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RESEARCH ARTICLE

THE CLOUD- CHANGING THE INDIAN HEALTHCARE SYSTEM

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Abstract— Cloud computing is the fastest growing field in Information Technology sector. Cost reduction, flexibility, scalable and sustainable, increased efficiency, reliability, usage defined payment and enhanced mobility are some of the features of cloud computing. The robustness and security of Cloud is increasing such that it could now be used in healthcare sector very easily. As in healthcare sector data privacy and security are of high importance. Right information at right time saves lives. But with the new opportunities come few risk too like Data security risks, the risk of loss of data and risk of system unavailability. We see that the information system of hospitals in India not very well managed, they have somewhat rare information. Cloud helps its client with the latest technologies but at a very low price. Client has to pay only for what he uses with minimum resource. The cloud is not about technology, it is the abstraction of technology for delivering pure services. This work proposes a solution based on cloud computing implemented for hospital systems having as a result a better management, high speed for the medical process, and increased quality of the medical services. In this paper we have analyzed the implementation of cloud computing in Indian healthcare sector. Cloud computing technology is still new but promises a revolution in the entire connected areas.

Key Terms: - Cloud computing; e-Health; cloud and health care

I. INTRODUCTION

Cloud computing is internet-based computing, where shared servers provide computing power, storage, development platforms or software to computers and other devices on demand. This frequently takes the form of cloud services, such as 'Infrastructure as a Service' (IaaS), 'Platform as a Service (PaaS)' or 'Software as a Service' (SaaS). Users can access web-based tools or applications through a web browser or via a cloud-based resource like storage or computer power as if they were installed locally, eliminating the need to install and run the application on the customer's own computers and simplifying maintenance and support. There are several possible deployment models for clouds, the most important being public, private and hybrid.[1] Cloud computing is the fastest growing field that provides many different services, which are provided on demand of the client over the web. Cloud computing is based on the model of pay-as-you-go.

This gives the user cost reduction, fast and easy way to deploy the applications. Cloud computing usage in the Information Support Systems will facilitate businesses to run smoothly and efficiently. A number of virtual machines and applications can be managed very easily using a cloud. With the use of cloud in businesses will

not only save the cost of staff required to maintain servers, but will also require lesser servers and with that less power consumption. [2]

The most important sector which requires a lot of information, data and computing power is healthcare system. Doctors require medical history of the patients in critical times and within no time. But we see that different departments of a healthcare system has have different information of the patients medical history, with require time to get assembled. Doctors have to start the treatment without the complete information of patient's medical history, which sometimes, is life threatening for the patient. Technologies could be used in healthcare sector to provide better healthcare facilities and reduce the operations costs. In our country we see that there is scarcity of doctors, nurses and pharmacy. But still there is rapid growth in healthcare services, while diseases are becoming more complex. More and more new and efficient diagnostic techniques and new way of treatments are being developed and used in healthcare sector so as to provide the patients with best possible treatment and in their budget. Many healthcare organizations are providing different kind of services to cater to highly diversified economic population which in turn has resulted in competition in the market. So the organizations which do not perform well are out of business. [3][4]

As healthcare providers need cost effective automating processes which gives more profits, cloud computing will provide perfect platform in the healthcare information technology space. Many hospitals may share infrastructure with large number of systems linked together. By this pooling the hospitals automatically reduce the cost and increase utilization. The resources are delivered only when they are required. This also means real-time availability of patient information for doctors, nursing staff and other support services personnel from any internet enabled device [5].

II. ARCHITECTURE AND CHARACTERISTICS OF CLOUD COMPUTING

Cloud computing, defined by NIST (National Institute of Standards and Technology) is a technology that supports ubiquity, it is convenient, supplies on demand access to the network for sharing computing resources (e.g., networks, servers, storage, applications and services), can be launched and developed quickly with minimal management and without service provider interaction. The figure 1 shows visual model of cloud computing definition and this model is composed of five essential characteristics, three service models, and four deployment models.

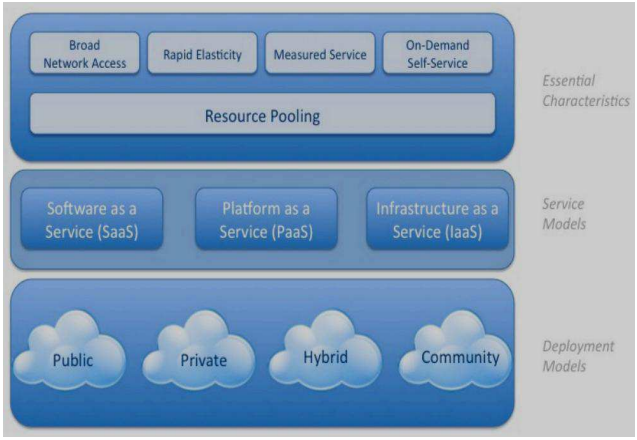

Figure 1: Cloud computing overview model (NIST)

A. Characteristics

1. On-demand self-service. A consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with each service provider.

2. Broad network access. Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, tablets, laptops, and workstations).

3. Resource pooling. The provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. There is a sense of location independence in that the customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level

of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, and network bandwidth.

4. Rapid elasticity. Capabilities can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward commensurate with demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.

5. Measured service. Cloud systems automatically control and optimize resource use by leveraging a metering capability1 at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilized service. [6]

B. Cloud computing Service Models:

1. Software as a Service (SaaS). The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure2. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

2. Platform as a Service (PaaS). The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider.3 The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly configuration settings for the application-hosting environment.

3. Infrastructure as a Service (IaaS). The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls). [6]

C. Deployment Models:

1. Private cloud. The cloud infrastructure is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises.

2. Community cloud. The cloud infrastructure is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off premises.

3. Public cloud. The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.

4. Hybrid cloud. The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds). [6]

For healthcare system private model could be used as it will provide data privacy and security. Only authorized healthcare professionals can access the data.

III. CLOUD IN INDIAN SCENARIO

The Indian healthcare sector, currently valued at USD 65 billion, is expected to reach USD 100 billion by 2015. Its growth rate is about 20 percent a year. Between 2000 and 2011 the foreign direct investment in hospitals and diagnostic centres was USD 1.1 billion. According to Rural Health Survey Report 2009 of the Ministry of Health the rural healthcare sector is also growing very fast, around 15,000 health sub-centres and employing 28,000 nurses and midwives during the last five years. Primary health centres in the country have grown by 84 percent. Due to economic boom in country, middle class has now more money to spend on healthcare. Due to the new government policies for healthcare, many convincing opportunities like improvement of new infrastructure and better medical equipment are being used. [11]

Small and medium business will have great benefits from the use of cloud computing. As we know, small and medium businesses contribute about 600 billion USD to Indian GDP. But these business spend very less on their IT infrastructure, therefore they will be the main target user of cloud computing. Clouds computing will help them not to make huge investments in the start. Cloud computing offers state-of-the-art IT infrastructure, software, security, customization, and access to emerging technologies. They only need to pay for the resources they use. Indian IT companies are also working on cloud computing services. There are many cloud applications on the Windows Azure platform by companies like Wipro, Infosys, TCS, HCL Technologies, Mahindra Satyam and many others, for the healthcare, banking, and manufacturing sectors, applications for both Indian and International clients [12].

IV. LIMITATION OF CURRENT E-HEALTH SYSTEM

Some of the limitations of current e-health (electronic system) are as follows [7]:

a) *Rising healthcare expenditure and unsustainable healthcare systems*: - In India we see every year the health expenditure is continuously rising faster than the economic growth of the country.
b) *Rise of chronic diseases*
c) *Medication errors*
d) *Medical errors due to poor communication*: - Poor communication is the causal factor in over 60% of medical errors.

V. BENEFITS OF CLOUD COMPUTING IN E-HEALTH

a) *Better treatment*: a unified medical record for patients available anytime and anywhere would help doctors to have all of the patient's medical history and treat them to the best.
b) *Reduced Cost*: due to the property of resource sharing of cloud computing , the cost of establishing the IT infrastructure is reduced as such that the client only need to bear a minimum cost of shared infrastructure with the flexibility of paying only for actual resource utilization. This property is very advantageous for small and medium sized healthcare providers.
c) *No scarcity of resources*: both scarcities of IT infrastructure and of healthcare professionals are met effectively as by using cloud computing would provide unlimited resource at a very cheap cost as well as good medical professional would be available in remote rural part of the country.
d) *Improved quality*: as all the medical data are stored at one place, it would be quite easy to provide it to Ministry of Health or the World Health Organisation with patient's safety and the quality of treatment given.
e) *Support research*: as all the data are available at a single repository, it would be easy for carrying out medical research to provide new medical facts, enhance medications, medical treatments and healthcare services.
f) *Support national security*: e-health cloud would help in checking the spread of contagious diseases, its cause for spread, spreading pattern and infection area.
g) *Support strategic planning*: e-health cloud data may be used by decision makers for planning and budgeting for healthcare services.[8]

Apart from the above discussed points, there are many more advantages of using cloud computing with e-health.

VI. E-HEALTH CLOUD RISKS

1. *Technical Risks*
   - *Availability*: as most of the healthcare providers would be using e-health cloud services, so to works continuously and effectively, services and data should be available all the time without performance degradation. Cloud services may not be available all the time due to hardware or software failure, network failure, security attacks and natural disasters. As e-health cloud would be available via Internet therefore serious steps should be taken to react rapidly and efficiently to such threats and ensure continuity of services to the healthcare providers. Services should not even stop for software installation, reconfiguration, and upgrade.
   - *Reliability*: using cloud computing for such a sensitive field require reliability for the provided services. Not even a minute mistake in medical data and services could be tolerable as decision regarding treatment of patients is dependent on these data and services. The data must be consistent and in valid state all the time regardless of being collected from multiple sources.
   - *Data Management*: a good database management is required for handling such a diversified data.

- *Scalability*: as e-health cloud would be having hundreds of healthcare providers with millions of patients, and this would always be growing, so e-health cloud should be scalable i.e. it should grow without compromising on performance.
- *Flexibility*: as different healthcare providers might be having different requirements like function, operations, users, auditing, management and quality of service, e-health cloud must be able to cater to all of them as per their need.
- *Interoperability*: as there are multiple cloud service providers, services of e-health cloud for a client could be provided by different service provider, therefore they all should work on same framework.
- *Security*: as many service providers could provide the e-Health Cloud services, and it would be used by many healthcare providers, therefore there security risk would be very high. When a single healthcare provider is using its own IT infrastructure then it won't be problem of security as it could monitor its network effectively but on a shared network various authentication methods and access controls would be required.
- *Privacy:* amongst all the issues of e-health cloud, the most important one is privacy. If privacy is not handled effectively then it won't be possible to use cloud computing in healthcare. Patient's medical data must be protected from other healthcare providers but associated organization might need that data so it is very important to control access of data. [8][9]

2. *Non-Technical Risks*
   - *Organizational change:* if e-health cloud is used in a healthcare organization, then many changes would be done like new policies, procedures and workflows as well changes in the process how documentation is done.
   - *Data ownership:* in healthcare sector still there is no clear guideline for ownership of patient's record. This needs to be addressed very well so that every party (like patient, doctor, insurer or hospital management) has clear understanding of his ownership boundaries.
   - *Privacy, trust and liability issues:* as cloud is on Internet there is a risk of data leakage, private data exposure and data loss which could result in loss of reputation of healthcare provider as well as patient's trust.
   - *Usability and end users experiences:* e-health cloud success lies in the fact that, it is adopted by patients, healthcare professionals, management and insurance companies. To overcome this marketing and training should be done thoroughly [8]

Figure 2. The generic architecture of e-Health Cloud

VII. CONCLUSIONS

E-health cloud is the next big buzz in healthcare sector. Cloud has the potential to transform the healthcare sector. With the use of cloud computing in healthcare sector, it would become centralized, and as data could be shared between all the healthcare providers on cloud, there would be collaboration as well as virtualization.

With the help of cloud computing, rural healthcare centres would efficiently use their IT infrastructure to the maximum and increase its profits. It would also help patients to have better treatment, hospitals as well as doctors. It would also help in carrying out research work, sharing data and analysing it. There cannot be one deployment model or the service model that can cater to Healthcare world. It has to be customized clouds.

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