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Transformation in Health Care with Cloud Services

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Abstract—An android application that can be used to get health checkups done immediately through nearest pathology labs and access the reports anywhere anytime on users phone.Though there are many applications available in the market like Practo, Thyrocare etc., each has got it's own limitations like Thyrocare android app is useful only for thyroid related patients, E-wireless is useful to store data of a particular hospital only and Practo app is useful to obtain the details of doctors in the user's locality and take online appointment. Thus to overcome all the disadvantages of the existing applications we are introducing online healthcare system using the concept of cloud computing which will be efficiently provide various facilities such as maintaining e-health records for the patients, online health checkups booking with discounted rates, get information about preventive measures, provide different path labs and keep track of user's health checkups records. Also the user will be able to broadcast the blood requirement directly on the application and the related notification will be send to all the users who are registered on the application having the same blood group through emails. Cloud can also help the researchers to help conduct tests on DNA samples to overcome few diseases like breast and ovarian cancers.

Keywords— *Cloud Services, Electronic Health Records, SaaS, PaaS, IaaS, Microsoft Azure, VMware*

I. INTRODUCTION

Technologies in healthcare are constantly evolving. Many hospitals have undergone changes with legacy systems to include electronic health records (EHRs), a digital format of paper 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 both administration personnel and physicians with timely access to medical records when needed. With the adoption of EHRs at many medical facilities, which are currently housed on traditional client-server architectures, technology has simplified operations making it more efficient and customer-centric. However, adopting cloud services would make health care operations even more convenient and cost effective. The cloud offers, as many people already know, on-demand computing. It uses the latest in technology to deploy, access, and use networked information, applications, and resources. It has a complex infrastructure that may be hard for some to understand. End users though are sure to find out that cloud computing is the suited choice for their business, as it is likely to be less costly than having multiple computers in medical rooms needing proper hardware, software and network accessibility to upload, store, and retrieve patient or other medical data. IT in healthcare has offered, thus far, worthy benefits to the healthcare industry. So one expects there to be in the near future, once secure and safeguards are in place for cloud computing, carrier clouds and cloud service providers having health data delivery networks offering storage, electronic data interchange (EDI) and patient management. Yet potential loss of control over certain sensitive patient data has slowed cloud adoption. Nonetheless, with IT spending on the rise, cloud-based electronic health records (EHRs) is beginning to have an impact on the health industry. In this busy world, it is difficult for the people to have focus on their regular health checkups so to have one such application with them would help people prevent diseases.

II. CLOUD SERVICE MODEL

Cloud computing is a delivery of computing where massively scalable IT-related capabilities are provided ―as a service across the internet to numerous external clients. This term effectively reflects the different facets of the cloud computing paradigm which can be found at different infrastructure levels. Cloud Computing is broadly classified into three services: "SaaS", "PaaS" and "IaaS". Cloud Computing have some different utility services.

A. SAAS: SOFTWARE AS A SERVICE

Cloud application services, or Software as a Service (SaaS), represent the largest cloud market and are still growing quickly. SaaS uses the web to deliver applications that are managed by a third-party vendor and whose interface is accessed on the clients' side. Most SaaS applications can be run directly from a web browser without any downloads or installations required, although some require plugins. Because of the web delivery model, SaaS eliminates the need to install and run applications on individual computers. With SaaS, it's easy for enterprises to streamline their maintenance and support, because everything can be managed by vendors: applications, runtime, data, middleware, OSes , virtualization, servers, storage and networking. Popular SaaS offering types include email and collaboration, customer relationship management, and healthcare-related applications. Some large enterprises that are not traditionally thought of as software vendors have started building SaaS as an additional source of revenue in order to gain a competitive advantage.

SaaS Examples: Google Apps, Salesforce, Workday, Concur, Citrix GoToMeeting, Cisco WebEx Common SaaS Use-Case: Replaces traditional on-device software

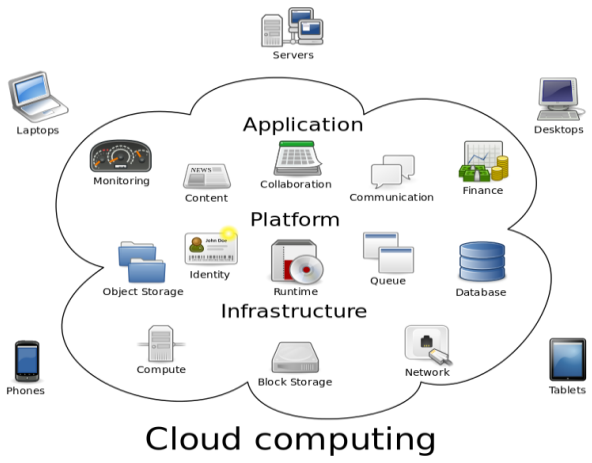

Fig.1. Cloud Computing Services

B. PAAS: PLATFORM AS A SERVICE

Cloud platform services, or Platform as a Service (PaaS), are used for applications, and other development, while providing cloud components to software. What developers gain with PaaS is a framework they can build upon to develop or customize applications. PaaS makes the development, testing,

and deployment of applications quick, simple, and cost-effective. With this technology, enterprise operations, or a third-party provider, can manage OSes, virtualization, servers, storage, networking, and the PaaS software itself. Developers, however, manage the applications. Enterprise PaaS provides line-of-business software developers a self-service portal for managing computing infrastructure from centralized IT operations and the platforms that are installed on top of the hardware. The enterprise PaaS can be delivered through a hybrid model that uses both public IaaS and on-premise infrastructure or as a pure private PaaS that only uses the latter. Similar to the way in which you might create macros in Excel, PaaS allows you to create applications using software components that are built into the PaaS (middleware). Applications using PaaS inherit cloud characteristic such as scalability, high-availability, multi-tenancy, SaaS enablement, and more. Enterprises benefit from PaaS because it reduces the amount of coding necessary, automates business policy, and helps migrate apps to hybrid model. For the needs of enterprises and other organizations, Apprenda is one provider of a private cloud PaaS for .NET and Java.

Enterprise PaaS Examples: Apprenda

Common PaaS Use-Case: Increases developer productivity and utilization rates while also decreasing an application's time-to-market

C. IAAS: INFRASTRUCTURE AS A SERVICE

Cloud infrastructure services, known as Infrastructure as a Service (IaaS), are self-service models for accessing, monitoring, and managing remote datacenter infrastructures, such as compute (virtualized or bare metal), storage, networking, and networking services (e.g. firewalls). Instead of having to purchase hardware outright, users can purchase IaaS based on consumption, similar to electricity or other utility billing. Compared to SaaS and PaaS, IaaS users are responsible for managing applications, data, runtime, middleware, and OSes. Providers still manage virtualization, servers, hard drives, storage, and networking. Many IaaS providers now offer databases, messaging queues, and other services above the virtualization layer as well. Some tech analysts draw a distinction here and use the IaaS+ moniker for these other options. What users gain with IaaS is infrastructure on top of which they can install any required platform. Users are responsible for updating these if new versions are released.

IaaS Examples: Amazon Web Services (AWS), Cisco Metapod, Microsoft Azure, Google Compute Engine (GCE), Joyent

Common IaaS Use-Case: Extends current data center infrastructure for temporary workloads (e.g. increased Christmas holiday site traffic).

III. RELATED WORK

Deng, M., Petkovic, M., Nalin, M., and Baroni, I., A home healthcare system in the cloud addressing security and privacy challenges, IEEE International Conference on Cloud Computing (CLOUD), pp: 549-556, 2011. Cloud computing, one of the emerging technologies which is expected to support the Internet based critical applications that would be essential in the health sector. Its resilience, high performance, scalability, connectivity, cost reduction, high performance and adaptability features have great capacity to raise the efficiency of healthcare. It is also important to understand the risks related to privacy and security which this technology brings. By making use of the different services provided by the cloud such as Platform as a Service(PaaS),Software as a Service(SaaS) and Infrastructure as a Service(IaaS) the health industry can have tremendous change in it. Physicians are targeting breast and ovarian cancer through research that crunches massive amounts of information from more than 2,000 DNA sequences at the Icahn School of Medicine at Mount Sinai. The data set is gigantic more than 100 terabytes and the analysis happens aboard a secure cloud-based platform through Amazon Web Services. By using AWS, we can store source files securely and cost-effectively with significant durability and accessibility," one of the researchers said. "We wouldn't be able to conduct our research without it." The case illustrates several reasons the healthcare industry's use of the cloud is growing aggressively. As Mount Sinai researchers hunt for the genetic causes of these cancers, their research platform helps them meet three key needs: The platform is secure, maintaining the confidentiality of patient information; it is scalable, allowing economic growth as the data set increases and performance needs change; and it is collaborative, enabling researchers to work with external partners. These needs drove $3.73 billion in healthcare spending on cloud services last year and will push that number nearly threefold to $9.5 billion by 2020. Cloud-based computing is on the rise in healthcare as physicians, hospital administrators, and patients demand cost efficiency, access to information, and security. According to Karin, director, healthcare vertical strategy, a study shows that in 2015, healthcare professionals largely depended on cloud-based solutions for back-office needs, such as email and data storage, or supporting the secure exchange of patient information. A survey of 105 healthcare industry IT and leadership professionals in 2016 shows the use case is expanding quickly. For example, 59% of respondents said they're using or planning to use cloud solutions for big data analysis, as in the Mount Sinai case. Virtual care, or telemedicine, is expected to explode in the next few years as researchers note that 70% of routine doctor visits don't require face-to-face interaction. Virtual care will become commonplace, with 80 percent of patient interactions relying on the Internet of Things and big data which both benefit from cloud computing solutions to bolster patient care by 2021. Meanwhile, 73% of industry professionals will use the cloud to host patient empowerment tools another key driver toward the cloud. This means healthcare providers are increasingly using cloud-based applications to put resources into the hands of patients that will allow them to educate themselves, monitor their own health, and store and share their health records. SweetSpot Diabetes Care is doing just that with a cloud-based application that empowers diabetics to take greater control of their glucose data. The company's application takes data from a variety of web-enabled metering devices and lets patients analyse, store, and share their glucose data with healthcare professionals in a format that's easy to evaluate.

IV. CLOUD COMPUTING DEPLOYMENT MODELS

Cloud hosting deployment models represent the exact category of cloud environment and are mainly distinguished by the proprietorship, size and access. It tells about the purpose and the nature of the cloud. Most of the organisations are willing to implement cloud as it reduces the capital expenditure and controls operating cost. In order to know which deployment model matches your website requirements it is necessary to know the four deployment models.

1. Public Cloud: is a type of cloud hosting in which the cloud services are delivered over a network which is open for public usage. This model is a true representation of cloud hosting; in this the service provider renders services and infrastructure to various clients. The customers do not have any distinguishability and control over the location of the infrastructure. From the technical viewpoint, there may be slight or no difference between private and public clouds' structural design except in the level of security offered for various services given to the public cloud subscribers by the

cloud hosting providers. Public cloud is better suited for business requirements which require managing the load; host application that is SaaS-based and manage applications that many users consume. Due to the decreased capital overheads and operational cost this model is economical. The dealer may provide the service free or in the form of the license policy like pay per user. The cost is shared by all the users, so public cloud profits the customers more by achieving economies of scale. Public cloud facilities may be availed free an e.g. of a public cloud is Google.

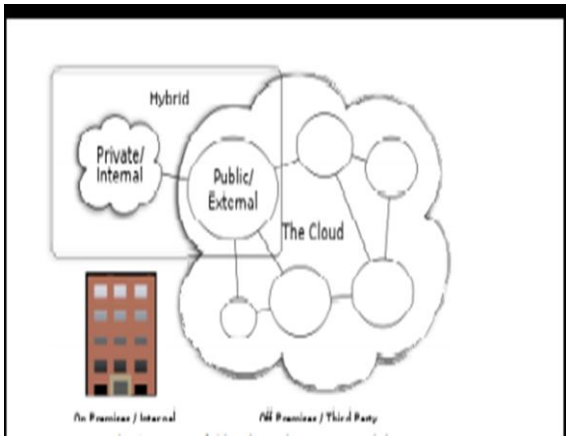

Figure 2: Cloud Deployment Models

2. Private Cloud: is also known as internal cloud; the platform for cloud computing is implemented on a cloud-based secure environment that is safeguarded by a firewall which is under the governance of the IT department that belongs to the particular corporate. Private cloud as it permits only the authorized users, gives the organisation greater and direct control over their data. What exactly constitutes a private cloud? It is difficult to define because when it's classified according to the services there are significant variations. Whether the physical computers are hosted internally or externally they provide the resources from a distinct pool to the private cloud services. Businesses that have dynamic or unforeseen needs, assignments which are mission critical, security alarms, management demands and uptime requirements are better suited to adopt private cloud. Obstacles with regards to security can be evaded in a private cloud, but in case of natural disaster and internal data theft the private cloud may be prone to vulnerabilities.

3. Hybrid Cloud: is a type of cloud computing, which is integrated. It can be an arrangement of two or more cloud servers, i.e. private, public or community cloud that is bound together but remain individual entities. Benefits of the multiple deployment models are available in a hybrid cloud hosting. A hybrid cloud can cross isolation and overcome boundaries by the provider; hence, it cannot be simply categorized into public, private or community cloud. It permits the user to increase the capacity or the capability by aggregation, assimilation or customization with another cloud package / service. In a hybrid cloud, the resources are managed and provided either in-house or by external providers. It is an adaptation among two platforms in which the workload exchanges between the private cloud and the public cloud as per the need and demand. Resources that are non-critical like development and test workloads can be housed in the public cloud that belongs to a third-party provider. While the workloads that are critical or sensitive must be housed internally. Consider an e-commerce website, which is hosted on a private cloud that gives security and scalability, since security is not a prime concern for their brochure site it is hosted on a public cloud which is more economical as compared to a private cloud. Businesses that have more focus on security and demand for their unique presence can implement hybrid cloud as an effective business strategy. When facing demand spikes the additional resources that are required by a particular application can be accessed from the public cloud. This is termed as cloud bursting and is available with the hybrid cloud. Organisations can use the hybrid cloud model for processing big data. On a private cloud, it can retain sales, business and various data and can initiate analytical queries over enabled with features like scalability, flexibility and security. If one is ready to overlook a few challenges like application program interface incompatibility, network connectivity issues and capital expenditures, then the hybrid cloud would be an appropriate option.

4. Community Cloud: is a type of cloud hosting in which the setup is mutually shared between many organisations that belong to a particular community, i.e. banks and trading firms. It is a multi-tenant setup that is shared among several organisations that belong to a specific group which has similar computing apprehensions. The community members generally share similar privacy, performance and security concerns. The main intention of these communities is to achieve their business related objectives. A community cloud may be internally managed or it can be managed by a third party provider. It can be hosted externally or internally. The cost is shared by the specific organisations within the community, hence, community cloud has cost saving capacity. A community cloud is appropriate for organisations and businesses that work on joint ventures, tenders or research that needs a centralised cloud computing ability for managing, building and implementing similar projects.

Organisations have understood that cloud hosting has a lot of potential. To be the best among the rest, selection of the right type of cloud hosting is needed. Thus, one need to know his/her business and analyse the demands. Once the appropriate type of cloud hosting is selected, they can achieve their business related goals more easily.

V. COMPARISON OF VARIOUS CLOUD SERVICES FOR THE HEALTH CARE

In transforming healthcare to use cloud computing services, there has to be strategy: A feasible cloud strategy for a health care facility could be to use a public cloud infrastructure to allow public access to generic health information or retrieve medical resources. Hospitals and health clinics could use a public cloud for remote storage of their own medical data, not the patients. Basically, a public cloud could offer the healthcare industry service agility and cost savings. A private cloud, instead, could be used to connect healthcare providers to transfer electronic documents and share health information on patients. Examples include:

- Clinical applications (EHRs, physician enquiries, pharmacy orders)
- Nonclinical, healthcare management applications (to handle revenue cycle management)
- Patient management (such as patient billing and claims)

Whether managed internally in the data center or hosted externally at a service provider, it is important to know that such an infrastructure could provide enhanced privacy and security over deploying a public cloud strategy. Even though there are also risks to data security for private clouds, certain measures like utilizing a virtual private network (VPN) can be taken to address possible security risks when one has remote access into the cloud. A secure, private cloud environment using policy-based control of computing resources is an apt solution for cloud consumers to avoid serious vulnerabilities. However, it still requires specific requirements to only allow authorized personnel to have access to the data either hosted

internally or externally. Healthcare facilities that decide on a private cloud resolution can opt for a virtualization platform at VMware or Microsoft. VMware vSphere has a suitable cloud computing operating system. There is also the Microsoft Azure cloud computing system that can provide on-demand simple access to healthcare applications and data. It uses a PaaS environment and the provider, in this case Microsoft, provides a service to supply the networks, servers and storage needs. Microsoft's Azure system complies with the data protection and privacy laws set forth in HIPAA and the HITECH Act. This system also meets Cloud Security Alliance (CSA) and Governance, Risk and Compliance (GRC) criteria. Either MS Azure's set of .NET Services integrate public cloud-based applications or SQL Server-based data services provide the secure infrastructure.

Regardless of what cloud service platform is used or which cloud provider has unmatched virtualized applications as a service via the cloud, the delivery of computing and service must permit sharing of propriety data resources to help physicians and health care providers to do their jobs effectively and efficiently. As well, both the cloud platform and provider must ensure all health data remains secure and private. If these conditions are met, there will no longer be resistance to cloud computing adoption in the healthcare industry.

VI. DISCUSSION

To enable health industry to achieve all the progress and to conduct various examinations on the samples to find a solution to every disease, the health care providers should first adopt a proper cloud service. All the hospital data, the patient data, the samples data etc., can be stored in a cloud and can be retrieved whenever required. As all the information is in the cloud the patient can book an appointment to a lab for a test, also he/she can know the availability of a doctor in advance.

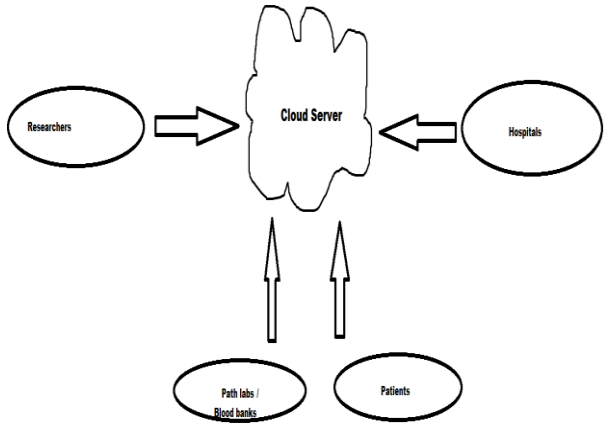

Figure 3: Working model for cloud in Health Care System

The researchers can work on the sample information present in the cloud. The time required to do each and every process of the hospital i.e. taking appointment, doing test, collecting the report is reduced. The cloud provides online platform for health checkup bookings with cheaper rates. This model provides online repository for user's health reports and medical history. It provides information about preventive measures and tips to user based on his/her Medical history. It can be used by the doctors for maintaining the patient's record. It can be used by the patients for taking appointment, performing tests, sending the blood requirements and he/she also gets the preventive measures details. It can be used by the hospitals to maintain the records. It can be used by the path labs. If in emergency if any one requires the blood then he can easily take the benefit of this application.

VII. FUTURE PREDICTIONS

The explosion in the healthcare industry's reliance on cloud-based computing — coupled with the industry's need to be flexible, collaborative, and consumer-focused — means that healthcare will inevitably adopt new ways of utilising the cloud. This leads to several predictions about emerging trends.

1. More patient-clinician interaction: Look for more two-way communication between healthcare providers and patients as care is increasingly delivered through mobile devices, wearable technology, instant alerts, and digital healthcare reminders.

2. Records in real time: Connected devices will give both patients and healthcare professionals real-time access to health records, painting a more holistic picture of our health as it happens. The trend could also give us the benefit of information aggregated from a population level, exposing community and public healthcare issues more quickly.

3. More ownership of our data: Expect developers to create tools to help individuals take more ownership of their own health and connect their experiences with schools, government organisations, legislative bodies, and beyond. Think of it as a virtual health information exchange.

The cloud is a highly effective platform for healthcare organisations to leverage, made more relevant by the industry's evolution toward a consumer-driven approach to care and its need for greater collaboration to serve long-term growth. Creating innovative, agile, and collaborative cloud environments for healthcare in which all players can participate helps to simplify, organise, and streamline its many moving parts. With cloud-based solutions, organisations can stop fretting over the small stuff and start focusing on improving the big picture for their patients.

CONCLUSION

There are various applications available in the market like Thyrocare, E-wireless, Practo and many more. All these applications were effective only for particular health related problems. Thyrocare android application is useful only for the people having thyroid problems. Ewireless healthcare application is useful to maintain the data about a specific hospital. Practo application is useful just to obtain the details of doctors in user's locality and take online appointment. Therefore to overcome all the drawbacks of the existing systems we have introduced a model where we can store the information of a patient, his previous health record. Also this online health care application with the help of cloud computing concepts will effectively provide various information related to preventive measures and tips that should be taken to avoid various contagious diseases, provide different path labs, online booking of doctor's appointment, keep track of user's health checkups reports. In this busy life, people cannot concentrate more on their health, so in this paper I have discussed various ways how by using a cloud a person can find doctors, path labs nearby, book appointment, go for the regular health checkups. If in case anybody requires any blood then he/she can broadcast the requirement on the application and the related notification will be send to all the users in the locality who are registered on the application and have same blood group through emails.

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