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ADVANCEMENT OF CLOUD COMPUTING IN HEALTHCARE SECTOR

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ABSTRACT
Cloud computing is a recent and fast growing area of development in healthcare. Ubiquitous, on-demand access to virtually endless resources in combination with a pay-per-use model allow for new ways of developing, delivering and using services. Cloud computing is often used in an "OMICS-context", e.g. for computing in genomics, proteomics and molecular medicine, while other field of application still seem to be underrepresented. Healthcare sector is facing more number of problems like high IT costs, more processing power, scalability and demand for interoperability etc. Present health technology is deficient to address these challenges. Cloud computing having many qualities such as multi-tenancy, flexibility and metered delivery appears a viable approach. The purpose of this document is to provide six areas in which health clouds are resolving key challenges for the healthcare community."How cloud solutions are applicable and impacting Healthcare" and some of the key principles that healthcare industry need to focus on when building a strategy for their organization's to adopt cloud computing.

INTRODUCTION
In order to understand Cloud Computing in the healthcare industry, we must understand the basics of cloud computing in general. Figure 1, gives overview of Cloud computing
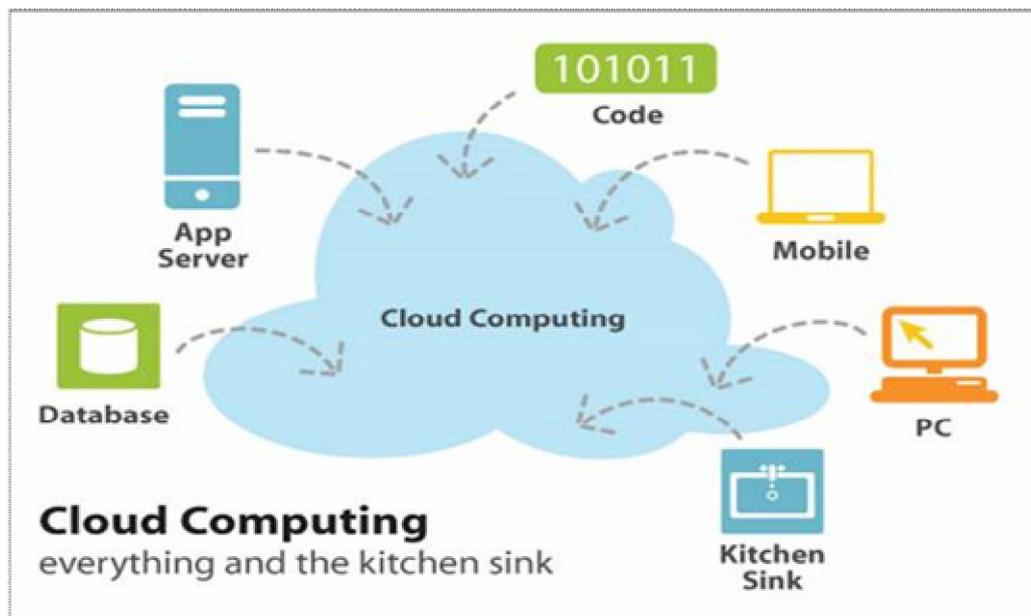

Figure-1: Cloud computing overview

A. Cloud Computing Architecture
To define Cloud computing, "Cloud computing is a new way of delivering computing resources and services". Cloud Computing can improve health care services, benefit of health care research, and change the face of health information technology. However as with new innovation type, cloud computing should be more rigorously evaluated before its widespread adoption. Healthcare is faster growing its way to adapt cloud computing. This is to use benefits of clouds services at minimum cost, effective use of resources and maximized availability of services. However, like in other fields healthcare is hesitant to embrace the cloud computing environment because of concerns of data privacy, availability and data integrity. Cloud-based services are steadily becoming very large adopted by healthcare organizations.

Cloud computing architecture can be broadly classified into two following parts

1. Front End

2. Back End

Each of the ends is connected through a network, usually Internet. The following Figure 2.ndepicts the graphical view of cloud computing architecture:
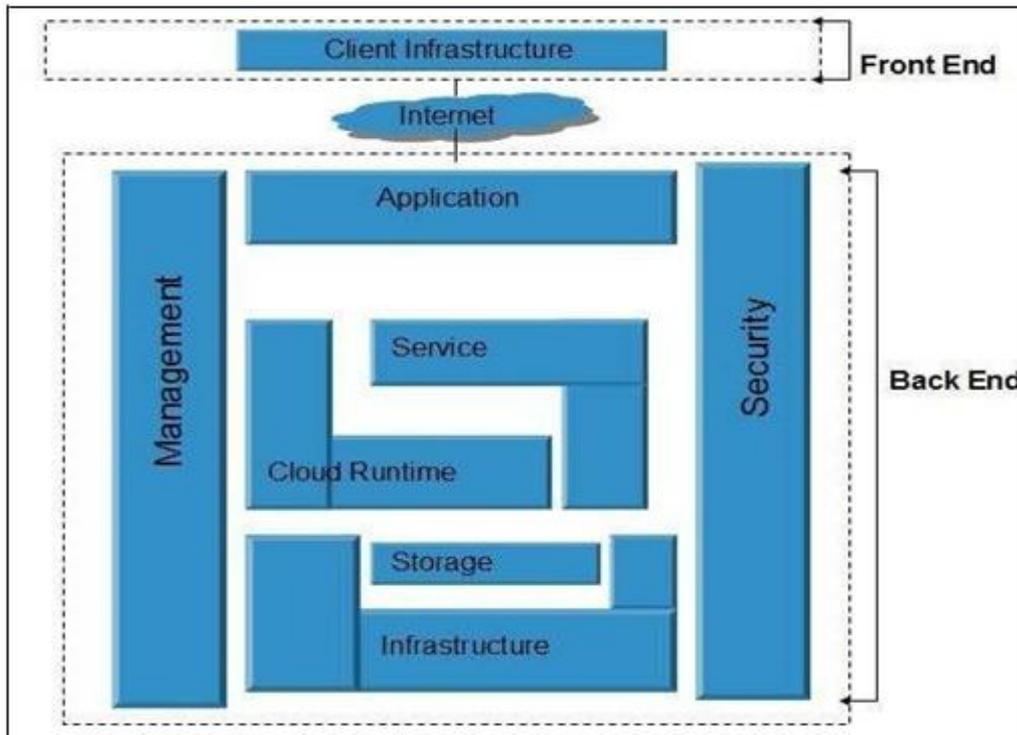
Figure-2: Cloud computing architecture

Front End

It refers to the client part of cloud computing system. As in the above figure, front end consists of interfaces and applications which are used for accessing the cloud computing platforms for example - Web Browser.

Back End

It refers to the cloud itself. The above figure gives overview of back end components; it consists of all the resources, which are required to provide cloud-computing services. Back end comprises of multiple things such as, huge data storage, virtual machines, security mechanism, different services deployment models, different servers, etc.

B. Cloud infrastructure

Cloud infrastructure comprise of many servers, storage devices, cloud management software, network, Deployment software and platform virtualization. The following figure depicts the Cloud Infrastructure Components:
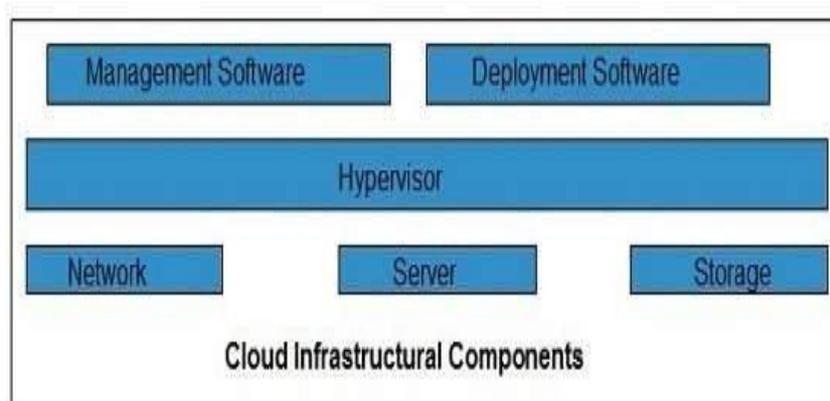

Figure-3: Cloud infrastructure

1. Hypervisor

Hypervisor is one of the infrastructure components; it is a firmware or a low-level program that acts as a Virtual Machine Manager. It allows sharing the single physical instance of cloud resources between many tenants.

2. Management Software

Management Software helps to maintain and configure the infrastructure.

3. Deployment Software

Deployment Software helps to deploy and integrate the application on the cloud.

4. Network

Network is the key component of cloud infrastructure. It allows connecting cloud services over the Internet. Network can be delivered as a utility over the Internet, which means, the customer can customize the network route and protocol.

5. Server

The main role of server is to help to compute the resource sharing and offers other services which include resource allocation, de-allocation, monitoring the resources, providing security etc.

6. Storage

Cloud keeps multiple copies of storage. If a storage resource fails, then it can be extracted from another one, which makes cloud computing more reliable.

Technology is increasing the connectedness of society. People use cell phones, the Internet, and handheld devices to stay in-touch and connected with friends, family, and work. A recent conducted by the American Life Project found that 74% of American adults use the internet and that 55% of adults connect wirelessly, either using Wi-Fi or WiMAX via their laptops or using handheld devices, such as a smart phone.

There are many businesses and industries affected by this trend in technology and one among them is the health care sector.

C. Impact of Cloud computing to Healthcare industry

Technology is constantly evolving, especially in the highly competitive healthcare industry. Many Hospitals have already undergone changing their legacy systems to include electronic health records (EHRs), a digital format of paper medical records which was mandated by the Health Information Technology for Economic and Clinical Health Act (HITECH) and enforced by the American Recovery and Reinvestment Act of 2009(ARRA). Such a transformation in healthcare has provided administration personnel, physicians, and nurses with timely access to medical records when needed.

EHRs at many medical facilities are currently housed on traditional client-server architectures. IT technology has already helped simplify operations in this regard, making the process much more efficient and patient-centric than in the olden days. **Adopting cloud computing solutions can make healthcare operations even more convenient and cost effective.**

The cloud offers on-demand computing by using the latest in technology to deploy, access, and use networked information, applications, and resources. Unfortunately, it also has a complex infrastructure that may be challenging to understand.

In most cases, end users are sure to find that cloud computing is the best choice for their healthcare business, as it's often less costly than having multiple computers in various medical rooms — each needing proper hardware, updated software, and network accessibility to upload, store, and retrieve patient or other medical data.

Healthcare IT solutions have offered many worthy benefits to the industry already. And now that enhanced security and safeguards are in place for cloud computing solutions, carriers, and service providers, healthcare organizations can rest easy knowing they're protected from potential loss of control over certain sensitive patient data.

With IT spending on the rise, cloud-based electronic health records (EHRs) is beginning to have an impact on the health industry.

D. Risks of Cloud Computing in Healthcare

Lack of security and privacy are the two primary concerns healthcare providers face when choosing a cloud Solution .In order to overcome these concerns, healthcare businesses must choose a reliable cloud provider Who acts in complete accordance with the provisions set forth in the Health Insurance Portability and Accountability Act (HIPAA) of 1996.

With massive data breaches increasingly reported in recent years, there is a growing uneasiness amongst patients who fear that hospitals and doctors that use a cloud service provider will complicate privacy of their data. There are also concerns of allowing multiple users to share EHRs among facilities.

In addition to patient privacy, data breaches cost healthcare organizations millions and millions of dollars each year. In fact, two of the most recent Cost of a Data Breach Studies from the Pokémon Institute shows that stolen healthcare records cost twice the global average. The average cost per stolen record was $380 in 2017 (global average was $141).**Such costs can be devastating for healthcare businesses.**

E. Benefits of Cloud computing in Healthcare Providers

Despite these concerns and risk, cloud computing is continually transforming healthcare in the modern age. First, as a **Software as a Service (SaaS)**, the cloud can offer healthcare organizations on-demand hosted services, providing quick access to business applications and fulfilling customer relationship management (CRM).As an **Infrastructure as a Service (IaaS)**, cloud solutions can offer on-demand computing and large storage for medical facilities.

And lastly, as **Platform as a Service (PaaS)**, the cloud can offer a security-enhanced environment for web-based services and the deployment of cloud applications. Transforming healthcare via the cloud is about more than just the delivery of medical information from multiple computers at anytime, anywhere, and on any mobile device. It's also about the benefits of being able to connect medical centers and cloud users for the purpose of sharing patients' health data over the Internet.

The cloud offers many benefits to a broad range of healthcare stakeholders by virtue of its elastic and virtually unlimited scalability, the high availability and accessibility of data despite volume, velocity, and variety, and a desirable IT budgetary shift from capex to opex. While initial concerns about data privacy and security limited cloud adoptions by the healthcare industry, those fears have been mitigated and cloud adoption has accelerated.

There are numerous advantages and benefits of cloud computing in healthcare. On-demand cloud computing and storage reduces operational costs for healthcare providers such as hospitals and clinics. The cloud can also help support the data-heavy health IT technologies being used in the industry today such as electronic medical records, patient portals, mobile apps, medical devices with IoT technology, and the big data analytics behind improved decision support systems, and therapeutic strategies. The cloud has also changed the face of clinical research, with enhanced support for knowledge-sharing and clinical trial management.

As a highly regulated sector that handles extremely sensitive data, the key health IT requirements of the cloud are

- High data availability, robust backup and disaster recovery capabilities, supporting minimal RTOs and RPOs.

- Effective data security, protecting from unauthorized access and breaches.

- Proven compliance with regulatory frameworks such as the EU's General Data Protection Regulation(GDPR) for the protection of personal data, the US Health Insurance Portability and Accountability Act (HIPAA) for secure data portability, and the HITRUST Alliance's CSF, an industry-mediated certifiable standard for safeguarding sensitive information.

To meet those challenges, some health IT companies need more than their in-house solutions and cloud native resources can provide. That's where NetApp can step in. Cloud Volumes ONTAP is built on AWS storage or Azure storage to meet the cloud requirements of health IT vendors and their end-users. The benefits include:

- Data Protection: NetApp Snapshot technology makes instant point-in-time data copies without affecting performance.

- Disaster Recovery: NetApp Snap Mirror provides quick and efficient data replication for seamless backup, disaster recovery, and data mobility across hybrid infrastructures.

- Significantly reducing cloud costs with built-in data storage efficiencies—compression, reduplications, thin provisioning.

- Volume cloning technology instantaneously creates a writable, point-in-time copies of volumes without using additional disk space, useful for dev/test requirements for health IT vendors as well as for data analytics for healthcare researchers and insurers.

- Automated storage tiring for cost-effective storage of "cold" data while keeping "hot" data accessible to clinicians, patients, and more.

- Secure encrypted data across the entire NetApp data fabric.

F. Examples of How Cloud Solutions Can Transform Healthcare

Healthcare facilities that ultimately decide on a private, public, or hybrid cloud solution can opt for a virtualization platform at VMware or Microsoft. At Innovative Architects, we usually recommend choosing Microsoft's secure cloud platform, which uses Windows Server with Hyper-V and the System Center. This scalable solution is best able to meet most growing business's needs, helping easily power cloud applications and/or supply cloud-based computing and services.

The Microsoft Azure cloud computing system, in particular, can provide on-demand simple access to healthcare applications and data. Using a PaaS environment, Microsoft provides a service to supply providers with networks, servers, and storage.

Microsoft Azure complies with the data protection and privacy laws set forth in HIPAA and the HITECH Act. This system also meets Cloud Security Alliance (CSA) as well as Governance, Risk and Compliance (GRC) criteria. Either implement Azure's .NET Services to integrate public cloud-based applications, or turn to SQL Server-based data services to properly secure the entire infrastructure.

Regardless of what cloud service platform you choose or which provider delivers the best service, the delivery of computing and service must permit sharing of proprietary data resources to help physicians and healthcare providers to do their jobs effectively and efficiently. Both the cloud platform and cloud provider must also ensure all of your digital medical data remains secure and private. So long as these conditions are met, there will be less and less resistance to cloud computing adoption in the healthcare industry.

G. Pros and Cons of Healthcare Systems
The Pros are
1. Low costs
   a. Cost is lesser with respect to man power ,paper work and many more factors ,but this is applicable to large organizations

   b. Outsourcing information reduce amount spent on new technology

   c. Easier to maintain when compared with existing system. Whether the existing system is On-premise or old traditional technique.

   d. More secure

   e. Companies are hired to watch over the information

2. Interoperability
   a. Access information from anywhere

   b. Can be accessed using different devices

   c. Patient don't need to visit hospital for reports

3. Clinical Research
   a. Data are stored on cloud and are available for clinical research

4. Electronic Medical Records
   a. Patients records are stored electronically

The Cons are
1. Privacy and Security Challenges
   a. Data maintained in a cloud may contain personal, private or confidential information such as healthcare related information that requires the proper safeguards to prevent disclosure, compromise or misuse.

   b. Globally, concerns related to data jurisdiction, security, privacy and compliance are impacting adoption by healthcare organizations

H. 6 Ways Cloud Computing Is Transforming Healthcare Systems

Here are six areas in which health clouds are resolving key challenges for the healthcare community.

The global healthcare cloud computing market is expected to reach $9.48 billion in 2020 from $3.73 billion in 2015 — a 20.5% compound annual growth rate. The market is expected to be dominated by North America, followed by Europe, Asia, and the Rest of the World (RoW). This growth will place new demands on healthcare systems' infrastructure to maintain and improve access to quality care while stabilizing healthcare costs. Enter cloud computing.

As digital transformation ripples across the healthcare industry, advancements in connectivity, security, and cloud services technologies are allowing the healthcare ecosystem to address several of the biggest challenges that this community is facing — leveraging health "clouds" to address key issues, such as healthcare access, personal data privacy, and drug theft and counterfeiting.

Here are six areas in which health clouds are resolving key challenges for the healthcare community.
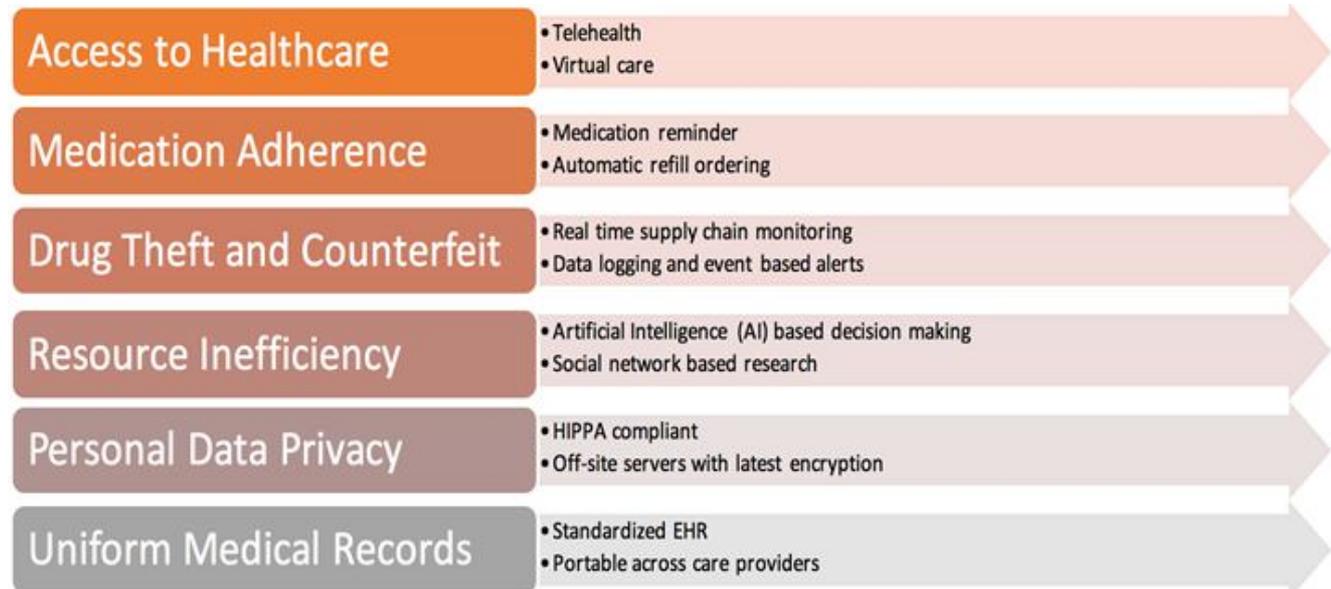

Figure-4: Six ways cloud computing addresses deficiencies in the healthcare system.

Access to healthcare: In remote parts of the country and for patients with busy schedules, accessing healthcare is a major issue. Telehealth or virtual care solutions are gaining popularity, with some states modifying laws to accelerate adoption and address this problem, e.g., Ring Central, Cisco.

Medication adherence: Patients not following the drug regimen prescribed by the doctor, results in avoidable re-admissions to the hospital costing the U.S. healthcare system $290 billion annually. Market for products that remind the patient when it is time to take the medicine, keep a log and automatically order refills is expanding at a rapid pace, e.g., Omnicell, Medi Pense, Medissimo.

Drug theft and counterfeiting: Theft, counterfeiting, selling expired medicine are some of the problems which can be controlled by monitoring the supply chain. Recently, government has passed the Drug Supply Chain Security Act (DSCSA) which will require all the stakeholders in the pharmaceutical supply chain to monitor and report status on drugs during transportation. This has opened up a market for solutions which monitor and log supply chain events in real-time and report suspicious events, e.g., RxTrace, rfXcel.

Resource inefficiency: Escalating cost of healthcare is always a hot topic among policy makers and no real solution has been implanted to date. One of the major factors adding to the cost of healthcare is inefficiency of resources like medical staff, equipment and easy access to patient resource pool for clinical studies. With the use of artificial intelligence in the healthcare environment, a doctor's bandwidth can be stretched since data can be augmented with smart machine-based analytics for doctor to evaluate. For clinical trials or scientific studies, a social network-based approach can be used to gain access to a patient pool, e.g., IBM Watson, Apple Research Kit.

Personal data privacy: Each healthcare organization maintaining their own medical records is a nightmare for data security and compliance to Health Insurance Portability and Accountability Act (HIPAA). Not to mention that it adds significant cost for organizations to maintain their own IT infrastructure and be liable for all the data directly. Using cloud-based solutions provides access to latest security technologies and reduces individual liability, e.g., Verizon Thingspace, IBM cloud.

Uniform medical records: Each hospital or care provider using their own Electronic Health Record (EHR) system is not in favor of the consumer. Not only does it add cost to the healthcare system since each hospital has to maintain a different system but it also makes it more resistive for a patient to change care providers. In other words the patient gets tied to a certain care provider and may not always get the optimum care which would be the case if they had easy access to their EHR in a standard format. Industry wide effort is going on to

have one EHR or Personal Medical Record (PMR) tied to the patient so that they get the best care agnostic of the provider network, e.g., Apple PMR, Picnic Health.

Cloud computing and healthcare is a match made in heaven to improve the quality of life for our society. With recent advances in cloud computing — improved performance and storage at better cost, robust security, interoperability, hybrid infrastructure, seamless integration — the healthcare ecosystem, is well positioned to take advantage of connected applications to create and deploy better healthcare solutions.

CONCLUSION

Cloud technology is used to create a network between patients, doctors, and healthcare institutions by providing applications, services and also by keeping all the data in the cloud. There are very wide opportunities and reasons to choose Cloud Technology in healthcare. It is right time to join hands with clinicians and computer specialists to forward in order to implement the large technology which suits small practices to big hospitals. The current technology of adopting Cloud computing in the medical field can improve and solve many collaborative information issues in healthcare organizations and cost optimizations. Standardized cloud-based applications will bring advantages to the patients, physicians, insurance companies, pharmacies, imagining centers, etc. Challenges such as security concerns and interoperability will rise because of 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 problems.

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