

Healthcare-As-A-Services – Hospit One – A Cloud Based Healthcare System

S. K. Senthil Kumar, P. Balasubramnie

Abstract - Our objective of this proposed research is to improve the reliability of cloud services and availability of cloud resources to efficiently provide services to all patients belongs to the cloud based Healthcare system. With the existing paper and hand written for of patient^{2,3} records, there are some consequences such as lack of accessibility of historical health and medical details about patient, unnecessary loss of time and money for collecting and/or analysing of patient's health details repeatedly and lack of access the patients' details by other Healthcare institutions even with patient's permission. We propose a new bio-inspired dynamic cloud framework derived from Ruminant Digestive System from Ruminant Animals, called RDS Framework with a set of two algorithms. The first is a LPP-TP (Linear Programming Problem-Transportation Problem) based resource selection algorithm for efficiently identify and select the number of resources are actually available, second 3 Dimension Hybrid Modified Bin Packing with Task Grouping (3DHBPTG) scheduling algorithm for making the maximum utilization of cloud resources for making it highly available and improves reliable cloud Our framework guide and optimize the cloud process to improve the reliable cloud service and availability of cloud resources. With the above framework, we can achieve a cloud based, device independent, platform independent, Language independent, utility based collaborative healthcare system named as HospitOne.

Keywords: Healthcare System, Healthcare-as-a-service, HospitOne, Cloud Computing, Reliability, Availability of cloud,

I. INTRODUCTION

Healthcare [1] sector is considered one of the largest sector in terms of both revenue and workforce employment. With the existing paper and hand written for of patient [2], [3] records, there are some consequences such as (i) lack of accessibility of historical health and medical details about patient, (ii) unnecessary loss of time and money for collecting and/or analysing of patient's health details repeatedly (iii) lack of access the patients' details by other Healthcare institutions even with patient's permission. Later this traditional way of paper based recording was replaced in some of the countries with Healthcare information system [2] (HIS) also called as e-Health. HIS or e-Health [4] is defined as, the cost-effective and secure use of information and communication technologies in support of Health and Health – related fields, including Healthcare-Services, Health surveillance, Health education, knowledge and research. In India [5] except of some places, still we follow the traditional way of recording.

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But with the HIS, we found several limitations such as lack of performance, inability of system integration, lack of storage capacity, high operating cost, lack of data portability and system maintenance. Limitations [3], [6] of current e-health without cloud computing

- Rising healthcare expenditure and unsustainable systems in India
- Rise of Chronic Diseases makes the system in unreliable prediction.
- Medication errors due to complexity
- Medical error due to poor communication which leads to 60% of causal for medical errors
- Corruption in healthcare.
- Economic Challenges that brings hurdles for the growth.
- Due to highly time consuming tasks, development of the system is delayed.
- Health Impacts of living and working Environments.

Cloud Computing, the recent technology, has become important mile stone and plays a vital role in the development of Information and Communication Technology. The advantages of the Cloud [7] Technology resides in Resource placement, resource provisioning and Resource allocation. Several Applications are already implemented in most of all the fields of business and business intelligence with mobile cloud storage [8] facility also. The main advantage of the cloud computing [9] is On-Demand Self-Service, Broad Network Access, Resource-Pool, Rapid Elasticity and Measured Services for business.

II. RELATED STUDY

In the Healthcare industry[10], [11], implementation of cloud technology with the potential advancement of Healthcare makes the dramatic changes. The development of the adoption of electronic health records (EHR) using Cloud computing helps a lot for the Healthcare community. Some of the implemented Healthcare tools and their description are given here. NEC and Fujitsu [12] had proposed their cloud computing solutions for hospitals in Japan Healthcare application Microsoft Europe also applied Cloud Computing technology to improve the patient's care. This led to reduce the cost in Italy's pediatric research and treatment. Taiwan government has made development cloud computing a key goal for their healthcare system. This develops the Electronic Healthcare system. The authors [12] proposed a study to investigate the critical factors that would affect the decision adoption of Cloud Computing in developing countries for Healthcare.



They studied various case study implemented across the world by various companies. The authors concluded that Taiwan had a matured way for e-Health development and this country can contribute to the world in developing the Healthcare system using cloud computing technologies. The authors focused only on the medical Centre in the metropolitan Hospitals as samples. The authors [13] discussed the advantage, limitations and the challenges involved in the medical imaging using cloud technologies. Major challenges involved as per the authors are the benchmark standards that allows image processing algorithms for reconstruction of medical imaging using the cloud computing. Authors [3] proposed a novel Healthcare system based on cloud. They followed the concept of utility computing and wireless sensor networks. The proposed system has diagnosis devices with wireless sensors which can capture the patient's health attributes from anywhere such as Ambulance and house. With the proposed novel method the patient details are made available in cloud using these sensor networks which can measure the ECG, temperature, basic health attributes such as heart beat, pulses and BP and with an expert system these parameters could be processed and proper decision can be taken. The author [14] proposed a conceptual model which is a scalable Service Oriented Architecture (SOA) and prototype implementation using Cloud computing, which has an objective to work in-hospital and pre-hospital that is either in ambulance or in home for supporting the information needs of inter-organizational emergency Healthcare procedure and for managing patients attributes in a ubiquities and distributed oriented, While supporting various platforms and systems types. The author also considered pre-hospital and in-hospital emergency for the better care to take for the patient. Authors [15] carried out the research in global Healthcare IT policy to move towards the cloud computing. They found that the privacy and security were important for the health care. They concluded that still there are many differences are present in US and EU in the field of healthcare. The Authors offered three conclusions and recommendations for the future research as cross-jurisdictional implications, trust issues when patients details outsourcing, and need for greater transparency and accountability. Authors [16] discussed various aspects of Health care using cloud computing. The Main discussion was on fears and doubts of using the cloud computing in the health care areas. The author showed various advantages of electronic storages of patients' records and also indicated the considerations required such as reliability and availability, privacy and security, type of cloud deployment, data portability and on service interoperability. The Author [17] proposed a cloud technology and pervasive computing based 12 Lead Electrocardiography (ECG), which serve to realize the ubiquities the 12-lead ECG Tele-diagnosis. Their system was capable that it can transfer the ECG details from outside the hospital such as ambulance, accident spot and even from their home. The 12-Lead ECG can transmit the signals to mobile phone to receive and understand the patients' health condition and act accordingly. The Author [18] presented a design e-health cloud system designed using M/M/m queuing system for improving QOS capabilities, which the maximum waiting time of regards. The author discussed about critical issues of platform scalabilities. Also they created an architecture that has a capability of adopting to different

dieses and incurs in number of patients. The Authors[19] proposed a prototype of data collection system called PubMed for finding aspects on rare dieses using MEDLINE and deployed. This system utilizes the PubMed search API for collection meta-data on rare dieses. Author [18] proposed a method to improve the monitoring nosocomial infections (MONI) software to create better performed reports according to consented national and international definitions for the infections. This system utilizes the processing algorithms developed already and evaluate, aggregate and intercept raw medical data in a step-wise until those data incurred by the established inference network. The author¹⁹ proposed and developed a web based tool, which had useful standard based for patients' and clinicians with limited resources for electronic healthcare. Instead the paper forms of clinical laboratory reports. This tool will utilize digital form of laboratory report to XLS form and stored permanently.

III. HEALTHCARE SYSTEMS – PROBLEM SPECIFICATION

In order to understand the need for this research, we need to understand the problem specification elaborately. Our problem to develop an application for healthcare that is a cloud based, device independent (Computer, Mobile, and other hand held devices), platform independent, Natural Language independent (English, Tamil, Telugu and other Indian Languages), utility based collaborative healthcare system named as HospitOne. The main objectives of HospitOne are 1). To connect the patients, clinicians and healthcare institutions together to form healthcare community, 2). To improve the healthcare by cooperation and coordination of Healthcare Community to achieve the quality of Healthcare, 3). To access the patient's Health and medical records anywhere, anytime with the permission of patient, 4). To eliminate the individual diagnosis which may lead to erroneous decision, 5). To educate the people to eradicate their health issues, 6). To reduce cost and time of Healthcare, 7). To consult virtually / physically / both with other clinicians and (or) healthcare institutions by sharing health and medical records of patient electronically for betterment the treatment of a patient, 8). To maintain the privacy and security of patients' vital information and 9). To make the system easier for better access to all.

A. Features

1. Patients, even at emergency condition, need not to be transferred to other healthcare institute due to lack of facility, clinicians, and for any other reasons. So the patients can be provided treatment in right time and the cost involved in transferring can be minimized.
2. The physical presence of special clinicians of same or / and other healthcare institutes may not be required to visit the patient for diagnosis or to provide treatment. So the precious time the special clinical consultants can be saved and the patients need not wait for the physical presence of other clinicians and the additional cost involved to bring the special consultant can be minimized.

3. The clinicians need not spend their time in travelling and can efficiently schedule their time to offer treatment to their patients and other also.
4. All the information of patient are electronically stored and controlled by cloud. This enables the accessing and transferring helps to makes the better decisions for the betterment of their patients.
5. Since the PPR (Patient Personal Records) is separately stored and securely managed by the separate software entity, the basic attributes of patient, such as identity and contact details, need not or / and cannot be revealed to any other, which prevents the privacy and social admiration of the patients can be saved.
6. Several support tools helps the healthcare community, to follow-ups, e-consultation, and e-appointment to have better service.
7. Mobile Apps for better connectivity, auto notifications and other consultations.

B. Architecture

The HospitOne, Health care system, consists of seven major divisions, namely (a). Records, (b). Diagnosis (c). Treatments, (d). Patient Monitoring, (e). Share to care, (f) HI Management System and (g). Supports. **Figure 1.** Shows the architecture of the HospitOne – the problem to be solved.

B. a). Records

All patients’ data related to personal and healthcare (PPR, PHR, PMR) are stored in backup-storage. This has two major advantages. First, the privacy of patient can be maintained. No one can access this information when this is in backup-store. When healthcare community (patient, Clinicians and Healthcare institute) needs to access this information, the records has to be moved to the cloud active storage. This is possible when patient, Home Healthcare institute (the hospital by which these information are created or / and maintained) need not be for all the cases and home clinical consultant (the medical Doctor to whom the patient is attached), jointly Permit to store in active cloud storage. (ii) The database access speed can be improved when stalled patients’ details are not in the active storage and the cost involved in searching information of the HospitOne can be reduced. This consists of three dockets which mainly focus on the

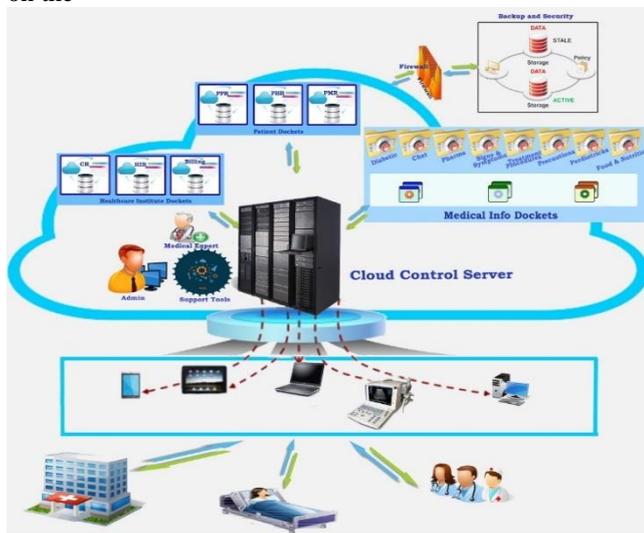


Figure 1. Architecture of HospitOne – Proposed Problem.

basic personal information about patients, clinicians and health care institutions. 1). **Patient Personal Records (PPR Dockets)** – these dockets consists of the personal records of patients such as patient ID (Auto generated), Name, Age, Date of Birth, Contact details and so on. A software code to create and maintain these records and includes facilities to keep these records confidential. 2). **Clinician Records (CR Dockets)** – these dockets consists of clinician’s record with software code to create and maintain these records and includes facilities to keep these records confidential. This record includes doctor ID (auto generated), Name, Specialization, Qualification, Experience, Research, Interest and list of Patient’s ID attached to the clinicians. 3). **Health Care Institution Record (HIR docket)** – This record includes hospital ID, Name, address, Contact Details, Facilities, list of diagnosis devices and so on.

B. b). Diagnosis

This division contains physically one data store called Patient Health Records (PHR) with 5 parts and 5 dockets to diagnosis the health issues of the patient with health records and signs and symptoms. These dockets are namely 1. **Patient Health Care Records (PHR Dockets)** – It consists of basic health details of the patients such as height, weight, age, occupation, habits, food styles and environments. 2. **Clinical Laboratory** – All laboratory report taken for the patient is stored by date wise. 3. **Medical Imaging** - Many medical Imaging reports such as X-rays, ECG, Scanning report stored by date wise. 4. **e-Consultation** – This contains the diagnosis report given by the various clinicians referred by the home clinician. 5. **Sign and Symptoms** – The list of signs and symptoms perceived from the patient are stored. This docket also contains the software code which helps clinicians in diagnosing by listing possible health issues for the patient.

B. c). Treatment

This includes various treatment procedures adopted for the patients against the diagnosis, which has four dockets, they are 1. **Prescription** – This docket has prescription suggested by the home clinicians and/or other clinicians referred home clinicians. 2. **Treatment and Procedures** – This docket consists of suggested treatment and other procedures based on the diagnosis suggested by the home clinicians and/or other clinicians referred by the home clinician. In this docket an intelligence suggestion system is available which works based on supervisory learning system which automatically suggests list of possible treatment for the particular diagnosis. 3. **Food and Diet** - By these dockets, the patients are advised to follow food & diet procedure against diagnosis & treatment prescribed by the home clinicians & referred clinicians by dieticians. 4. **Physiotherapy** - This docket suggest physiotherapy procedure if required to the patient suggested by physiotherapy against diagnosis and treatment.

B. d. Patient Monitoring:

This dockets helps to monitor the patient’s’ health condition by the clinicians with their mobile devices. Presently, the medical staffs periodically updates the patient’s health attributes such as heart beat,



Blood pressure, breathing rate and so on in the patient's health record which can be automatically monitored by the clinicians by their mobile devices. The frequency of updating by the medical staff is based on the health condition of the patient. This docket can be enhanced by adopting IOT and sensor network that automatically update PHR without medical staff frequently.

B. e). Share for Care

This docket helps the home clinicians to share PHR & PMR of their patient to one or more other clinicians in the same healthcare institute and/or other healthcare institute also to get consultation for diagnosis and/or treatment from specialized clinician.

B. f). HI Management System

HI (Healthcare Institute) Management System has the following responsibilities. It maintains the ward details, clinicians remunerations, medical staff salaries, various expenses heads, standard procedures of the HI, and produces various reports to make decisions related to the HI business with business intelligence. It handles the Patient Evaluation track and Patient feedbacks against the clinicians and other medical staff to improve the quality of Healthcare.

B. g). Support

This is a common division which has several dockets for healthcare institute, clinician, patients and other to get all healthcare related details and also act as a media to share the knowledge. It includes the following dockets with different types of applications for various devices. 1. Gather-N-Share - This docket is a device independent application. The objective of this tool is to share new procedure, food & diet, diagnosis model & method, patience of patient, clinicians & health care institute to all. 2. Kel-N-Get – This is a device independent platform in which one can post his queries related to healthcare. He can get response from volunteers (or) automatic appropriate response from database (or) both. 3. e-Yojana – This is an automated information broadcasting tool in which any valid information about healthcare is randomly generated from to database (suggested by clinician also) from the volunteered clinicians will be broadcasted. This tool broadcast information based on current situation & weather. 4. Food & Nutrient – This docket consists of record storage in which all food, nutrient, diet procedures are stored suggested by clinician and/or recognized healthcare institute (or) medical association. It also helps to broadcast food & diet information. It also provides information to Kel-N-Get docket as response to the query related to food, nutrient & diet. 5. Precautions (Varum-mun-kaapom) – This docket consists of various precautionary actions to avoid (or) prevent various diseases. It also helps to E-Yojana&Kel-N-Get. 6. Treatment Procedures – This docket consists of various treatment procedures for various disease suggestions by clinician's procedures for various diseases suggested by clinicians and/or valid healthcare institute (or) secures Medical association & Medical staff only. 7. Science and Symptoms – This docket consists of various signs & symptoms for diseases suggested by clinicians and/or Medical association and/or Healthcare institution. 8. Dia-Cloude – This is a separate tool which helps to understand, practice, avoid and prevent diabetic to the common man. Also helps to maintain the diabetic level of the patient. It is a common media where the clinician or

healthcare institute can broadcast information related to diabetics to the subscribed patient or common man (non-registered user). 9. Chat – This docket helps to chat between two clinicians and a patient to the clinicians and patient to patient. This docket may help to get appointment from clinicians and/or healthcare institute. 10. Mail – This facility helps to officially inform to one (or) more by selecting appropriate group. For example, A clinician may send a leave letter to higher official, A healthcare institute can inform officially to all patient group to indicate about a new special doctor visit. 11. Billing – This is a common docket to generate bill for a patient. This data store consists various charges to patients for both in-patients and out-patients. This docket jointly works with HI management System to maintain the financial accounts and to have seamless functionality of Healthcare Institute. 12. Pharmaceutical – This docket is having much information about pharmaceutical item such as expiry detail, billing details, dosage & precaution side-effect details. This also linked to Gather-N-Share, E-Yojana, and all other application tools. 13. Child-Care – This docket is especially for child healthcare which includes (i). Monitoring the infant growth, (ii) Precautionary actions (iii) Healthy activities of a child (iv) Food & Nutrient and (v) Vaccination.

IV. ADVANTAGES OF CLOUD BASED HEALTHCARE SYSTEM

- Mobility of records [17] - The Cloud computing helps to share easily to anywhere. When the patients records needs to be reviewed by two or more healthcare institutions and/or clinicians, the patients' electronic records can be shared without revealing the patients personal records. With this the patients need not to be transferred to anywhere.
- Speed [17]– Since Cloud Computing provides broad network access; we can make all the electronic records can be shared or transferred faster, accurate and safer.
- Reduction of cost [23] – ThisCloud based system can reduce the Healthcare cost by using e-consultation.
- With the combination of mobile cloud, we have a great advantage of personalized follow-ups¹⁸, such as monitoring the patients' health condition, their habits like smoking and drinking and prediction of sudden emergency by using remote tracking applications with the patients' mobile we can improve the patient's care.
- The clinicians can efficiently schedule and manage their time by avoiding the travel to the patient's place using this cloud based healthcare applications. With this the clinicians can dedicate themselves for the personalized follow-up their patient using this technology. So the performance of healthcare can be improved. This also helps to avoid transferring the patient unnecessarily with feeling confidently and closely taken care by the clinicians.
- The healthcare technology is used to create network between patients, doctors and healthcare institutions by providing applications services and also by keeping the data in the cloud.



- The cloud technology follows the pay-as you go model. So the cost involved can be minimized for the patient and healthcare institutions. Using this, the healthcare community and feel closely and feel comfort, which improves the healthcare operations.

V. CHALLENGES OF CLOUD BASED HEALTHCARE SYSTEM

Even though there are several benefits and opportunities for using cloud computing for Healthcare system, we have some challenges [4], [21]-[23] too. Those challenges are

1. Service Reliability - Though the cloud computing can be defined as unlimited resource to share, the reality is, the cloud computing and any enterprises infrastructure may have hardware and software interruptions. Also when more requests requested by users the resources may be allocated and the resource may not in a position to cope up with Healthcare user's request. In Healthcare, lack of reliability we may lose a life. So it is a very big challenge to maintain the Reliability and Availability
2. Resource Availability - Though the reliability and availability seems to be same, we need different methods to maintain the both. Another big challenge is to schedule and allocate the available resource for all service requests by the user. We need appropriate optimized algorithm for maintain the availability of critical resources such as processor, storage and software services.
3. Privacy and security challenges - In the healthcare system, all the stored data are personal, private and confidential information and health and medical records of patients. When these data are stored with cloud, we have a big challenge of keeping them safe and preventing them from miss use from others. We need a strong secure and authenticated method to maintain them.
4. Data portability - One of the biggest challenges is the data portability. The Healthcare institutions are required that adapting the cloud computing for their Healthcare system faces the problem of ability to transfer the data to other without interrupting the operations and loss of data. This Data portability requires a seamless way to transfer and utilize them.
5. Type of cloud service - There are different type of cloud service such as public cloud, private cloud and hybrid. Each type has its own merits and demerits. The biggest challenge is to select the appropriate type of cloud for the Healthcare and achieve the performance with cost effective.
6. Approximate results – Healthcare system holds a large volume of data. So to get a faster results the approximation of results are the order of the day. The system should have a capability to decide to generate an accurate results or approximate result required for the particular request by the user.
7. Query Optimization – we need a best query optimization technique for mining the required knowledge from the huge data.

VI. DISCUSSION

To achieve the above problem and its success is on based on the solving the challenges. We have several success stories

about the cloud computing and its service provisioning. We try to improve the basic challenges such as reliability of cloud services and availability of cloud resources. There are several registered patients with variety of physical status. So they need to addressed and provide the services as and when they need.

VII. CONCLUSION

To solve some of these challenges such as reliability of cloud services and availability of cloud resources, we propose a new bio-inspired dynamic cloud framework derived from Ruminant Digestive System from Ruminant Animals, called RDS Framework With a set of two algorithms (i) LPP-TP (Linear Programming Problem-Transportation Problem) based resource selection algorithm for efficiently identify and select the number of resources are actually available, (ii) 3 Dimension Hybrid Modified Bin Packing with Task Grouping (3DHBPTG) scheduling algorithm for making the maximum utilization of cloud resources for making it highly available and improves reliable cloud Our framework guide and optimize the cloud process to improve the reliable cloud service and availability of cloud resources.

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