A Comparative Analysis of Various Healthcare Frameworks in Cloud Environment

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Abstract- **In a country like India, conflicting to popular belief, technologies have reached in places, where at least hospitals with basic facilities yet an illusion. During emergency, the patients find difficult to meet doctors while they are out of station. Since the patient's data are stored in local server, they are not able to access their data from anywhere. So, if the data is present in cloud, healthcare professionals, pharmacist, doctors and authorized patients will be able to access the data anytime from anywhere. Hence, in recent days, many healthcare sectors are moving towards the cloud. There exist several pitfalls in existing healthcare frameworks. So, this paper aims to analyze the various framework of healthcare sector and find out the challenges to precede this research on that direction in future.**

Keywords: Cloud Computing, Healthcare Sectors, Cloud Models, Cloud Frameworks.

I. INTRODUCTION

The emergence and rapid adoption of cloud has seen a significant increase in research on provenance as it is regarded as the foundation for any model. Anyone can get anything as a service at anytime from anywhere through internet on demand basis. Cloud computing archetype is seen as a trend in the current scenario with all the organizations are moving on it. Health care sectors are also moving towards cloud to offer great service to the patients, healthcare professionals, pharmacist and doctors. Doctors, pharmacist and patients can access healthcare information from anywhere around the globe at anytime. Cloud computing is a boom for hospitals, clinics, insurance companies and pharmacies to share health care information to offer better service in less cost.

The objective of this paper is to analyze various frameworks in healthcare industries in cloud. The remaining part of the paper is organized like this. Section II describes cloud computing. Section III focuses on analysis of existing frameworks on health care system. Section IV discussion and analysis and Section V concludes the paper.

II. CLOUD COMPUTING

Cloud: Anyone can access anything as service at anytime from anywhere through internet on demand basis. According to U.S National Institute of Standards and Technology (NIST), — "Cloud Computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or cloud provider interaction" [7].

Characteristics of cloud computing:

1. On Demand Service.
2. Broad Network Access.
3. Resource Pooling.
4. Rapid Elasticity.
5. Measured Service. [6]

Cloud computing provides number of different services. One set of services, namely, **Software-as-a-service (SaaS),** where software and its related data are located in the cloud and are accessed by users using a web browser. Examples for SaaS: Google Apps, Salesforce.com. Another set of services, namely, **Platform-as-a-service (PaaS),** where developers can develop applications using the programming languages and the tools over the internet. It provides an environment where the developers can implement and test their cloud based applications. Examples for PaaS: Google App Engine, Force.com A third set of services, called as, **Infrastructure-as-a-Service (IaaS),** which provides an infrastructure to share hardware resources for executing services with the help of virtualization technology. Examples for IaaS: GoGrid, Amazon S3.

Cloud computing can be classified into four main types depending on deployment:

(i)Public cloud, (ii) Private cloud, (iii) Community cloud and (iv) Hybrid cloud.

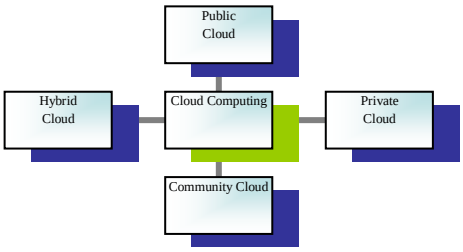

Figure 1 Classification of Cloud Computing

a) *Public Cloud*

It provides services over a network. This model of cloud is the most popular form of cloud computing. In a

public cloud, resources are dynamically provisioned on a self-service basis over the internet via web services. It is less secure.
Examples: Google App Engine, Microsoft Azure.

b) *Private Cloud*

This model of cloud provides a secure and unique cloud based environment where only the respective organization can operate. This model of cloud is owned by respective organization. Example: Eucalyptus Systems.

c) *Community Cloud*

This type of cloud is maintained by a group of organizations. Community cloud may be managed by one or more of the organizations that belong to the specific community or by a third party. Example: Facebook.

d) *Hybrid Cloud*

Hybrid cloud is a combined form of other cloud deployment models such as private cloud, public cloud and community cloud [12]. Hybrid cloud allows users to access solutions across various deployment models. Example: Amazon Web Services (AWS).

A. HEALTHCARE IN CLOUD ENVIRONMENT

Healthcare sectors have been dealing with huge amount of patient's data and digital images. Hence, healthcare sectors are showing much interest on moving their sector towards cloud. Cloud computing is evolving as a key computing model for sharing resources such as applications, infrastructures, software and business processes. Cloud introduces a new way of delivering services and a business model to the medical community. Now, healthcare sectors found a way to shift the burden of maintaining and managing complex data to the cloud service providers. Cloud technologies increase the efficiency of services to hospitals, research clinics and healthcare institutions. Cloud enables the doctor's to access their patient's data from anywhere anytime in the globe. Cloud computing can help healthcare sectors to share information such as prescriptions, insurance information, doctor's references, test results that are stored across various information systems. There exist certain anomalies in the traditional healthcare sectors such as privacy, data loss, security and so on would be solved by implementing the cloud technology into the healthcare sectors. A cloud based framework can offer an easy and ubiquitous access to patient's data and provide opportunities for the patient's to employ the services of experts in that field.

III. ANALYSIS OF EXISTING FRAMEWORKS ON HEALTHCARE SYSTEM

Bamiah et al. [1] designed a Healthcare Trusted Cloud Computing (HTCC) framework that maintains security, privacy and considers HIPAA regulations. This framework uses Trusted Computing Group (TCG) technologies such as Trusted Platform Module (TPM), Trusted Software Stack (TSS), virtual Trusted Platform Module (vTPM), Trusted Network Connect (TNC) and Self Encrypting Drives (SEDs). They used strong multi-factor authentication access control mechanisms and strict security controls, as well as encryption for data at rest, in-transit and while process. They customized cloud Service Level Agreement (SLA) based on the healthcare requirements. This framework will assist in optimizing trust on cloud computing to be adopted in healthcare sector.

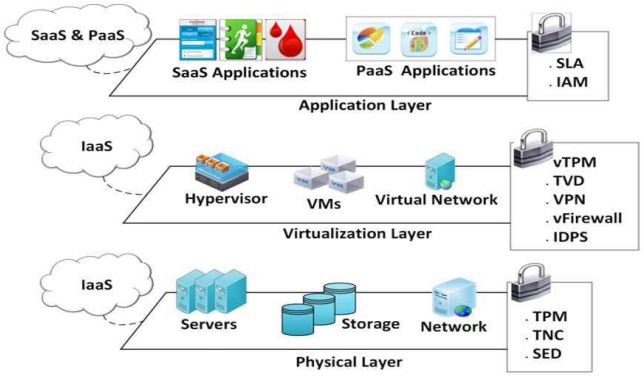

Figure 2: Healthcare Trusted Cloud Computing (HTCC) framework

Yang-Ye et al. [2] proposed a framework that attempts to provide a smart living helper for the betterment of elderly people. This framework had two systems namely, Web-based user remote management service(WURMS) and multimodel interactive computation services(MICS).This model is coordinating couple existing audio-visual and communication techniques, including the speech/sound recognition, the speaker identification, the face identification, the sound source estimation, the text to speech (TTS) and the event recognition. The above figure shows the framework of proposed ubiquitous healthcare system based on cloud computing infrastructure. The proposed model provides user with three types of web-based services, (i) manageable reminder service, (ii) remote monitoring service (iii) communication system. This model improves healthcare environment for elderly people.

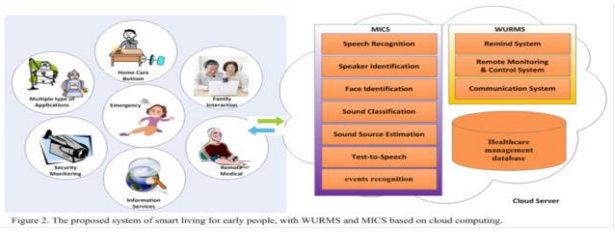

Figure 3: Ubiquitous Healthcare System (UHS) framework

Ryan et al. [3] discussed the key challenges in achieving a trusted cloud through the use of detective controls, and forwarded the TrustCloud framework, which addresses accountability in cloud computing by adopting technical and policy based approaches. The proposed one focuses on detective rather than preventive techniques to increase accountability. As for as, accountability is concerned, auditing place a major role in it. The proposed TrustCloud framework consists of the following layers of accountability. The workflow layer focuses on audit. The data layer enables data-centric logging. The system layer

performs file-centric logging within Operating Systems, File Systems and Cloud's Internal Network.

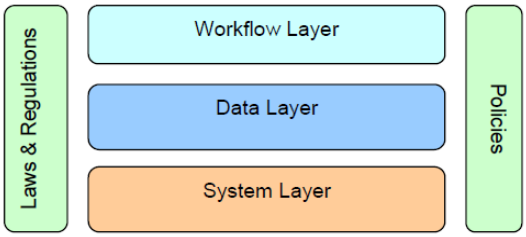

Figure 4: TrustCloud framework

Mukherjee et al. [4] designed a sensor-cloud framework for hosting remote health-care services. Here, they first analyzed the requirements for delivering remote health-care services and then they presented an overview of the sensor-cloud. To maintain health care data in a secured way, they proposed a data model which solves issues related to storage and retrieval of health records. This paper also proposed a remotely accessed, low-cost healthcare system based on sensor-cloud environment. They proposed a generalized sensor-cloud framework that can be used for various applications including healthcare management. Here, they also discussed how healthcare records should be scalable to include sensor data and also they discussed issues related to storage and retrieval of healthcare records.

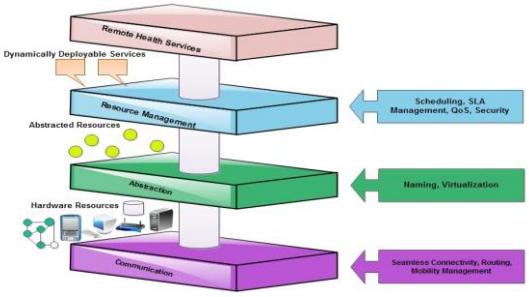

Figure 5: A Layered Architecture for Sensor-Cloud Framework

Irfan, et al. [5] proposed a novel framework to secure personal health records under distributed environment in the cloud. This framework addresses the challenges faced by multiple medical records owners and users. This framework reduces the difficulties of key management. This system is divided into various security domains such as personal domains (PSDs) and public domains (PUDs) based on user's requirements to access data. This system also supports the dynamic policy management model. This paper also proposed an approach to enhance security and privacy for the existing PHR system using attribute based encryption.

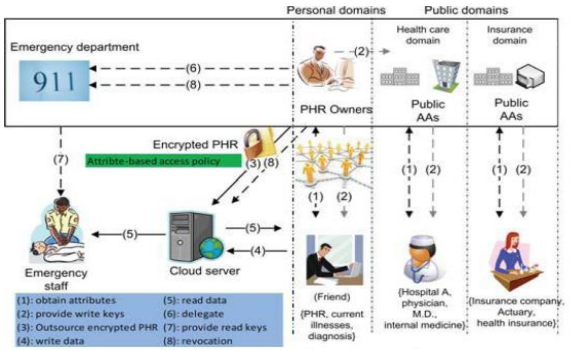

Figure 6: A Novel Framework

III. DISCUSSION AND ANALYSIS

The design proposed by Bamiah, et al. [1] was not implemented since the requirement of resources to implement this design is more. There is a need to simulate this framework in healthcare sector. Since the data being encrypted in three stages such as data at rest, data at transit and data in process, the key management is key issue. Yang-Yen et al. [2] focused only on elderly people. In order to provide efficient services to lonely elders this framework has to be integrated to more web-based services. To support disabled people, more functionality can be added in MICS. Also, to keep lonely elders in safe and secure environment more sensors can be added to WURMS. This framework works only in smart environment. The framework proposed by Ryan et al. [3] needs a technique to perform logging over the three components namely Operating Systems, File Systems and Cloud's Internal Network in system layer. Mechanisms are needed to provide more security and privacy. This framework mainly focuses only on one parameter, accountability. It doesn't focuses on other QoS parameters like scalability, reliability. The framework suggested by Mukherjee et al. [4] needs a mechanism to provide heterogeneous communication nets within the sensor-cloud computing environment. Mobility, Security and Confidentiality issues also have to be addressed. The key management has to be improved in the framework modeled by Irfan et al. [5] and there is a need to enhance privacy guarantee. A summary of review of several techniques is provided in Table I.

Focused Area	*Tools/Techniques*	*Merits*	*Demerits*
Trust on Cloud computing in healthcare.[1]	TPM, TSS,vTPM,TNC,SED, multi-factor authentication access control mechanisms.	This framework provides better security and privacy.	This technique is not implemented since the requirement of resources to implement this design is more.
Healthcare trusted cloud computing.[2]	Web-based user remote management service (WURMS) and multimodel interactive computation services (MICS).	It Improves healthcare environment for elderly people.	This framework works only in smart environment. To keep lonely elders in safe and secure environment more sensors can be added to WURMS.
Accountability in healthcare.[3]	Adopting technical and policy based approaches.	This model addresses accountability. Performs file-centric logging within Operating Systems.	This framework mainly focuses only on one parameter, accountability. It doesn't focuses on other QoS parameters like scalability, reliability.
Sensor-cloud framework.[4]	Adopts data model.	Remotely accessed, low-cost healthcare system. This model solves issues related to storage and retrieval of health records.	Mobility, Security and Confidentiality issues have to be addressed.
Securing patient's records.[5]	Use attribute based encryption.	This framework reduces the pitfalls of key management. Supports the dynamic policy management model.	Key management has to be improved and there is a need to enhance privacy guarantee.

Table I. Review of Several Techniques

V. CONCLUSION

This research work analyzed the various frameworks of healthcare sector. And, also this paper finds out the pitfalls and challenges of the existing frameworks such as certain frameworks are not suitable for all categories of people. In some frameworks, issues like mobility, security, reliability, confidentiality, accountability, privacy, integrity, maintenance and network inconvenience have to be addressed. Even though there exists several pitfalls in the existing healthcare sector framework, cloud is becoming an attractive prototype for healthcare sectors. In future, the main aim of this research work is to focus on the discussed challenges by designing an efficient framework.

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