

# Impact of Cloud Computing on Health Services

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## ABSTRACT

In today's real world, technology has fast and long lasting impact on health care services. Existing system for healthcare are not scalable enough for large growing number of services provided to the increasing number of patients. Cloud computing is one of the most fast growing and recent technology for using in the development of healthcare services. Cloud computing can match the requirements of various healthcare service providers over the internet regardless of location and amount of data. The objective is to identify the current state and adoption of cloud on healthcare services. However before its widespread adoption, cloud computing should be explored and evaluated. The paper covers impact, challenges and benefits of cloud computing on healthcare services.

## 1. Introduction

Cloud Computing is architecture for providing computing services through internet as per the demand, completely dependent on internet technology. According to the definition of NIST[1] Cloud computing is the model for convenient, on-demand network access to shared resources such as networks, servers, storage, applications and services without physically acquiring them. It saves cost and time for various organizations. The adoption of cloud computing will lead to increase in efficiency and effectiveness in developing and deployment of infrastructure in healthcare services. There are also various reasons to move towards cloud computing as they are required to pay on consumption basis for the resources.

Cloud computing enables computers and various other devices in different geographical locations to access shared computer services or applications over the "cloud" or internet rather than a local environment. Cloud technology is at the heart of health care's transformation and health care industries utilizing various cloud technologies. Private clouds are now being used to access medical records and promote information sharing among medical professionals rather than using traditional paper charts. Cloud technologies are rapidly

transforming and changing the way health care information is being handled and processed in a positive way [2].

The essential characteristics of cloud computing are [4]:

- **On-demand self-service:** a consumer can provision computing capabilities, such as server time and network storage, as needed.
- **Broad network access:** broad range of network accessibilities by various client platforms.
- **Resource pooling:** the provider's computing capabilities are pooled to serve multiple consumers using a multi-tenant model. Resources are dynamically assigned and reassigned according to consumer demand.
- **Rapid elasticity:** capabilities can be rapid, elastically provisioned, and in some cases automatic; the consumer capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.
- **Measured service:** cloud systems automatically control and optimize resource use by leveraging a metering capability.

## 2. Service Models



Fig 1:- Cloud Computing Service Models

From service point of view cloud services are divided into 3 different categories or models:-[4][5][7]

- 1) Software-as-a-Service (SAAS): The applications are provided by the cloud service providers and are made

available to the customer over the network i.e. internet. The customer does not have to manage or control the application capabilities which make the customer to get rid of installing and removing

tremendous load of software maintenance [3]. SAAS is placed on the top of PAAS and at the foundation is IAAS. SAAs can be build directly on IAAS.

- 2) Platform-as-a-Service (PAAS): PAAS provides programming and execution environment to the user. User can directly deploy the applications on the cloud providers infrastructure , also the users can create various applications by using various programming API's.
- 3) Infrastructure-as-a-Service (IAAS): In IAAS cloud providers provides the resources to the customer or user that includes virtual machines, firewalls, network devices and so on.

general public by the service provider over the internet. The services can be free or offered on a pay-per usage model.

- **Private Cloud:** - In private cloud instead of general public the computing services are offered over the network or the private internal network for the dedicated use of the single organization. All the expenses are borne privately.
- **Community Cloud:** - Community cloud are built to serve the specific needs of different business communities where the infrastructure is shared with common concerns whether managed internally or by third-party and hosted internally or externally.
- **Hybrid Cloud:** - A hybrid cloud is a computing environment which combines public cloud and private cloud by allowing data and applications to be shared between them.

### 3. Deployment Models

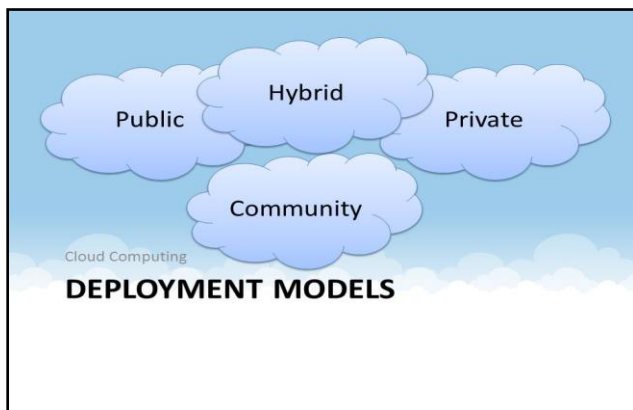


Fig 2:- Cloud Deployment Models

There are 4 cloud deployment models which are as follows:-[6]

- **Public Cloud:** - In Public cloud, resources such as applications, storages are made available to the

### 4. Cloud computing based healthcare services

Following are the cloud services which can be adopted in healthcare which can improve the healthcare and reduce the cost and management overhead:-

#### 4.1 Data Management

Cloud data management is the way to manage data across cloud platforms with or without on-premises storage. [8] Data can also be shared among public, private or hybrid cloud. With data management, data can be managed in the cloud, for this resource can be purchased as required. The components of cloud management are shown in fig:-3 [9]. The cloud data storage is distributed in nature so there is fast storage and retrieval process.

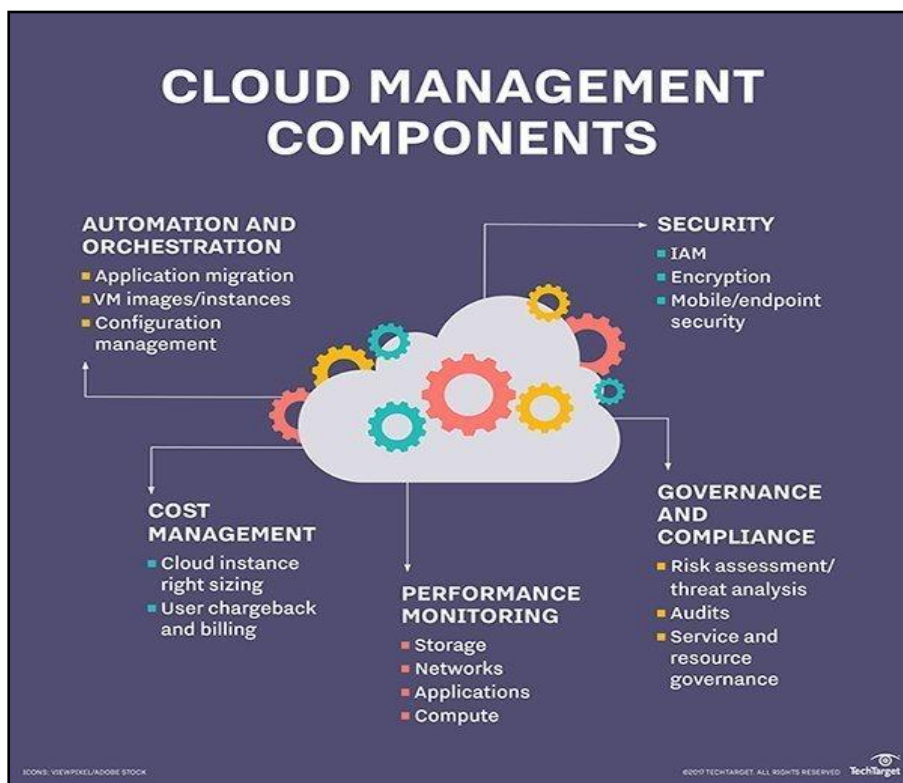


Fig:-3 Components of cloud data management

#### 4.2 Data Access

Cloud computing allows to access information and services using existing technology and existing infrastructures so that communication can be established between the user and server. For healthcare, having cloud access also means access to more accurate information with consent to improve overall quality of healthcare services. Users just pay the fees and gain access to the resources [10].

Cloud computing offers information and supports the user to access the information which is readily accessible to the same type and amount of information.

#### 4.3 Data Sharing

Cloud system enables data sharing which provides lot of benefits to the user. Various organizations consider data sharing as a top priority since data sharing leads to higher productivity [12]. With multiple users from different healthcare services contribute the data in the cloud because of which the time and cost will be much less as compared to having manually exchanged data and also the various types of patients can be treated more accurately and in less time independent of the location.

In traditional methods radiology images were shared on hard copy films and CDs. But now there is a digital alternative called as Image Zone which is a cloud based medical image sharing platform that allows the healthcare providers to securely access and share patient medical images like X-rays, MRIs, CT Scan and so on[11]. Another tool used for handling medical images is PACS (Picture Archiving and Communication System) [13] used to store, access and distribute medical images to handle complex treatment procedures.

#### 4.4 Wireless Technology for Cloud

Over the large number of population, practice of evidence based medicine in healthcare services, increased patient monitoring, fast and secured network connectivity everywhere, accessing patient record in an emergency situation is possible because of cloud technology since cloud provides real-time data.

Among the top applications in the survey for wireless technology are electronic health records and medication administration. Researchers say these initiatives drive overall improvements in patient care and new efficiencies and were associated with a 31 percent reduction in manual errors and an increase of 39 productive minutes per worker per day. [14]

IEEE 802.15 (WPAN) wireless personal area network is the standard covering link technologies between data collectors and wireless sensors for healthcare application [16]. ZigBee-based WSNs wide sensor networks are for used in acute care hospitals. Body sensor networks (BSN) is a type of WSN. It is deployed on human body to get physiological parameters for health purposes [17].

#### 4.5 Telemedicine

Telemedicine is the invention of technology in medicine. Telemedicine is a method of providing health care services where the information about the patient can be viewed in the form of images send from distant areas. Using telemedicine the medical information can be send from anywhere at any time. Telemedicine utilizes the infrastructure of telecommunication to provide the facility of exchanging the electronic information such as medical images and videos for remote monitoring and diagnosis. [18]

IEEE 802.16 (WiMax) is a good choice for telemedicine service providers not only in mobile, but also in a fixed environment. The advantages are transmission speed, security, mobility and QoS [16]. Radiology and ultrasound images can be transmitted through the high bandwidth increasing the efficiency and reliability of data transmission. The IEEE 802.16 MAC fits with health applications that are designed as per the requirements [15]. Other examples are Emergency Medical System(EMS), Health Cloud eXchange (HCX), Health ATM Kiosks, Digital Imaging and communications in Medicine(DICOM)-based system and @HealthCloud.

#### 4.6 Drug Discovery

Drug discovery is the process through which drugs are discovered and designed to improve the human health and decrease the side effects. Companies focused on drug development are moving towards the cloud technology to create a central location for the drug development data which is dispersed all over the world so that the researchers and patients access the data from anywhere i.e. independent of location or geographically separated and also faster access or sharing.

The greatest hurdle of healthcare industry is the cost and time span from discovery of therapy to the marketing or commercialization. In healthcare the cloud have the life changing impact on the speed at which patients get the treatment and medicines they require. Healthcare companies also must balance development and demand of the resources required for the discovery of the drugs along with drug manufacturing, drug marketing, drug selling and drug distribution. To improve the drug development efficiency, automation and artificial intelligence help researchers to reach worldwide systems to integrate the information and finding accurate results. This approach adds value as the speed of software deployment in the cloud provides organizations with a strategic advantage, increases efficiency and improves an organization's overall offering and time to market. Clouds against Disease, a joint venture of Molplex; Newcastle University; and Microsoft Research, introduce the cloud technology in drug discovery process. [19]

#### 4.7 Digital Libraries

Digital library is the library of using digital technology to process and store the information and literature which is geographically distributed. Cloud computing offers information retrieval system used in digital library. The dynamic and elastic

features of cloud computing allows the increase in growth in collection of information minimizing the maintenance needs and management issues. Such cloud adopted digital libraries will be the source of knowledge for patients, medical students, researchers, practitioners etc. The advantages of such cloud based libraries are as follows:-

- ✓ Information regarding healthcare could be readily available and hence search will be minimized.
- ✓ The availability will be according to the demand and hence can be cheaper since the payment will be as per usage.
- ✓ Current updates can improve the work of researchers, users etc.
- ✓ Information can be accessed by multiple users.

## 5. Challenges of cloud computing in healthcare

### 5.1 Interoperability

In cloud computing there is an interaction between many cloud platforms which are independent and heterogeneous in nature [20]. Through interoperability various clouds can gain access in different environments and share their data, applications, platforms and infrastructure.

There are different application programming interfaces for the user to interact with the cloud or cloud interacting with the cloud which restricts cloud choice because of portability, vendor locking, using of cloud services provided by many vendors. [21] Hence there is a requirement of developed applications on the clouds for interoperability. If not then cloud adoption in healthcare will be hampered.

### 5.2 Stability Of Operation:

Organizations are strongly depending on the cloud servers to create different business models according to the capabilities of the organization. As healthcare services are increasingly adopting cloud, it becomes necessary to ensure that the entire system is stable since stability ensures that optimal performance can be achieved with minimum outages. The stability depends upon the 3 core factors i.e. cloud server monitoring, cloud server Replication, and cloud server security. [22] If one of the core factor goes down then it may lead to the abnormal quality of service for the end user.

### 5.3 Information Privacy

Information privacy also called as data privacy is the aspect of information technology (IT) that deals with the ability an organization or individual has to determine what data in the computer system can be shared with third parties.

Expanding the quantity of data will require demand for cloud services if cloud computing provides the customers with low costs and provides new models of business for healthcare providers.

Among the main privacy challenges for cloud computing are [23]:

- a) Complexity of risk assessment in a cloud environment
- b) Emergence of new business models and their implications for consumer privacy
- c) Achieving regulatory compliance.

### 5.4 Software Licensing

One of the issues for healthcare provider willing to move their core applications to the cloud is the existing investment in software licensing. Three factors should be considered when multiple licensing models are available in the cloud: [24]

- 1) The number of users accessing the software based on physical hardware.
- 2) The number of the processors on the device hosting the application means virtual CPU capacity.
- 3) Software License Tracking

## 6. Advantages of adopting cloud computing in healthcare

### 6.1 Reduced workload and Saved costs

For healthcare services hybrid cloud model proves to be more efficient since hybrid offers both the benefits of private and public. Private cloud have the greatest amount of control whereas public provide with greatest savings and resource capabilities. [25][26]. Reducing cloud computing costs is subject to the volume of resources deployed on the cloud and how they were configured on launch. Switching off the resources used for non-production workloads and automating the scheduling process is the most cost-efficient. Another way to lower your cloud computing costs is to take advantage of discounted instance types and tiered storage classes. Annual hardware cost and Internet service provider's costs are also reduced. Cloud computing significantly reduces costs in healthcare while keeping a consistent higher patient quality.

### 6.2 Cloud services in Disaster Recovery

Disaster whether it is manmade or natural leads to expensive service disruption. Recovery problem is more crucial in cloud computing because cloud service providers have to provide the services to their customers even if data center is down due to disaster. Getting the required information for healthcare professionals to their places like consulting one another, requiring additional staff or manpower, additional resources is difficult task. Traditional on-site computing plans have many problems that can be overcome using cloud computing.

Using cloud all these difficulties can be overcome. Healthcare professionals can have real-time guidance from an expert. The main advantage in cloud computing the entire server can be back up when the disaster struck. All the healthcare information is coupled with systems as one software block as an easy backup and it can be sending to other data centers to any part of the world within very small time. Hence recovery will take very few minutes.

Another advantage is cost efficiency where huge maintenance cost and large initial investment will be reduced since the cloud will be third-party data center which makes the disaster recovery cheaper.

Also automation can recover the data from disaster using disaster recovery plans in the cloud which is a smart decision to help the healthcare services avoiding costly interruption.

### 6.3 Better Collaboration

Collaboration means teamwork, group effort which is important to the healthcare industry making the cloud a perfect



companion. Cloud offers remote data access that helps professional to store and access the data without any delay, at any time and independent of location. In addition updates on healthcare developments, research, patient's conditions, remote conferencing is possible resulting in better patient care and more efficient diagnosis.

Collaboration is vital to the healthcare industry, which makes the cloud a perfect companion in the field. By allowing professionals to store and access data remotely, healthcare professionals around the world can gain access to patient data immediately and apply the necessary care without a delay. In addition to this, remote conferencing, up-to-the-second updates on healthcare developments and patient conditions, and more, is allowing doctors to save those precious life-saving minutes.

The use of cloud computing in healthcare has become more and more useful as a method for collaborating better.

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Data can be used amongst various doctors together, resulting in better patient care without delay.

A patient's condition can be updated and used between doctors and other employees within minutes, if not instantly. Better and more efficient diagnosis equals better care and fewer costs due to sharing of real-time data. This creates a reduced chance of unnecessary treatments and time in hospitals for patients.

## 7. Conclusion

Although cloud computing offers more advantages to the healthcare industry still there are some most common concerns which make the organizations reluctant to move towards cloud such as interoperability, security and confidentiality of patient information, compliance with government regulations. These all can be overcome by carefully selecting the right partners.