Design and Implementation of a Cloud based TeleDermatology System

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Abstract

Telehealth care services are growing up in the recent years. The patient-doctor relationships symbolize a new elucidation to the medical problems of the modern life. With the technological advancement, the life span of people has been increasing in the preceding years. However, as livelihood is more worrying than ever, there are added cases of new diseases. The difficulties of transport in the big cities and the shortage of hospital beds turn the remote care an attractive solution. On the other hand, its routines can be switched by telemedicine. A cloud based information system can offer new possibilities, such as easy and worldwide access to medical data, and opportunities to put together use of the services of medical experts which are otherwise unavailable in remote places. However, they also elevate new risks and challenges with respect to security and privacy aspects. This paper describes the implementation of a teledermatology system for patient monitoring using cloud computing. The system proved to be quick and reliable and represents an applicable solution to teledermatology care.

Keywords: Cloud Computing, Remote Healthcare Services, Teledermatology.

1.0 Introduction:

Telemedicine system is one of the most important forces determining the future of healthcare industry. Telemedicine is still a baby chicken industry. Telemedicine refers to the utilization of telecommunication technology for medical diagnosis, treatment and patient care. It also can be described as the transfer of electronic medical data from one location to another. Today, a lot of the technical activity in the telemedicine industry consists of vendors integrating suites of components to create turnkey solutions for specific clinical settings .This system allows you to regularly monitor a patient's data without having to see them in person and also capture a series of images and send them off to a specialist for review. Even though some of the systems have achieved astonishing clinical successes. Telemedicine environment include hospital care management, remote teleconsulting , collaborative diagnosis and emergency situations handling. Different types of information need to be accessed by means of heterogeneous client devices in different communication environments in order to enable high quality continuous hygienic assistance delivery wherever and whenever needed. Telemedicine applications are a valid method to improve the quality of the delivered sanitary assistance. All the applications have a common objective to improve efficiency and quality of the healthcare with use of technology. Medical data – such as heart rate, ECG, temperature and other vital signals – can also be grouped in packets and transported through TCP/IP and UDP. Cloud computing introduces a new business model and way of delivering service and value to the medical community, as well as

medical-related trading partners, business associates and customers. There are a number of benefits i.e. point-of-care service delivery, cost-savings, the leveraging of new applications and support for an increasingly mobile workforce-that are enabled through adoption of cloud technologies. In cloud computing, the resources are dynamically scaled and are used over the Internet as services. In the medical field, cloud computing offers great potential for quick access to medical information. Health IT infrastructure is very complex and for this reason organization has taken additional measures to protect the patient's private data under HIPAA (Health Insurance Portability and Accountability Act). Maintaining confidentiality and integrity of information stored in all forms, and providing data backup and recovery processes in extreme cases are extremely important in this field. Quick access to medical history of each person at any location can accelerate diagnosis and treatment quality, avoiding complications, increasing quality and saving lives. In addition, cloud computing can help patients to gain access to their medical history from anywhere in the world via the Internet contributing to personalization in healthcare. Cloud Computing has many properties with respect to the existing traditional service provisions like scalability, availability, fault tolerance, capability and so on which are supported by many IT companies like Google, Amazon, Salesforce.com. These IT companies have more chances to adapt their services into a new environment, known as Cloud computing systems. There are many cloud computing services which are being provided by many IT companies. Cloud computing refers to an on-demand, self-service Internet infrastructure that enables the user to access computing resources anytime from anywhere. It is a new model of delivering computing resources, not a new technology. Examples of commonly used non-health care applications include Microsoft Hotmail and Google Docs, while some better known applications in health care include Microsoft HealthVault and Google Health platform .

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2.0 Characterstics 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 cloud model consists in five essential characteristics, three service models and four models of development

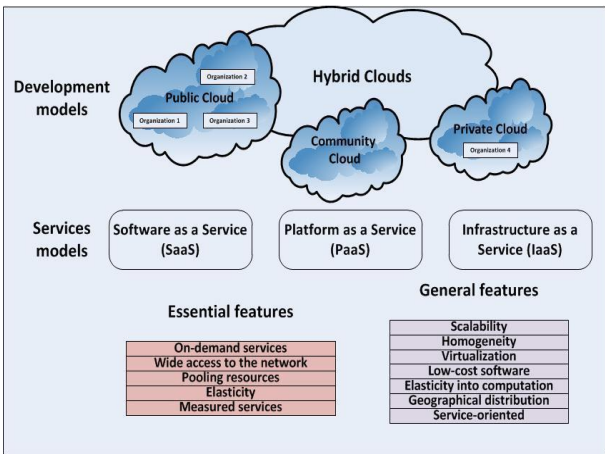


Fig-1 (Cloud Computing)

The essential five characteristics of cloud computing are: On-demand services: consumers can connect to a website and can use web services to access additional computing resources whenever they need; Wide access to the network: web services are based on cloud computing and for this reason can be accessed from any device connected to the Internet; Pooling resources: customers can share computing resources with other clients, so these resources can be reallocated dynamically and can be hosted anywhere; Elasticity: cloud computing allows users great flexibility that customers can scale systems (and costs) up or down as required; and Measured services: cloud computing monitors and records resources usage, which enables customers as payment for use (pay-per-use), a fundamental paradigm for cloud computing .

Architecture of Cloud Computing

Cloud computing architecture consists of: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Infrastructure as a Service is delivering hardware (servers, network technologies, storage) as a service. It also includes the operating system and virtualization technology for resource management. Currently, the best job profile is Amazon's Elastic Compute Cloud (Amazon EC2). It provides a web interface that allows customers accessing virtual machines. Platform as a Service offers an integrated set of software that provides everything that a software developer needs to build an application - an online environment for quick development of web applications using browser-based development tools. Software as a Service – business applications hosted and delivered as a service via the web. These kinds of applications do not require installation of additional computer programs, the most popular being the e-mail in a web browser

Models of development clouds

Cloud computing is offered in four different forms:

Public clouds – are held by a company selling cloud services to the general public.

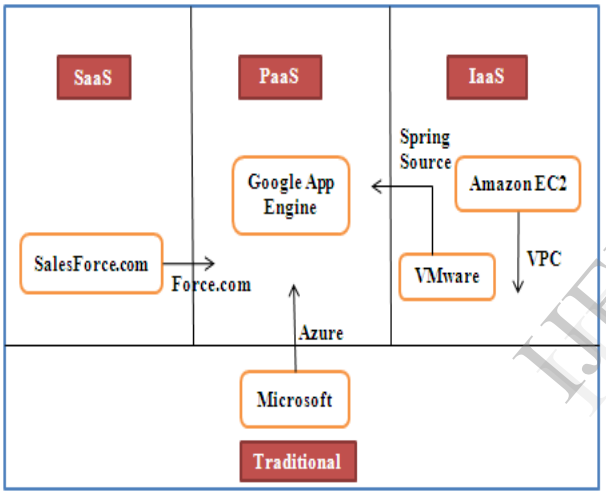
Private clouds – are owned by a single organization and are being used only in that organization.

Community clouds – belonging to several organizations and allowing access only to those concerned for certain actions.

Hybrid clouds – a composition of two or more types of clouds (private, public or community) that remain unique entities but are linked by standard technologies that enable portability of applications.

For medical applications, the best choice of a model is the private one for reasons of security and data privacy.

Examples of Companies Providing Cloud Computing Services



.Fig-2

3.0 Proposed System

In the present health scenario, lots of telemedicine applications do exist in the environment and lots of parallel architecture has been projected for patient monitoring but our application prejudiced by Cloud Computing Architecture. We present a cloud based healthcare dermatology information system model. The targeted patients of this application will be skin diseases patients and the main purpose of this application is to treat out those patients who can not move easily from one place to another. Their pictures of infected areas will be fetched through digital camera by the health care takers/nurse/health administrator from their location, after fetching the picture he/she will send those pictures into our application server along with explanation of patient history. This application architecture is utilizing telecommunication and internet technology and their major's components/modules are more dependent on those technologies. This architecture is also confirming and assuring the availability of medical data from the other resources. Specialists in the doctor's end would be needed with internet access and a browser so that they can help out patients from any place or city or even country for serving the patients. This proposed architecture also provides :

a. Provide medical experts and patients with a mobile user interface for managing healthcare information

b.Storing, querying and retrieving medical images (e.g., CT scans, MRIs, US etc.), patient health records and patient-related medical data (e.g., biosignals)

c.Data may reside at a distributed Cloud Storage facility, initially uploaded/stored by medical personnel through a Hospital Information System

d.Communication and data exchange has to be performed through non-proprietary, open and interoperable communication standards

The components of proposed model

Cloud Control server: In a typical cloud, the cloud controller is responsible for managing physical resources, monitoring the physical machines, placing virtual machines, and allocating storage. The controller reacts to new requests or changes in workload by provisioning new virtual machines and allocating physical resources.

(a) The cloud central server accepts network policy specifications (in addition to requests for VMs) and parses them to generate a communication matrix for the tenant's resources. The matrix captures the requirements for the network between tenant VMs. An entry in the matrix indicates whether the virtual network between the source and the destination VM (row and column, respectively) should permit packets; if so, whether layer 2 broadcast is allowed, or layer 3 traffic is allowed, or both are allowed. And when layer 3 traffic is allowed, the entry also specifies bandwidth reservations and any middlebox traversal required by traffic between the endpoints. The matrix is then passed to the network controller which interfaces with the programmable switches.

(b) It prior to placing a VM on a physical host, the cloud controller consults the network controller to determine which hosts are candidates for placing the VM. The network controller utilizes a placement algorithm designed to minimize the network state and maximize the performance and the number of virtual networks that can be supported in the cloud

(c) It manages a software programmable virtual switch on each physical host that supports network services for tenant applications. The software switch is configured to connect any number of virtual machines to the physical network. The software switches are crucial for extending network control beyond the physical switches and into the end-hosts

themselves. Once configured, the cloud controller informs the network controller of the location of the software switches and subsequently sends updates about the set of virtual machines attached to the switches (e.g., if a VM is removed or moves to a different host).

Authentication Server: Because in the application and data is hosted outside of the organization in the cloud computing environment, the cloud service provider has to use Authentication and Authorization mechanism. Authentication means that each user has an identity which can be trusted as genuine. This is necessary because some resources may be authorized only to certain users, or certain classes of users

Advantages of this Model

Patients can view their health records and prescriptions on their mobile phones on a request basis

It can also be used to share information seamlessly and in near-real-time across devices and other organizations.

In this cloud model, customer providers only pay for what they use.

It offers remote access (the data can be accessed via the Internet from anywhere), allows data sharing between authorized units the updates for the medical history of the patient - consultations, prescriptions, hospitalization - are made in real time and are useful for future treatment validation.

It offers more flexibility compared to other architectures. The staff of the organization can access the files and data that they need, even when they are working remotely from home or from clients office. Organizations can work collaboratively on files and documents which can be viewed and edited from multiple locations.

It is dynamically scalable in which organizations can access as much as computing power necessarily on hourly basis. In an organization the demand for internal users and external customers‟ increases and decreases, therefore the necessary storage and network capacity can be added or subtracted on hourly basis.

There are many cloud providers that provide cloud services to different organizations. If the cloud provider is not delivering acceptable performance, an organization can move to another cloud provider which is offering better service with fewer prices.

4.0 Methodology

Teledermatology services are based in this architecture. There is a server application which stores and makes available the incoming skin images from the patients. The client, in its turn, is responsible for acquiring data from patient transmitting them through Internet. Health care Administrator monitors their patients using the server application. Also, data can be exported to XML files or printed. In the application of telemedicine, the medical information usually needs to be distributed among medical doctors and display, archival, and analysis devices .Therefore, the server side was developed with the purpose of receiving, storing and distributing the vital sign data from patients. It was developed under Java technology too. So, any classes were reutilized. Basically, the server is composed of a Java application and a relational database(MySQL). The application offers the features: a) List of doctor/patients; b) Information about patients; c) visualization of skin images; and d) data storage. XML has becoming an important standard in computer science, it was utilized as an export format.

The architecture is to build up a medical image archive solution in windows Azure Cloud and SQL Azure The application will be made use of by the dermatologist, or hospital administrator or health care taker The patients in the hospital can register patient id and password. Te patient send the requests to the DICOM server. The job of the health administrator is to make the registration for the patient and upload patient images and also checks for the valid id of the patient. The dermatologist can register and they can view the image requests sent by the patient and they can save the report in SQL Azure. The SQL Azure consists of hospital data , patient data , patient image data etc.

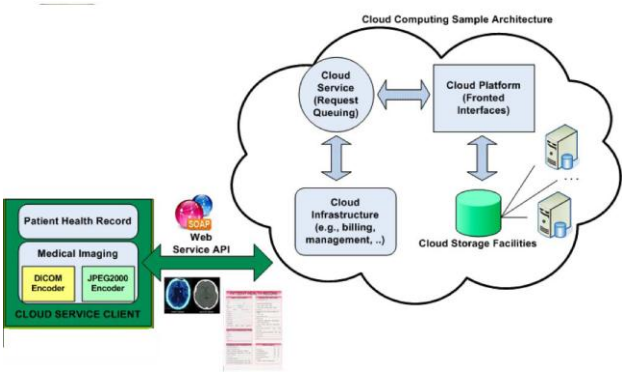


Fig-3

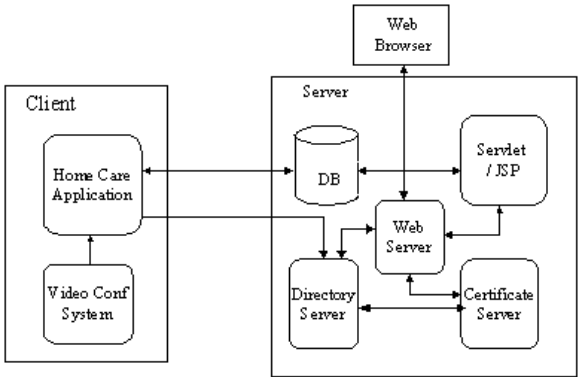
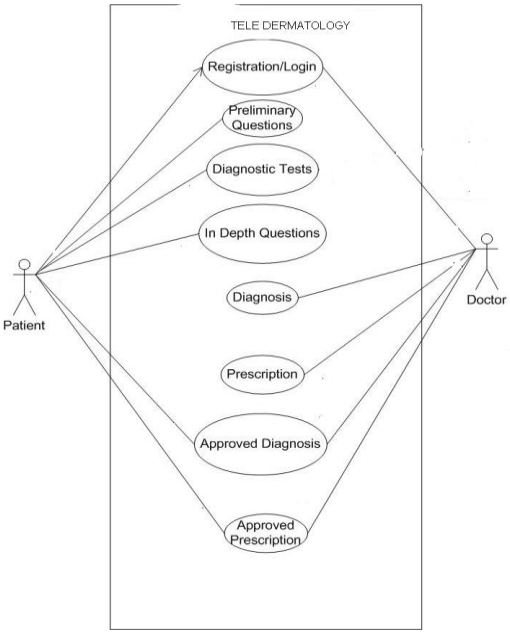


Fig-4 System Architecture

Design Description:

Sequence diagram explains how groups of objects work together in achieving the system behavior. Sequence diagram contains one main object for doctor's end. From this component doctor will receive the pictures from email server as well as in mobile. In case of error occurred, the message will be displayed on doctor's end. Doctor can also check the patient's record in order to see entire patient's history. That history will be fetched from perspective database. When any error occurred, the doctors will get message on their screen, otherwise doctor will receive entire patient's history, so that they can make prescription for their patients.



Use Case Diagram

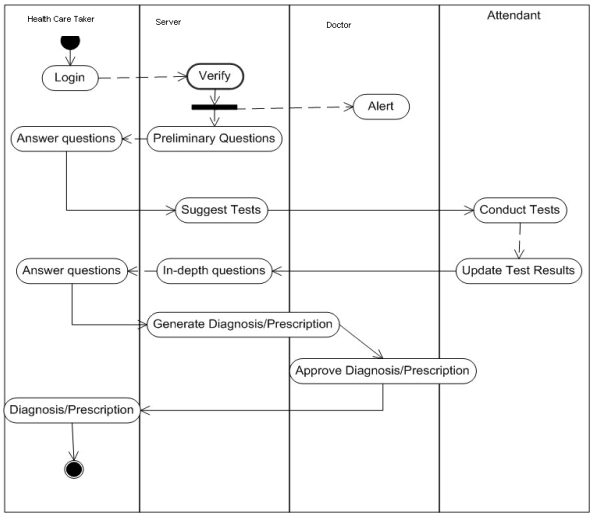


Fig-5 Activity Diagram of TeleConsulting

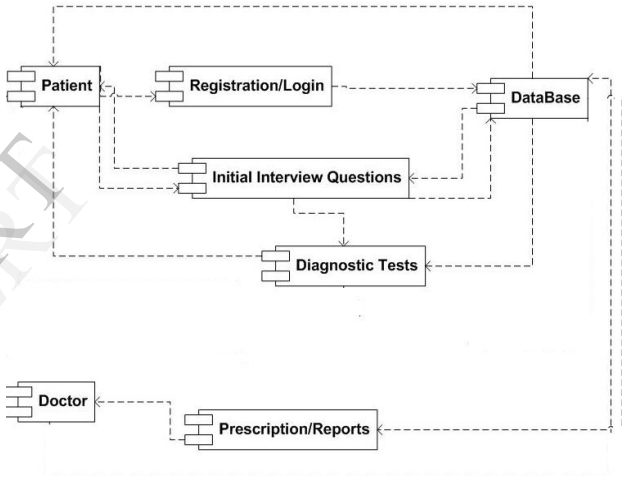


Fig-6 Component Diagram

Conclusion

There is a incredible assure for cloud computing infrastructure in the healthcare industry. Cloud computing would help healthcare centers to achieve efficient use of their hardware and software investments and to increase profitability by improving the exploitation of resources to the maximum. The purpose of implementing cloud computing systems in health care is not to compete with each other but serves to facilitate and improve the excellence of patient care. When a health organization considers moving its service into the cloud, it needs strategic planning to examine environmental factors such as staffing, budget, technologies, organizational culture, and government regulations that may affect it, assess its capabilities to achieve the goal, and identify strategies designed to move forward.

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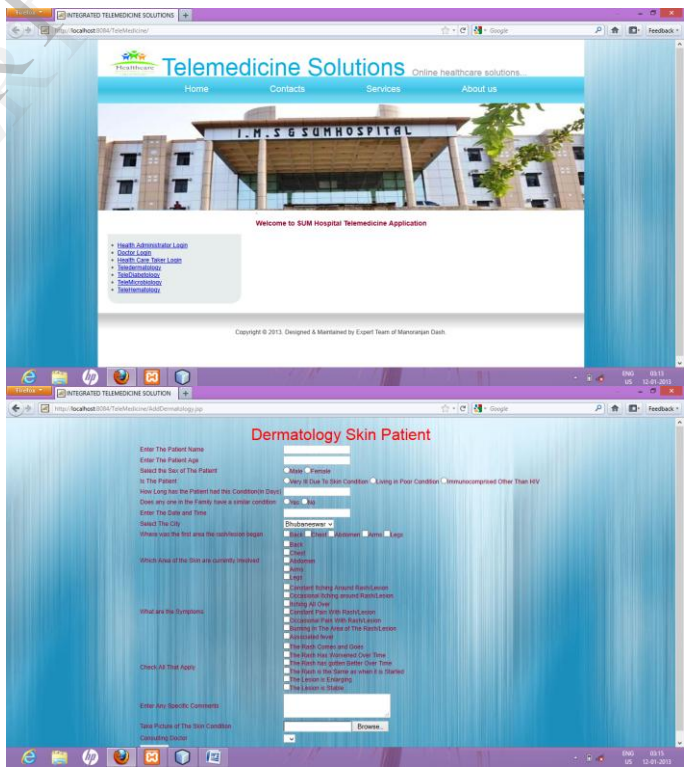
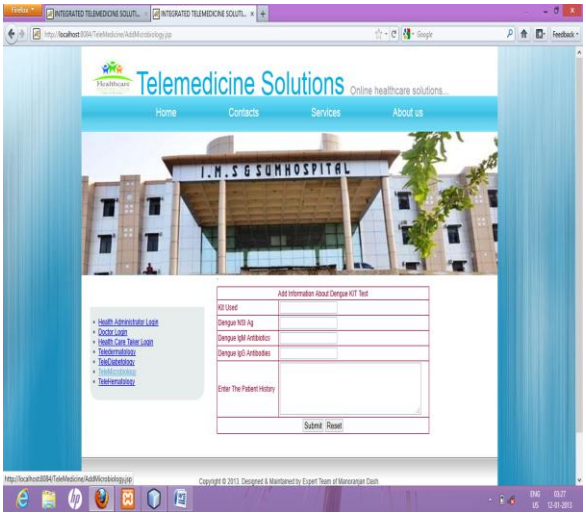
Appendix:

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