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ADVANCED HEALTHCARE SYSTEM USING E-HEALTH & M-HEALTH IN CLOUD & MOBILE ENVIRONMENTS

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ABSTRACT

Large-scale distributed systems, such as e-healthcare, are difficult to develop due to their complex and decentralized nature. The service oriented architecture facilitates the development of such systems by supporting modular design, application integration and interoperation, and software reuse. This article describes a distributed e-healthcare system that uses the service-oriented architecture as a means of designing, implementing, and managing healthcare services. We present a cloud-based approach for the design of interoperable electronic health record (EHR) systems and the concept of "m-health" is defined in transactions as "mobile computing, medical sensor, and communications technologies for healthcare." We propose an EHR system—cloud health information systems technology architecture (CHISTAR) that achieves semantic interoperability through the use of a generic design methodology which uses a reference model that defines a general purpose set of data structures and an archetype model that defines the clinical data architecture. The m-health concept has become one of the key technological domains that reflect the key advances in remote healthcare and e-health systems. The m-health is currently bringing together major academic research and industry disciplines worldwide to achieve innovative solutions in the areas of healthcare delivery and technology sectors. The new and novel concept of 4G health and 5G technology that represents the long-term evolution of m-health.

KEYWORDS: Distributed E-Healthcare, Cloud EHR, Service-Oriented Architecture (SOA), Web Services, CHISTAR, 4G mobile Technologies.

INTRODUCTION

Healthcare is a field in which accurate record keeping and communication are critical and yet in which the use of computing and networking technology lags behind other fields. The Current communication mechanisms, based largely on paper records and prescriptions, are old-fashioned, inefficient, and unreliable. In an age of electronic record keeping and communication, the healthcare industry is still tied to paper documents that are easily mislaid, often illegible, and easy to forge. This shows it is essential to make improvement in this process, the prescriptions could be communicated electronically from the physician to the pharmacist, and the human computer interfaces for the physicians, nurses, pharmacists and other healthcare professionals could be voice enabled.

According to Carmen Catizone of the National Association of Boards of Pharmacy, there are as many as 7,000 deaths from incorrect prescriptions in the United States each year. A Washington Post article indicates that as many as 5% of the 3 billion prescriptions filled each year are incorrect. These numbers indicate that there is an urgent need to reduce the errors in healthcare. A distributed electronic healthcare system based on the service-oriented architecture (SOA) [1] can address some of these issues and problems.

Healthcare ecosystem consists of the healthcare providers (doctors, physicians, specialists, etc.), payers (health insurance companies), pharmaceutical companies, IT solutions and services firms, and the patients. The process of provisioning healthcare involves massive healthcare data which exists in different forms (structured or unstructured) on disparate data sources (such as relational databases, file servers, etc.) and in different formats. When a patient is admitted to a hospital, his/her information is entered into electronic health record (EHR) systems.

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Physicians diagnose the patient and the diagnostic information from medical devices such as CT scanners, MRI scanners, laboratory tests, Radiology, Digital X-rays, etc. is stored in EHR systems. In the diagnosis process, the doctors retrieve the health information of patients and analyze it to diagnose the illness. Doctors can take expert advice by sharing the information with consulting specialists.

Fig. 1 shows how cloud computing environments can be applied to the healthcare ecosystem [2]. The cloud can provide several benefits to all the stakeholders in the healthcare ecosystem through systems such as health information management system, laboratory information system, radiology information system, pharmacy information system, etc.

Using the concept of cloud-based "e-health" system that propose an EHR system—cloud health information systems technology architecture (CHISTAR), Hospitals can access patient data stored in the cloud and share the data with other hospitals. Patients can provide access to their health history and information stored in the cloud (using SaaS applications) to hospitals so that the admissions, care, and discharge processes can be streamlined. Physicians can upload diagnosis reports (such as pathology reports) to the cloud so that they can be accessed by doctors remotely for diagnosing the illness. Patients can manage their prescriptions and associated information such as dosage, amount, and frequency, and provide this information to their healthcare provider. Health payers can increase the effectiveness of their care management programs by providing value added services and giving access to health information to members.

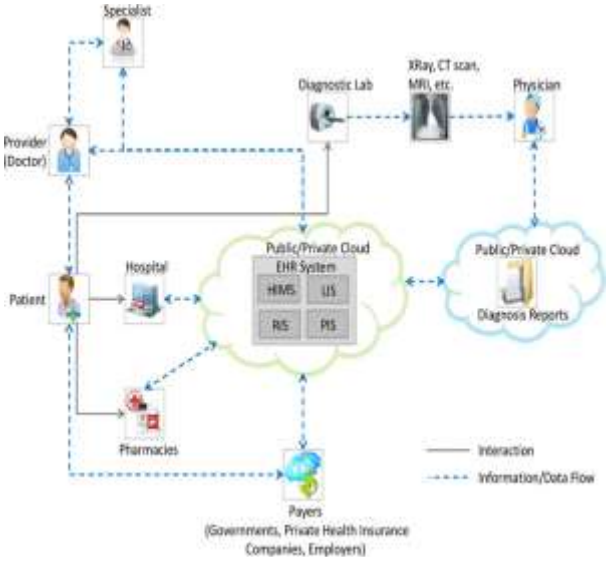

Fig. 1. Application of cloud computing environments to the healthcare ecosystem.

The concept of m-health was published in the special section, "Special Section on mobile telemedicine and telehealth systems," [3]. One of the key notes stated that the "convergence of information and telecommunications around telemedicine and mobile tele-care systems is fostering a diversity of cost-effective and efficient mobile applications and will provide a new dimension to the original definition and concept of telemedicine as 'medicine practiced at distance' that will envisage new mobility directions in reshaping the structure of healthcare delivery globally into the next millennium." This potent prediction was the key to the massive successes of m-health systems that we are lacking today.

Fig. 2 shows the general concept of m- health systems. Furthermore, since then major advances in these m-health sub-disciplines were introduced within the worldwide research community. In particular, major advances were introduced in the mobile broadband and wireless internet m-health systems [5]. Similar advances in wearable and body area sensor networks and challenges were also reported [4]. The contributions presented in this special section represent some of these developments and illustrate the multidisciplinary nature of this important and emerging healthcare delivery concept.
However, one of the major breakthroughs and turning points in this evolution is from the introduction of the fourth-generation (4G) mobile communication systems. The introduction of 4G technologies and networks in this decade will bring new services and consumer usage models that will be compatible with

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these emerging mobile network architectures. It is timely that such major evolution is also reflected in corresponding m-health systems and services and introduced as 4G health. This new concept is defined as "The evolution of m-health towards targeted personalized medical systems with adaptable functionalities and compatibility with the future 4G networks." This 4G concept can be progress with coming 5G Technology.

Fig. 2. General concept of m-health systems.

DEFECTS IN THE EXISTING E-HEALTHCARE SYSTEM

- In existing e-Healthcare systems has focused on record keeping and databases.
- Traditional EHR systems use different and often conflicting technical and semantic standards, which leads to data integration and interoperability problems.
- Human errors are more by exploiting electronic communication and record keeping.
- Traditional EHR systems are based on different EHR standards, different languages, and different technology generations [11]. The consequence is that EHR systems are fragmented and unable to exchange data.
- Most of existing EHR systems are built on Client-Server model with dedicated hosting that involves single Server which is installed with limited functions.

FUNCTIONS OF DIFFERENT TECHNOLOGIES FOR ADVANCING HEALTHCARE ECOSYSTEM

Service-Oriented Architecture

Service-Oriented Architecture, along with Web services, provides the opportunity for diverse systems to interoperate without requiring the use of a particular kind of computer system. SOA is an architecture in which the building blocks are services, not only encompasses the services from a technology perspective but also includes the policies and practices that govern service provision and consumption. SOA [6] enables reusability of software components, provides protocol independence, and facilitates application integration. It enforces basic software architecture principles such as modular design, abstraction, and encapsulation. With open standards, SOA provides interoperability between services operating on diverse platforms and between applications implemented in different languages. It supports diverse processing efficiently and easily, enables cross-platform communication, and adapts dynamically to meet changing needs.

For healthcare in particular, SOA and healthcare standards enable interoperability by encoding healthcare information using one or more common representations. With healthcare standards, diverse but interoperable systems can improve the quality of healthcare delivered to patients.

Integration with Cloud Computing

E-Healthcare systems can establish a profile for each individual. As the population grows, a huge amount of data will be collected and stored on trusted e-Healthcare servers. At the same time, the servers must facilitate efficient and secure access from system users so that they can monitor and manage their own health information. Therefore, reliable and robust data servers with large storage capacity and strong computing capability are required to store, process, and distribute health information [8]. The emerging cloud computing concept fits well in this scenario. Cloud computing is an evolving paradigm that enables ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction.

Service reliability is another concern of cloud-based e-Healthcare. Due to the importance of health information, it is necessary for geographically distributed clouds to guarantee the integrity and security of health information. In case of a power

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failure or system failure, backup cloud servers must be invoked and the healthcare services uninterrupted. In addition, when cloud servers are employed, the information access delay may be enlarged due to the potential long geographical distance between the cloud servers and the users, and the overloaded access systems from a larger number of users to the servers. From an energy efficiency point of view, e-Healthcare allows users to perform information access by themselves and thus requires the cloud servers to provide such access all the time. Novel cloud server architecture to meet the security, reliability, and energy efficiency requirements for e-Healthcare requires joint efforts of academia, industry, and government agencies. As the cloud-computing is pay-per use service, using database service for large amount of healthcare related data is cheap.

Distributed E-Healthcare System

Our prototype distributed e-healthcare system uses SOA to enforce basic software architecture principles and provide interoperability between different computing platforms and applications that communicate with each other [7]. The clinic, pharmacy, and patient modules provide the actual services for the distributed e-healthcare system. The devices accessing these modules can be desktop or server computers as well as PDAs or smartphones. They can also be electronic medical devices, such as blood pressure monitors or any BAN devices.

Although our distributed e-healthcare system provides user-friendly interfaces for busy healthcare professionals and patients. As the security and privacy are particularly important in this area, so we designed the prototype with security and privacy in mind. The system authenticates users and logs session information and attaches resources to the resource creator, so that only privileged users can view or modify the data. For applications deployed on devices such as PDAs, the system strictly enforces authentication and session management.

m-Health Services

This is considered as the major element of 4G health systems and the key to their success and future evolution. In a recent WHO report on m-health [10] provided a comprehensive literature review and reporting on current m-health systems. Some fields where m-health services are essential were categorized as follows:

1) Emergency response systems (road traffic accidents, emergency obstetric care, etc.).
2) Disease surveillance and control (Malaria, HIV/AIDS, TB, Avian Flu, chronic diseases—especially diabetes).
3) Human resources coordination, management, and supervision.
4) Synchronous and asynchronous mobile telemedicine diagnostic and decision support for clinicians at the point of care.
5) Remote patient monitoring and clinical care.
6) Health extension services, health promotion, and community mobilization.
7) Health services monitoring and reporting.
8) Health-related m-learning for the general public.
9) Training and continuing professional development for healthcare workers.

From these studies, three innovation example areas were cited as potential and successful examples of m-health applications and services especially for the developing world.

1) SMS services and alerts that remind patients to take their prescription drugs at the appropriate time.
2) Remote diagnosis and appropriate treatment for patients who do not have easy access to a physician.
3) Remote health monitoring devices that track and report patients' conditions.

E. Web Services

Web services are applications that typically execute on a remote computer and can be accessed by clients over the Internet. Web services are based on open standards—in particular, XML and SOAP. These standards aim to achieve interoperability between applications implemented in different languages, running on diverse computer systems, and communicating over a network. Implementing our prototype e-healthcare system with some technology that is work as platform independent [11] because of its ability to be deployed on small wireless devices as well as on powerful servers. To ease development and debugging of the system, It also supports different web services.

Web Services Security [12] provides a means of incorporating security features in a SOAP message's header. It supports multiple trust domains, encryption

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technologies, signature formats, and security token formats.

BENEFITS

Cloud-based e-health system

In this section, we describe the advantages of cloud-based EHR systems over client–server EHRs that are based on a dedicated hosting model [15].

Interoperability: Cloud Health Information System Technology Architecture (CHISTAR) has better interoperability as compared to client–server-based EHR systems. To achieve interoperability, CHISTAR adopts a two-level modeling approach for separation of information from the clinical knowledge. Furthermore, the data integration engine of CHISTAR allows integrating data from disparate data sources such as MySQL servers, JDBC servers, Oracle, file servers, and different EHR standards (HL7 messages, HL7 CDA documents, etc.) into a cloud-based storage.

Scalability: Cloud-based EHRs such as CHISTAR have better scalability as compared to client–server EHRs. CHISTAR adopts the cloud component model approach for application design which provides better scalability by decoupling application components and providing asynchronous communication mechanisms. Since components are designed to process requests asynchronously, it is possible to parallelize the processing of requests.

Maintainability: CHISTAR has better maintainability as compared to client–server-based EHR systems. The functionality of individual components of CHISTAR can be improved or upgraded independent of other components. Loose coupling allows replacing or upgrading components, without changing other components. Since CHISTAR has loosely coupled components, it is more resilient to component failures. In case of client–server-based EHR systems with tightly coupled components, failure of a single component can bring down the entire application.

Portability: Cloud-based EHR systems such as CHISTAR have better portability. By designing loosely coupled components that communicate asynchronously, it is possible to have innovative hybrid deployments in which different components of an application can be deployed on cloud infrastructure and platforms of different cloud vendors.

Reduced Costs: Client–server EHR systems with dedicated hosting require a team of IT experts to install, configure, test, run, secure, and update hardware and software. With cloud-based EHR systems, organizations can save on the upfront capital investments for setting up the computing infrastructure as well as the costs of managing the infrastructure as all of that is done by the cloud provider. Though hardware maintenance overhead is reduced, organizations still need to pay for the software maintenance and support costs. Additional cost benefits come by scaling cloud resources up (or scaling out) only for those components which require additional computing capacity.

Mobile-based m-health system

The purpose of applying Mobile Cloud Computing (MCC) in medical applications is to minimize the limitations of traditional medical treatment which contains small physical storage, security and privacy, and medical errors. Mobile Cloud healthcare i.e. m-healthcare provides users with convenient helps to access resources like patient health records easily and quickly. Besides, m-healthcare offers hospitals and healthcare organizations a variety of on-demand services on clouds. The schemes of Mobile Computing applications in healthcare are: [20]

1) Health is monitor comprehensively. This services enable patients to be monitored at anytime and anywhere through broadband wireless communications.
2) Intelligent emergency management system can manage and coordinate the fleet of emergency vehicles effectively and on the time when calls are receiving from accidents or incidents.
3) For Healthcare emergency system to alert health-aware mobile devices detect pulse-rate, blood pressure, and level of alcohol.
4) Access to healthcare information allows patients or healthcare providers to access the current and past medical information.
5) Pervasive lifestyle incentive management should be able to pay healthcare expenses and manage other related charges automatically.

Similarly, Health Cloud, a prototype implementation of m-healthcare a information management system is based on mobile computing and a clients using different mobile devices using different platforms.

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FUTURE ENHANCEMENT

Our e-healthcare system currently focuses on the relationships between patients, physicians and pharmacists. We plan to extend the system to other healthcare facilities and professionals, such as laboratory technicians who perform and report tests and analyses requested by physicians. We also plan to investigate whether our Clinic and Pharmacy modules can be interfaced to applications supplied by pharmaceutical companies that provide information on medications and dosages and warn of interactions between medications.

Future work will focus on the development of a cloud-based information integration and informatics (III) framework for healthcare applications. III framework will allow development of smart and connected healthcare applications backed by massive scale healthcare data integrated from heterogeneous and distributed healthcare systems within a scalable cloud infrastructure.

The concept of 4G health [14] and the 5G health will be one of the key focus areas for future m-health research and enterprise activities in the coming years. This evolution of m-health requires a clear global plan and framework on how these systems will work and function in different countries and healthcare systems globally. These will ensure the successful and large-scale adoption of 4G health systems globally.

CONCLUSION

In conclusion, by applying advanced communication networking and sensing technologies to healthcare and e-Healthcare on the Cloud platform can improve our living standard at low cost. This note presents several changeling issues to be resolved for advancing e-Healthcare and mobile healthcare systems. The concept of 4G and the resent 5G as emerging technologies will also make our healthcare system remotely faster.

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