Cloud Based Solutions and its Impact On Medical Image Storage and Retrieval

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Abstract: Cloud based technologies are on the rise with providing various flavors of solutions in SAAS, PAAS and IAAS models. With this technology in place, there are doors open for medical imaging vendors to explore the possibilities of "Anywhere Anytime Data" and low cost solutions with high retrieval speed. This paper discusses about the various benefits rendered by the cloud for the medical imaging domain and the challenges lying ahead for the medical imaging vendors to address when they use the commercial cloud products in the current trend.

Index Terms - Cloud, medical, disaster recovery, security, modality

I. INTRODUCTION

Medical imaging solutions across the world generate humangous amount of data every second. Based on the growing trend, it was estimated that over 100000 terrabytes of data will be performed in the United States during year 2014, which will generate Petabytes of data [1].In 2015 the data growth is more than 100 % increase when compared to the data generated in 2013[6]. There is an exponential growth of the acquisitions happening due to the developing modality procedures .With increase in the size of the data, information shared about the patient including the diagnosis details becomes more efficient and at the same time requires optimal solutions to manage such a huge amount of data. In addition to day today management the patient data has to be maintained for a minimum of 25 years according to the FDA regulations[2]. This makes way for new requirements for increasing scalability, security, performance and efficiency of the patient data which are catered by different cloud based platforms available currently.

The scope of this paper is to discuss about the advantages of a cloud and how it adds value to a medical imaging product and the challenges that are analysed for providing high quality solutions all over the world. It also discusses about the various factors involved in storing medical images in cloud.

II. WHAT IS CLOUD?

Medical imaging solutions across the world generate humungous amount of data every second. With increase in the size of the data, information shared about the patient including the diagnosis details becomes more efficient and at the same time requires optimal solutions to manage such a huge amount of data. In addition to day today management, the patient data has to be maintained for a span of 7- 25 years according to the FDA regulations .For instance the UK NHS code of practice specifies to maintain the record for 30 years[5].This makes way for new requirements for increasing scalability, security, performance and efficiency of the patient data which are catered by different cloud based platforms available currently.

The scope of this paper is to discuss about the advantages of a cloud and how it adds value to a medical imaging product and the challenges that are analyzed for providing high quality solutions all over the world.

III. WHY CLOUD?

History of cloud dates back to 25 years before when research was initiated to go ahead with huge servers servicing multiple clients all over the world. But the conventional client server system were having a lot of disadvantages like

- Bottleneck for multiple clients and requests
- Scalability issues
- DOS attacks
- Hardware cost
- Maintenance issues
- Availability problems

To overcome all these problems, the one stop solution is to explore the cloud based technologies .

IV. MEDICAL IMAGING REQUIREMENTS WHICH LEAD TOWARDS CLOUD

Imaging for medical purposes involves the services of radiologists, radiographers, medical physicists and biomedical engineers working together as a team for maximum output. This ensures the production of high quality of radiological service with consequent improvement of health care service delivery. Computing and storage in the cloud seem to be a natural solution to many problems we face today for long-term medical image archives [3].

Some of the modalities involved in business are

- Plain radiography
- Fluoroscopy
- Angiography
- Mammography
- Computed Tomography
- Ultrasound
- Magnetic resonance Imaging
- Nuclear Medicine

A medical imaging software caters to all the above modalities by providing basic features related to medical services and it works closer to the operating system. It provides all the imaging capabilities, DICOM services, medical data transfer capabilities so that modality applications are developed with radiology services instantly.

V. BASIC FUNCTIONALITIES

The basic functionalities include the support of one or more of the reliability and data hazard requirements. Medical imaging requirements are highly risk related beacuse of the following possibilities

- Complexity of Medical requirement
- Adherence to various international Standards
- Multimodality testing
- Risk involved in failure of the software (Affecting Human life)
- Loss Of data cannot be entertained even to minimal extent
- Continuous evolution of the Technology with various sized and quantified images.

VI. APPLICABLE LAWS AND STANDARDS

There are various laws and standards applicable for medical devices like ISO standards, WHO directives, FDA regulations, and CE european regulations.

In addition to all these regulations Risk Management becomes mandatory for a medical device manufacturer. This is because there are high risks involved like

- 1.device defect
- 2.patient data loss
- 3.procedures dealing with human life
- 4. Exposure to radiation.

VII. ADVANTAGES OF USING CLOUD IN MEDICAL IMAGING

7.1 Seamless integration of hospitals

Modern Corporate hospital network can retrieve data seamlessly using cloud. There can be multiple client workstations simultaneously accessing data at a much effecient speed from the cloud compered to conventional PACS system. The cloud based platform makes it easy to multiply the number of servers based on the peak load and traffic time and hence caters to hospitals at a higher speed. The cloud provides virtual centralization of applications, storage, etc. which can be accessed by any webfriendly device (computer, laptop, smart phone, tablet, etc.) virtually anywhere. Centralization gives the cloud service provider systemwide control over, for example, security and application upgrades, negating the need for installation of upgrades on individual devices..

7.2. Data can be accessed from multiple geographical locations

Simultaneous access of data across various geographical locations possible from cloud.Based on the demographic and social data the cloud providercan increase the availability of the data at a particular time across different timezones.This helps the doctors in various

locations to diagnose the same patient data with different modality information from different hiospitals. In [18], the medical image archive service using DICOM [19] standard as a cloud computing based solution under Microsoft Windows Azure platform proved to have better accesibility. As described by Fig 1, the data can be downloaded in multiple devices.

7.3.Business ROI is improved

In a typical medical imaging workflow at a majority of situations, it is not required to access the entire data set or use teh complete set of DICOM services but only minimal one. For instance a radiologist might require only viewer service in the client and Archivar might require only the DICOM Storage SCP. In such cases cloud charges only for the used service and hence the medical imaging solution vendor leverages the full capability in a reduced cost. The latest cloud based PACS ensures that there is a immediate reduction in cost for storage and retrieval. On site Data centres are also not required if cloud based solutions are used.



The altest cloud platforms support multiple devices in which the data can be received and viewed with higher resolutions. For instance the same study can be viewed in a laptop, desktop or a mobile device without any flaws at any point of time. Cloud assures scalability. A cloud based Architetcure known as MIFAS was compared with PACS [16] on the basis of image retrieval time, proximal failure problem, synchronization and concurrency. Which proved that it is scalable, cost effective and easy to manage

7.5. Reliability and Redundancy can be provided by the cloud .

Medical imaging specialists need not worry for the data loss. Cloud products in latest tends to provide redundancy of data by maintaining proxies. At the same time reliability also is increased by providing multiple copies of same software at different locations which makes it easy to retrieve the data in case of hazards.

7.6.Pay per use applications increase the revenue of many hospitals worldwide

The pay per use strategy helps small hospitals to gain more revenue because the cloud concept provides way to use only what is needed.

7.7. Testing made easy by using IAAS

Because of extensive hardware availability in cloud, it is possible to test the performance requirements in various hardware for the same software and compare the behaviour. This is very useful in stress testing and performance testing.

VIII. INFLUENCE ON MEDICAL IMAGE STORAGE AND TRANSFER

When a cloud based medical image archive is provided it can perform the following functionalities seamlessly.

- 1. Download images seamlessly
- 2. Secure sharing of images with referring physicians
- 3. Disaster Recovery
- 4. View images anytime, anywhere, on any device

Cloud computing addresses the problem of storing a large amount of data across different locations. Eventhough the same can be achieved by different techniques, the main attraction here is 'pay as u use". This can help the medical imaging vendors to reduce the cost to large extent. At the same time the inherent advantage of cloud, a form of cloud in which the required hardware can be used based on necessity ie "Infrastructure As A Service" will be of great help for the medical imaging vendors in terms of scalability and redundancy.

8.1 Download images seamlessly

The data growth in medical systems requires the infrastructure to store ,transfer, retrieve data improve tremendously. Healthcare researchers are moving their efforts to the cloud, because they need adequate resources to process, store, exchange, and use large quantities of medical data[9]. There is a high complexity in medical practitioners communicating to Mentally affected, differently abled and unconscious patients about their medical. Karthikeyan et.al. provided palm vein pattern recognition based medical record retrieval system, using cloud computing for the above disabled people[11]. Yao et.al proved the possibility of using of a Cloud-based Virtual Desktop Infrastructure (VDI) to serve multiple hospitals, with different hospital information systems dynamically assigned and reassigned according to demand[12].

8.2 Secure sharing of images with referring physicians

As explained in[7], HIPAA (Health Insurance Portability and Accountability Act) plays a vital role in medical informatics .

The security issues with cloud are

- 1.User access control for a particular data
- 2.data reliability
- 3.Patient privacy issues
- 4.Data loss that might occur duing anonymization and conversions.

The SWOT analysis performed in [8] confirms that cloud computing could have huge benefits for healthcare but there are a number of issues that will need to be addressed before its widespread use in healthcare considering the nature of the processed information especially health care organizations need to assess and treat specific risks according to cloud computing in their information security management system[10].

8.3 Disaster Recovery

The cloud storage has to implement a robust disaster recovery(DR) management because of the limitation of cloud regarding security. When medical images are stored in cloud ,DR is inevitable. The DR plan includes the following analysis about the services running in cloud

- 1. How much downtime is allowed for a user
- 2. Whether the data, services and applications have to be backed up
- 3. What is the priority of the data that needs back up

There are various strategies adopted for DR, like where exactly the server is located and how much data needs to be recovered.

8.4 View images anytime, anywhere, on any device

The concept of viewing medical images in any device involves the following steps.

- 1. authenticating the device
- 2. Retrieval of Data
- 3. Providing the data to various applications in the device.

There are various radiology apps and DICOM viewers available today, which provide high resolution medical images and used for diagnosis. Radiologists are quickly adopting mobile apps to view and share images, collaborate with other physicians, and review files and databases[13].

IX. CHALLENGES

9.1 Medical imaging Security challenges (HIPAA requirements)

With the increasing trends of cloud computing there are some basic security and functional privacy issues come in to picture especially with medical imaging workflows. The Security of a medical imaging software is assured by allowing a particular user to access a particular patient data.

The major risks involved are

- 1. When the medical images are exposed to cloud, it is highly
- Required to anonymize the data.
- 2. Most of the cloud vendors according to current trend compress The data to achieve better efficiency but in a medical domain Compression is usually avoided to ensure data clarity
- 3. Eavesdropping the network is possible

When accommodating to a cloud environment, we should take care that the security of the patient data is not tampered by any case. This makes the customization and adaption difficult for the vendors. The presence of a reliable, high-speed, bandwidth Internet connection is the most important factor when considering such systems, as it is the operational backbone. Strict third-party checks and audit trials are required in order to ensure that these data centers are secure in storing medical data and capable of maintaining confidentiality[14].

9.2 Anonymization Issues

Since the cloud clients are not aware of the data storage location it necessitates to anonymize the medical data to be stored on cloud.

There are various issues foreseen like

- 1. Data Conversion
- 2. Performance penalties
- 3. Data Loss

A percept which clearly defines the challenges that are lying ahead.

"However, privacy and security concerns have slowed adoption of cloud storage, according to Nahim Daher, an analyst at consulting firm Frost & Sullivan. Cloud-storage vendors store data at multiple sites, and the provider "doesn't know where the data is sitting and doesn't have direct oversight into who is looking at it," Daher says[4].

X. CONCLUSION:

Eventhough the advantages are tremendous, there are lot of hazards that need to be addressed by future research in security of medical images in cloud. The future research will confirm the usage of cloud technologies to overcome the bottlenecks in medical image storage and transfer.

XI. ABBREVATIONS

DOS-Denial Of Service DICOM-Digital Imaging and Communications in Medicine IAAS-Infrastructure as a service PAAS-Platform As a service SAAS-Software As A Service

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