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Proposed Cloud Computing Solution for Accessing Patient's Information

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***Abstract*—** Cloud computing is primarily a network based model and is referred as platform, infrastructure and software sold as a service. Cloud computing offers an innovative way of computing with various service models that facilitates in accessing patient's information. This paper proposes a cloud computing based solution for public sector hospitals of UT Chandigarh for accessing patient's information. Existing system is based on manual paper work supported by independent isolated applications in almost every hospital of UT Chandigarh which results in underutilization of resources, high development and up-keeping costs and rate of success. Main aim of proposing cloud computing based solution is to bring all the public sector hospitals on one platform to access patient's information for easy running and up-keeping, to reduce the price (development and up-keeping) and to diminish threats of data loss. The proposed cloud computing solution is for the public sector hospitals of UT Chandigarh; however the suggested solution is generic and can be used by any hospital of India.

***Keywords*—** Cloud Computing, Hospital Information System, Patient Information, SaaS, PaaS, IaaS.

I. INTRODUCTION

Cloud computing is becoming popular as virtualization power, distributed computing with server cluster and increase in the availability of broadband internet accessing is increasing. The Information Technology (IT) word is looking forward for the services provided by cloud computing thus enhancing the development of cloud computing.

[1] National Institute for Standards and Technology (NIST) has defined cloud as "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, services, storage, applications and servers) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Progression in Science and Technology has considerably transformed our lives and style of living. Cloud computing, data warehousing, big data and data mining are the most common topic for research in the field of Information Technology (IT). Data mining technique can be applied to explore the risk factors of parenting stress [2].

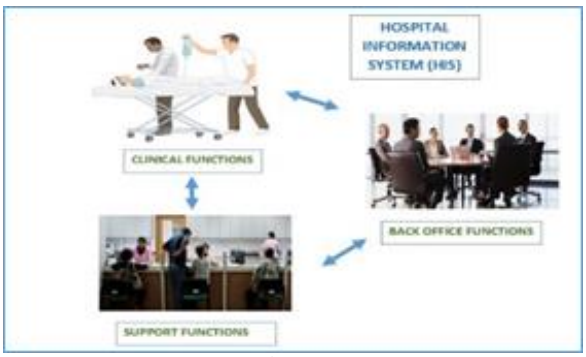

Fig. 1. Hospital information system (HIS).

At present most of the public sector hospitals of UT Chandigarh are using Hospital Information System (HIS) to manage their patient information. HIS can be grouped into three category on the basis of their functionality like Clinical modules, Back Office modules and Support modules. The HIS can have sub-module like Registration, Out-patient module, In-patient module, Diet Kitchen module, Blood Bank module and can have more of them. The health care organization which use HIS always need to update its all Information Technology (IT) resources as a result of swift development in health care facilities. The investment to set up Information Technology system in any hospital cost a lot, bearing in mind that Information Technology is not their prime activities, and spend this saving for providing efficient health care service. Most of the hospital of UT Chandigarh (such as PGIMER, Sector-12, Govt. Medical College & Hospital (GMCH) Sector-32, and Govt. Multi-Specialty Hospital (GMSH) Sector-16) are using HIS which was developed in-house or have purchased for maintaining patient's information. Apart from this there are few other health care provider organizations which are maintaining patient health related records manually. A big investment need to be made by any hospital or health care service providers to get design, develop and implement an Hospital Information System (HIS). The variation on how the different hospitals or health care providers are maintaining health care records of their patients make it very difficult to access patient's information related to their investigation, diagnose, treatment, etc. Cloud computing provide a new business model and way of delivering health care service and value to health care provider, as well as pharmaceutical organizations, other business partners and customers. Cloud computing technologies offered number of benefits in delivering cost effective and efficient health care services.

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Fig. 2. HIS Modules.

The benefits of cloud computing in healthcare industry like Mobility of patient records, Speed of accessibility, Security & Privacy and Reduction of costs motivated us to provide a cloud computing based solution for public sector Hospitals of UT, Chandigarh. Three main Hospitals in UT Chandigarh i.e. PGIMER, Sector-12; Govt. Medical College & Hospital (GMCH) Sector-32 and Govt. Multi-Specialty Hospital (GMSH) Sector-16. Apart from the above cited healthcare service provider there are many other dispensary/primary health care service provider exists in other sectors of UT, Chandigarh.

The patient's information sharing is a great concern in the existing system. The core goal of the proposed cloud based solution is to diminish this investment and to deliver an enhanced approach for patient's information sharing among different health care service providers of UT, Chandigarh.

Cloud Computing: A cloud model is consist of five critical attributes, three service and four distribution models.

1.1 *Critical Attributes*

- On-Demand Self-Service: A user equipped with a suitable delegation of permission of computing capabilities like server time and network storage space, as needed and automatically, without requiring cooperation with all cloud service provider.
- Broad Network Access: Competences are accessible over the system and accessed through customary mechanisms that promote use by diverse thin or fat client platforms (e.g., smart phones, tablets, laptops, and workstations).
- Resource Pooling: The computing resources can be shared to work for several customers by applying a multi-tenant model, with different physical and virtual resources dynamically allocated and reallocated as per the customer requirement. The consumer using computing resources normally has no idea or control over the exact location of the provided resources but may be able to state location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, network bandwidth and virtual machines.
- Rapid Elasticity: Capabilities can be rapidly and elastically provisioned, in some cases automatically, to scale rapidly outward and inward commensurate with request. To the consumer, the 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 at some level of abstraction appropriate to the type of service (e.g., storage space, processing, networking bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and purchaser of the utilized service.

1.*2 Cloud Service Environments*

Clouds includes several types of service models (i.e. SaaS, PaaS and IaaS) as discussed below.

- Software as a Service (SaaS): In this type of service model the cloud users access applications made available on cloud infrastructure from various clients devices (web browser). The end user needn't to manage or control the cloud infrastructure but have limited end-user specific applications settings. The examples of SaaS service models are Email, CRM and ERP.
- Platform as a Service (PaaS): In this type of service model the development tools are made available through cloud and the user can used them through a browser. The users can develop web applications without installing any software on their systems, and then deploy those applications on the cloud without any technical skills. The user needn't to manage or control the cloud infrastructure but has control over the deployed applications. The examples of SaaS service models are Application development, web designing and web streaming.
- Infrastructure as a Service (IaaS): In this type of service model the cloud user outsources the apparatus used to support operations like data storage, hardware, servers and networking equipments. It has also been referred to as a Hardware as a Service (HaaS). The cloud service provider owns the apparatus and is responsible for its installation, running and up-keeping. Payment made on a per-use basis. The user needn't to manage and control the cloud infrastructure, but has control over OS, programming frameworks and application software. The examples of IaaS are System, Security and Networking management.

1.3 *Cloud Deployment Modules*

Cloud deployment is generally dependent on the functional requirement and organizations operational environment. Mostly deployment of a cloud can be made in the following ways:

- Private Cloud: In this kind of cloud the infrastructure is operated for a one organization only. Private clouds are deployed, operate and manage by third party or itself, and they may reside on-premises or off-premises. E.g. MS Azure enables users to make the foundation for a private cloud infrastructure using Microsoft Windows Server and System Center family of products with the Dynamic Data Center Toolkit.
- Public Cloud: Public cloud is open to the common public or a big industry group [3]. Public cloud is owned,

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operated and managed by the cloud service provider, academic, or government organization or some combination of them and it reside on the premises of the cloud service provider. E.g. the Amazon Elastic Compute Cloud (EC2) provides users a capacity to lease virtual computers on which to run their own applications. The users pay only for what they have used and EC2 executes within Amazon's network infrastructure and data centers.

Figure 3: Cloud Deployment Types

- Hybrid Cloud: Hybrid cloud combine two or more clouds 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). An organization provides and manages some resources within its own data center and has other provided by cloud service provider. Public cloud services are more cost effective and scalable than private clouds [4]. E.g. IBM collaborates with Juniper Networks to offer a hybrid cloud infrastructure to enterprise to seamlessly extend their private clouds to remote servers in a secure public cloud [5].
- Community Cloud: In Community cloud the cloud infrastructure is shared by several organizations with common interests (e.g., security requirements, mission, policy, and compliance considerations). E.g. the Google GovCloud provides the Los Angeles City Council with a segregated data environment to store its applications and data that are accessible only to city's agencies. 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. But to have physical and virtual controls in the cloud environment one must protect data by implementing strong encrypting techniques using secure connections and applying data loss prevention policies [6].

This research paper is planned as follows: Review of literature was done in section 2. In section 3 drawbacks of current HIS and inspiration of our research work were discussed. In section 4 a Cloud computing based solution is suggested to access patient's information and conclusion is completed in section 5.

II. Review of Literature

Yan Hu, Fangjie Lu, Israr Khan, Guohua Bai et al. [7] concluded that Information sharing among different healthcare organizations and between healthcare providers and receivers becomes significant. In e-health domain, sharing information is one of vital issue to fulfill the needs of public healthcare. To achieve the needs of healthcare information sharing in e-health, cloud computing is a superior solution. Cloud computing is a new technology and have good performance in storing and accessing information. Their research mainly emphasis on the implementation of GAE as a SaaS cloud computing technique to share healthcare information. With the designed prototype, could cover the current interoperability gap in e-health. The research results indicates that there are many strengths to use GAE based SaaS service to solve the problem such as quick development, high availability, large data table storage, application as web service and authorized information. In the other hand, obvious drawbacks like limitation of picture sharing and unpredictable latency are still challenges for widely using GAE to e-health development.

G.Nikhita Reddy, G.J.Ugander Reddy et al. [8] explored that Cloud computing is bringing lot of change in our lives in several ways at a very fast speed. Applications of cloud computing technologies are growing in each part of the world. Cloud computing based solutions in healthcare services can help the health care providers to keep in touch with their patients and monitor their health condition effectively at a very low cost. Although concern regarding the security and other issues of data are there but still as every problem has a solution in the similar way these issues too will be overcome one day by man after which utilization of cloud technologies in healthcare industry would result in a new era in the field of healthcare. Every section in the society can access this healthcare by implementation of this technology. It is need to kept in mind that cloud computing is still a developing technology, which implies that in the coming years the more services it will offers which will be quite useful in every walk of life.

Neha Dubey, Sangeeta Vishwakarma et al. [9] concluded that cloud technology is used to establish a communication channel between patients, physicians, and hospitals by providing applications, services and also by saving all the data in the cloud. Health care service provider choosing Cloud Technology for delivering better healthcare services because of number of reasons. It is good time to for health care service providers and IT specialists to forward in order to implement the large technology which suits small practices to large hospitals. The current technology of adopting Cloud computing in the healthcare 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, doctors, insurance companies, pharmacies, imagining centers, etc. Challenges like data security and interoperability will rise because of the cloud-computing model. Therefore, the adoption of the cloud is progressing slowly. With the implementation of best practices in the design, development, 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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Amrita Parashar, Dheeraj Pal et al. [10] explored that cloud storage with a great deal of promise, aren't designed to be high performing file systems but rather extremely scalable, easy to manage storage systems. Here a different approach to data resiliency, redundant array of inexpensive nodes, coupled with object based or object-like file systems and data replication, to create a very scalable storage system. These days application software are data-intensive and to Designing storage architectures for these types of application presents several challenges and opportunities. Deal with these complications requires a combination of architectural optimizations to the storage devices and layers of the storage hierarchy as well as hardware/software techniques to manage the flow of data between the cores and storages. As each users use different application software and data non-uniformity happen across cloud vendors there is a requirement to provide uniform user interfaces and seamless integration with the mainstream desktop and server computing. Moreover, since a cloud infrastructure is a distributed system, storage facilities may be designed like the distributed file system.

Yan Hu, Guohua Bai et al. [11] concluded that exploration on applying cloud computing technology to eHealth is in its primary stages; most scientists have offered ideas without real-world testing. The apparent features of cloud computing technology provide more reasons to adopt cloud computing in sharing and managing health related data. The core purpose of their review is to discover some challenges and feasible cloud-based solutions which can be applied in eHealth. It has observed that with the distinctive superiority of the cloud in big data storage and processing ability, a hybrid cloud platform with mixed access control and security protection mechanisms will be a main research area for developing user friendly home-based healthcare system.

Yu-Yi Chen, Jun-Chao Lu and Jinn-Ke Jan et al. [12] suggested a technique to make qualified physician to access the patient's treatment related information on the cloud. The suggested proposal successfully improves the shortcoming of present electronic health record system. Their proposed design, the patient's treatment detail like medicines, investigation result, pathology result and nursing care related information are saved in hospital's private cloud as well as public healthcare cloud provider. Using hybrid cloud computing atmosphere, the patient's information can be easily accessible between the seeker health giver and the owner-hospital. In the paper a mechanism was also suggested to make sure the ownership of the medical information is been sheltered in the scheme in normal and emergency situation. Patient's information are all encoded. The health care giver need to inform the patient's information owner in advance before accessing the patient's information.

T. Swathi, K. Srikanth, S. Raghunath Reddy et al. [13] suggested that a resilient data encryption techniques must be used to keep the physical and virtual controls in the cloud computing world. Apart from this a vital secure connections and strong data loss preventions policies also need to be implement. So, that patient's information can be migrate from private cloud computing environment to public cloud providers. As more and more health care providers are using Information technology and cloud computing for providing health care services.

III. MOTIVATION

At present all the three major public sector hospitals of UT, Chandigarh are using autonomous standalone Hospital Information System (HIS) for their own specific purpose. These autonomous standalone HIS which are being used by these hospitals create a big problem related to sharing patient's information which is very difficult to address.

3.1 *Interoperability*

Clinical research is very difficult as data is stored and owned by different hospitals. At present all the three major hospitals of UT Chandigarh are maintaining patient's information and some staff manage operations manually and even some HIS modules have implemented on their own individual HIS system. The major issue is that the patient cannot get proper treatment in other hospitals. If any patient getting treatment in GMSH Sector-16 and if he want to visit PGIMER, Sector-12, Chandigarh for better treatment which is possible only when existing patient's information available on sharing basis. This is not possible at present due to non-sharing of patient data.

Fig. 4. Individual HIS systems.

3.2 *Huge Amount of Investment Require For Development, Testing and Implementations*

While implementing Hospital Information System (HIS) for any hospital cost a lot for data center (servers, network storage devices, power distribution system and cooling system) cost, software designing, development, testing and implementation and up-keeping cost. Present autonomous individual HIS systems are fairly pricey to setup and just to facilitate one hospital of UT Chandigarh bears the burden of these independent systems, even though this money can be spent on enhancement of healthcare services. Different companies need to be hire to watch over the information.

3.3 *Executions, Upgradations and Up-Keeping*

To setup and implement an information technology solution for a healthcare service providing organization is not a big problem; though execution, upgradation and up-keeping the HIS particularly in a public sector Hospital is always a big problem. Present autonomous individual HIS systems are very difficult to execute, upgrade and up-keep; as for the three

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major health care service provider of UT Chandigarh i.e. PGIMER, GMCH and GMSH separate execution and up-keeping is required. As execution and up-keeping practice needs regular investment and practical skills and professionals updation with latest technology of the current HIS has also remained a great concern as the user expectations are varying from time to time

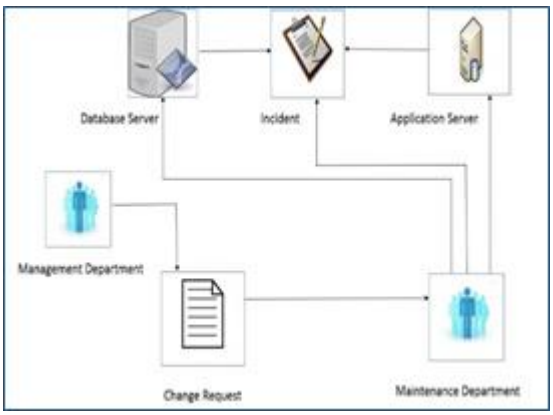

Fig. 5. Upgradation & Up-keeping resources.

Figure 6: Resource Wastage

3.4 Inefficient Usage Of Resources

An existing individual standalone HIS systems serve only the need of specific hospital i.e. PGIMER Sector-12, GMCH Sector-32 or GMSH Sector-16 Chandigarh. Each hospital are maintaining their own data center, server, network and application software.

IV. Proposed Cloud Computing Solution

This proposed Cloud computing solution is based on hybrid cloud deployment model. As the hybrid cloud computing model consist of private cloud which facilitates the different hospitals of UT Chandigarh, to manage the important information related to patient's family medical history, investigation reports, significant diseases / cases, treatment/ medicine prescription details etc.

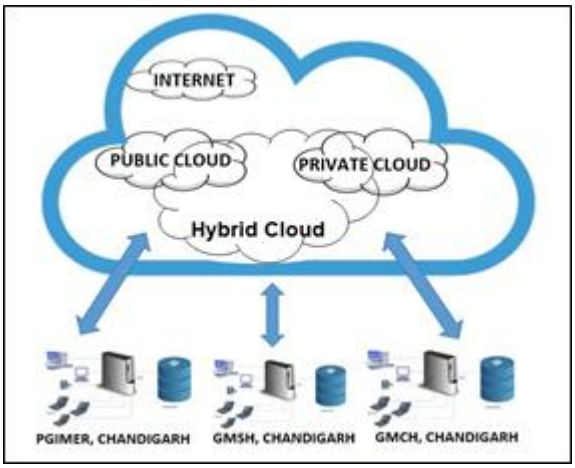

Fig. 7. Proposed cloud based solution.

Apart from this hybrid cloud model also contains public cloud to facilitate various other management (Employee details, salary, recruitment etc.) and also facilitates the outside users for appointment and viewing laboratory reports, procedure charges etc. The proposed cloud computing solution also provides the end user Scalability, Security, Flexibility, Cover Legacy Gaps and also Cut Energy Costs.

V. Conclusion

In this paper we have proposed a hybrid cloud computing solution for public sector hospitals in UT Chandigarh for efficiently accessing patient's information. Cloud computing based HIS system not only shares patient's information but facilitates the proficient doctors to better establish the patient's disease. Hybrid Cloud computing solution offers many other benefits such as reduced development, implementation, up-keeping and upgradation costs. Better security policy can be implemented by deploying hybrid cloud model. The proposed solution is for public sector hospitals of UT Chandigarh (PGIMER, Sector-12, GMCH Sector-32, and Govt. GMSH Sector-16) however it can be implemented in any other hospital. The amount thus saved can be better utilized for other health care services to improve the overall health services in the city.

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