for providing treatments for distance patients [10]. Advantages of telemedicine include:

- Patients can interact with doctors live over the internet.
- It saves the patient time and traveling cost.
- Patent medical records can be shared in real time.
- It is flexible, it saves time and money of patients.
- Doctors adopt this to reduce unnecessary visits of patients.

### ✚ **TELEMEDICINE-BASED ON GADGETS**

Telemedicine is dependent upon mobile devices. Devices such as tablets, and smartphones, they support the mobile computing and services and as a result sales of mobile devices are rising at a rapid pace. These devices support different type of networking technology and the computational power [13]. In smartphones, security as a service is the improved security which is offered to the user as a service in the cloud. Smartphones Applications used for telemedicine improve the services in monitoring, diagnosis, treatments and the workflow which improve the patient health. Telemedicine-based mobile cloud computing minimizes the limits of medical treatments done in traditional manner, namely privacy problems, medical error, and storage problem.

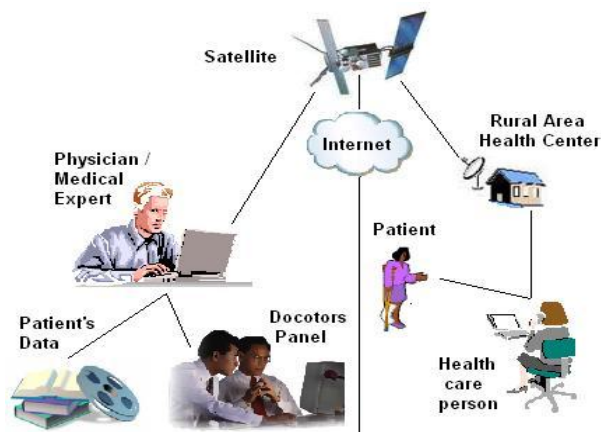


Fig. 4: Steps involved in telemedicine using

Mobile cloud computing separates cloud computing into the mobile environment. There are many challenges to mobile cloud computing and smartphone-based telemedicine. This problem can be resolved only by the using smartphone and advanced technology like 4G, 5G and more.

### ➤ **CHALLENGES OF CLOUD COMPUTING IN HEALTH CARE**

An important issue of a cloud is security, data interoperability, and data jurisdiction. In the healthcare field, the acceptance of cloud computing is slow because of data interoperability and security. In organizations, the SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis are done for identifying and addressing the positive and negative factors of cloud computing by the necessary methodology planning [14]. Where the strengths and opportunities are positive factors, and the weaknesses and threats are negative factors. Many organization share their data with each other, there are chances of data leakage [7]. The privacy and the security do not come in suits, so every company has their own reliable security concern and accordingly they implement the technology to protect the

data. Many clouds also have firewall and intrusion for prevention [11].

#### a. **Security**

Every data has confidential, security and privacy concern, even healthcare data too. By hackers and crackers, security and privacy problems are caused [3]. Due to loss of control, invalid storage, access control and data boundary makes the cloud computing somewhat insecure. When medical records are moving towards the cloud then HIPAA compliance is the important fundamental requirement. Many popular cloud suppliers like Google, Microsoft, and Amazon, etc. in the markets have the commitments to develop best policies and security of data [6].



Fig 5: Standard for sensitive patient data protection

#### b. **Interoperability**

When the healthcare system is moving to the cloud the interoperability is the biggest challenge. In healthcare, one can port the health insurance from one organization to another organization, this system is provided by the health insurance company. Healthcare interoperability occurs at different levels; provider, system, computer, levels of data, and the integration of the system [6]. In the healthcare system, the providers must maintain their own independent data and incompatibility. With HIPAA requirements, they all must meet legal frameworks and standards in order to comply with the law-related [4].

#### c. **Biometric-based Authentication**

The role of biometrics is growing rapidly, especially in the healthcare sector, generally when the need to switch the access over authorized user identification. HIPPA regulations are mandatory for patients behind-the-scenes and help to ensure that only authorized person can access the records. It avoids insurance fraud and theft.

In authentication, there are 3 identification methods:

- Possession,
- Knowledge
- Biometrics.

Possession is a certain physical object corresponding to a magnetic stripe card, keys etc. Knowledge can be a secret like password, the answer to a questions etc. Biometric is a method of identification or verification of individual based on physiological and behavioral characters [13].

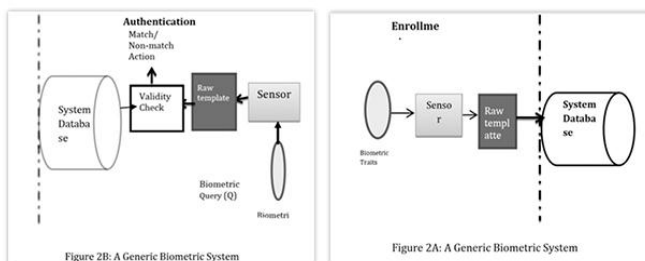


**Fig. 6:** Biometric authentication over cloud

Biometric can't be changed, steal or shareable. It uses fingerprint, signature, face recognition, voice, iris, retina, and DNA recognition. In healthcare, biometric authentication plays a vital role. Using biometric, the patient and doctors can access reports anywhere using internet via cloud computing. When any person gets enrolled for counselling with the doctor, the person is asked to submit their multiple biometrics, fingerprint data for security purpose. All the biometrics of the organization is stored on the cloud provider's site. If the user wants to access it, then they have to give their fingerprint and the user is given access to the data. This could be only accessed by the patient and doctor themselves. As long as the number of users is increasing the security concern is of utmost importance. The security of biometric is very advanced now, all biometric data are highly encrypted. If anyone tries to read or change it, that is not possible. Even twins do not have the same fingerprint. India has the highest biometric data available in the world today e.g. Aadhar. It is linked everywhere like, bank, phone, insurance, healthcare etc. There are two types of modes involved in the biometric system–

- a. Enrollment
- b. Verification.

Enrolment is a process, in which a user provides their fingerprints and iris recognition to register itself. The sensors are used which creates an image which is fed into the software. The software extracts all unique data from an image and converts it into biometric templates.



**Fig. 7:** Two modes of Biometric System: Authentication and Enrollment.

Verification is a process when a patient returns for a checkup, where the patient has to go through the same procedure of biometric system where the captured data is checked with the database, this search is known as one-to-many searches [5].

In healthcare, the personal data of patient's health information in EHRs is protected to reduce the fraud from hospitals. In the hospital, the identification for security also helps to avoid unnecessarily or the duplicate test and treatments, which avoid patient for unnecessary tests and procedures [14]. In the healthcare sector and in hospitals biometric is used to reduce the insurance scam, recognize patients and bond patient data to various healthcare institutes. Biometrics method has some limitations namely noisy sensor data, distinctiveness or non-universality [4].

### III. DISCUSSION AND CONCLUSION

Technologies are very useful for an emergency situation. In this era, cloud computing and mobile phone together are transforming the patients' treatment. Satellite, telemedicine system, short-range telemedicine system, and cellular telemedicine system are combined to form Mobile telemedicine, which fully depends upon the distance of transmission. Smartphones have contributions in telemedicine in oral. There are much android application and cloud which can be used in an emergency situation. These applications are mostly used by elderly individuals, those who lives alone. These applications retrieve a patient's health records remotely from the doctor's database. Teleconsultants access the available information's through the server via smartphones or computer and give their opinions for treatments, and diagnosis recommendations.

### REFERENCES

- [1]. Hamid Moghaddasi, Alireza Tabatabaei Tabrizi "Applications of Cloud Computing in Health Systems" Published by Canadian Center of Science and Education 9(6) ISSN 1916-9736. (2017).
- [2]. Priyanshu Srivastava, R. Khan "Review paper on Cloud Computing" International Journals of Advanced Research in Computer Science and Software Engineering; 8(6), ISSN: 2277-128X. (2018)
- [3]. Steven Mathew, SaritaGulia, Varinder Singh. "A Review Paper on Cloud Computing and its Security Concerns" Proceedings of the Second International Conference on Research in Intelligent and Computing in Engineering, Vol. 10 pp. 245–250 ISSN 2300-5963 (2017).
- [4]. Lidong Wang, Cheryl Ann Alexander "Medical Applications and Healthcare Based on Cloud Computing" International Journal of Cloud Computing and Services Science; 2(4), pp. 217~225 ISSN: 2089-3337 (2014).
- [5]. Omotosho Folorunsho Segun, Fadiora Babatunde Olawale "Healthcare data breaches: Biometric technology to the rescue" International Research Journal of Engineering and Technology; 04(11), e-ISSN: 2395-0056 (2017).
- [6]. Vaibhav Kamal Nigam, Shubham Bhatia "Impact of Cloud Computing on Health Care" International Research Journal of Engineering and Technology; 3(5) | p-ISSN: 2395-0072, e-ISSN: 2395-0056 (2016).
- [7]. Lingkiswaran Devadass, Sugalia Santhira Sekaran, Rajermani Thinakaran "Cloud computing in healthcare" International Journal of Students' Research In Technology & Management; 5(1), pp 25-31, ISSN 2321-2543 (2017).

- [8]. Mervat B., Sarfraz B., Suriyati C., Jamalul-lail Ab Manan "A Study on Significance of Adopting Cloud Computing Paradigm in Healthcare Sector" Proceedings of 2012 International Conference on Cloud Computing, Technologies, Applications & Management 978-1-4673-4416-6/12/\$ 31.00 © 2012 IEEE
- [9]. Tatiana Ermakova, Jan Huenges, Koray Ereğ "Cloud Computing in Healthcare – a Literature Review on the Current State of Research" Proceedings of the Nineteenth Americas Conference on Information Systems (2013).
- [10]. Khyamling A. P., Naveen kumar, C. Patil, Shivananda R. Poojara, Tejaskumar, S. Kamble "Cloud-based Intelligent Healthcare Monitoring System" International Conference on Issues and Challenges in Intelligent Computing Techniques (2014).
- [11]. Roma Chauhan, Amit Kumar "Cloud Computing for Improved Healthcare: Techniques, Potential and Challenges" The 4th IEEE International Conference on E-Health and Bioengineering (2013)
- [12]. Vom Brocke, J. Simons, A. Niehaves, B. Riemer, K. Plattfaut, R. Cleven "Reconstructing the Giant: On the Importance of Rigour in Documenting the Literature Search Process" In Proceedings of the 17th European Conference on Information Systems. (2009).
- [13]. Lidong Wang, Cheryl Ann Alexander "Telemedicine-Based on Mobile Devices and Mobile Cloud Computing" International Journal of Cloud Computing and Services Science; 3(1), pp. 26-36 ISSN: 2089-3337. (2014).
- [14]. Shaftab Ahmed, Azeen Abdullah "E-Healthcare and Data Management Services in a Cloud" 978-1-4577-1169-5/11/\$26.00 ©2011 IEEE (2011).

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