

Extensibility of Mobile Cloud Computing (MCC) for Medical and Health Usage

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Abstract:- According to the statistics of WHO, the diseases are increased to the level where it has leading to cause of death. In the busy lifestyle it is important to have real-time healthcare for elderly patients. With the increased use of Smartphone in daily life and combining with the new emerging technologies we can solve the health related problems. Cloud computing the emerging concept aims to provide as service based model across multiple platforms. Mobile cloud computing (MCC) is the subset of Cloud computing where many cloud applications can run on mobile. Mobile and wireless devices leads to emergence of new type of advanced services for healthcare, making more realistic and feasible in terms of providing expert medical care. Mobile technology has many impacts on one's personal life as it advances in 3G and 4G. In this paper we discussed about developments of MCC in healthcare, mHealth which include relevant issues and challenges. The main focus of this paper is to set recommendation for both cloud computing provider and mobile healthcare technologists.

Keywords: MCC, Healthcare, Security

I. INTRODUCTION

No doubt Cloud Computing is established as the newest big shift in the computing. 'Anytime-Anywhere' is the key which says repository can be accessed/managed/stored anytime from anywhere as the data managing and storing is centralized.

Mobile Cloud computing is subset of cloud computing where many cloud applications can run on mobile. Delivery of service to the customers in MCC is achieved with just the usage of network capability alone. Of course for timely delivery of information to the user one has to reserve the network bandwidth. MCC rely on services such as on demand access and no on-premise software. Mobile computing provides new opportunities to personal users of healthcare services. Mobile and cloud technologies are considered as the heart of healthcare's transformation. Mobile devices like Smartphone, Tablets are replacing paper medical charts. Mobile cloud collaboration tools are improving information sharing among medical professionals and academics and private clouds are enabling secure access to medical records.

II. Why MCC?

Why do we need to shift from cloud computing to Mobile cloud computing? The following are the few applications that give us the need to shift from cloud computing to mobile cloud computing:

- **Image processing**

By running GOCR, an optical character recognition program on pool of mobile devices one can extract words from the image and translates words into known language. Reference [1] discusses how a foreign traveler is benefited in understanding the street signs.

- **Natural Language Processing**

The most useful tool which plays important for a foreign traveler to communicate with locals is the Language translation. A special application especially for visually impaired is the Text to speech where an user may have a file read to them [1].

- **Sensor data applications**

Recent technological advances in sensors [3] facilitate the use of the listed sensors in mobile devices such as GPS, light sensor, accelerometer, clock, temperature, microphone, compass for time stamped and linked with other phone, physiological sensors such as WBASN is typically capable of sensing, sampling, processing, and wirelessly communicating one or more physiological signals.

- **Sharing GPS/Internet data**

One of the cheaper, faster [4] and effective way to share data among group of mobile devices which are near to each other is through local-area or peer-to-peer networks. GPS reads and Bluetooth scans are used to discover devices.

- **Mobile Learning**

Mobile learning (m-learning) is the practice of electronic learning (e-learning) supported by Smartphone. Cloud-based m-learning applications are extensively used to solve the limitations of traditional m-learning applications e.g. high cost of devices and network, low network data transmission rate, and limited availability of educational resources.

- **mHealth**

The growth of telecommunication technology in the medical field benefited many people for easier diagnosis and treatment. Patients are regularly monitored on their health and can have timely treatment as well. Also leading to increase in the development about qualities of healthcare services. Never-the-less there are many challenges (e.g., medical errors, physical storage issues, security and privacy) to face. The solution for the above mentioned problems can be provided by cloud computing. Cloud computing provides the handiness/easy reachable for users to help them access resources quickly and easily. However, it offers services on-demand and always-on over the network to perform operations that meet changing needs in electronic healthcare or mobile healthcare application. Mobile Health (mHealth) is the subset of eHealth supported by Smartphone.

• Other Practical Applications

Users share photos and video clips efficiently and tag their friends in popular social networks as Twitter and Facebook with the help of tool such as cloud computing. A cloud becomes the most effective tool when mobile users require searching services (e.g., searching information, location, images, voices, or video clips).examples of such applications is Multimedia search: Mobile devices store several types of multimedia content for example music, videos and photos.

III. Architecture of Mobile Cloud Computing

Base transceiver station (BTS), access point, or satellite are used as base stations to connect mobile devices to mobile networks which establish and control links(connections) and functional interfaces between devices and networks. When users made a request, information is transmitted to central processors which are connected to servers to provide mobile network services.

The general architecture of MCC is given in figure 1:

AAA which stands for Authentication, Authorization, and Accounting are the key factors based on which mobile users get service from their mobile network operators, based on the home agent (HA) and subscribers' data stored in databases. Through the Internet subscribers' requests are delivered to a cloud. Cloud controllers in the cloud process these requests to provide mobile users with the corresponding cloud services, which are developed with the concepts of virtualization, SOA (service-oriented architecture i.e., web application) and utility computing. Here the focus is on a layered architecture of cloud computing, which is commonly used to demonstrate the effectiveness of the cloud computing model in terms of meeting the user's requirements.

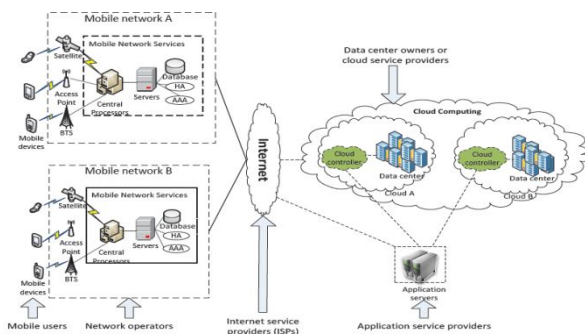


Fig 1. Architecture of Mobile Cloud Computing

Types of Architecture scheme:

- Agent-client scheme-** To enhance capability of mobile devices with cloud technology
- Collaborated scheme-**the use of cloud computing to execute mobile applications in behalf of the device.

Agent-Client Scheme

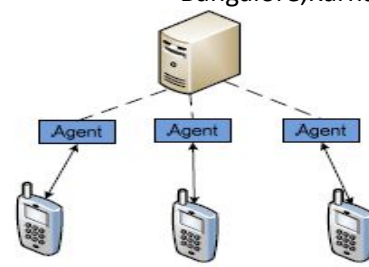


Fig 2. Agent – Client Scheme

In this scheme, cloud side:

- ✓ Generates agent for each device which helps to communicate the agent to contact with other entities outside the domain.
- ✓ Provides resource management for mobile devices to overcome limitations such as processing power and data storage.

Collaborated scheme

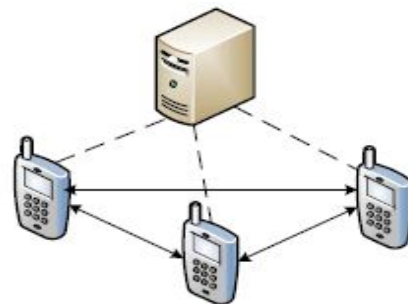


Fig 3. Collaborative Scheme

In this scheme the cloud server:

- ✓ Is used as controller and scheduler for collaboration among mobile devices.

Protocol Model

Based on the delivery manner, we have 3 types of cloud computing service:

- Infrastructure as a Service (IaaS)
- Platform as a Service (PaaS)
- Software as a Service (SaaS)

However, Mobile Cloud Computing would not separate into these types. Mobile Cloud Computing mainly focuses on the connection between client and cloud, that may differ from common features of cloud computing.

IV. Advantageous of MCC

• Extending battery lifetime

Increased battery life due to efficient cloud network connectivity (e.g., connectivity-on-demand, low-power prolong connectivity)

- **Managing Records are easy**

Easy management of EHR (Electronic Health Record), MHR (Mobile Health Record), and Personal Health Record (PHR)

- **Faster Access**

Faster access to healthcare personnel to avoid health crises

Easy creation and management of circle of trust in regards to the patient's health conditions

- **Access to private and public sources**

Efficient access to medical information and data management both for the private and public sources.

- **Improving data storage / access capacity and processing power**

Storing / accessing the large data on the cloud through wireless networks.

- **Improving reliability**

The data and application are stored and backed up on a number of computers. Thus reducing the chance of data and application lost on the mobile devices.

- **Anywhere-Anytime**

This translates to ubiquitous network access, where any client with any device (assumed capable of minimum functionality), is able to get connected and receive services.

- **Ease of Use**

Requesting services via cloud computing has taken the ease-of-use bar to a whole new level due to the fact that any device is able to get connected and receive services independent of the location.

V. Applications of Mobile Health Care

There are a few schemes of Mobile Cloud Computing applications in healthcare. For example, [7] presents five main mobile healthcare applications in the pervasive environment.

- **Comprehensive health screening services** enable patients to be monitored at anytime and anywhere through broadband wireless communications.
- **Smarter emergency management system** can manage and coordinate the fleet of emergency vehicles effectively and in time when receiving calls from accidents or incidents.
- **Health-conscious mobile devices** detect pulse-rate, blood pressure, and level of alcohol to alert healthcare emergency system.
- **Ubiquitous access to healthcare information** allows patients or healthcare providers to access the current and past medical information.

- **Ubiquitous lifestyle incentive management** can be used to pay healthcare expenses and manage other related charges automatically.

VI. Mobile Cloud computing from mHealth perspective

Mobile Health (mHealth) is the subset of eHealth supported by Smartphone. The biomedical data is captured at the body-worn sensor end. The data is transmitted to a data collector (Smartphone) via a link technology (i.e., Bluetooth, Bluetooth Low Energy, and ZigBee). The data collector transmits the information to the cloud/Internet via the cell-tower.

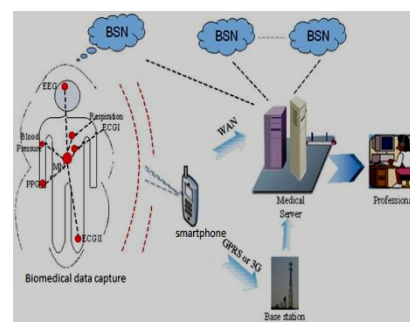


Fig 4. mHealth in MCC

Medical community has completely accepted the deployment of mobile technologies in medical field. Mobile technology extends in helping with chronic disease management, empowering the elderly and expectant mothers, reminding people to take medication at the proper time, extending service to underserved areas, and improving health outcomes and medical system efficiency, helps in medical imaging data management, WBAN, MHR.

Let us look each in detail:

➤ Wireless Body Area Network(WBAN)

Sensors are placed on patient bodies for the continuous monitoring of patient health. Reference [12] proposes a framework which is a physiological sensor WBAN helps in capturing Electrocardiography (ECG), Electromyography (EMG), Electroencephalography (EEG), and Pulse Oximeter (SPO2) data. The data is captured by an Android based Smartphone or tablet and is transmitted to the cloud.

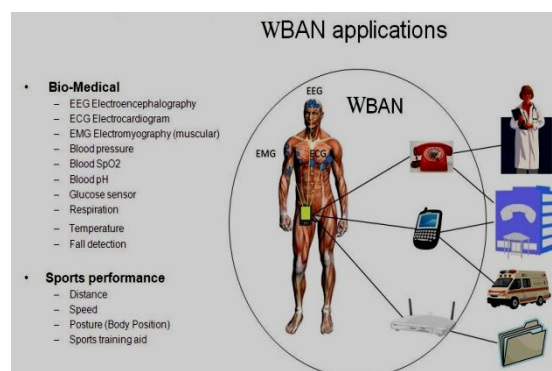


Fig 5. WBAN in MCC

➤ Medical Imaging Data Management

Reference [10] proposes a framework for handling compressed medical images, providing storage at faster access, faster mobile access, preserving security and privacy requirements. When compared to other classical face to face treatment models in mHealth medical imaging becomes more important in monitoring and handling.

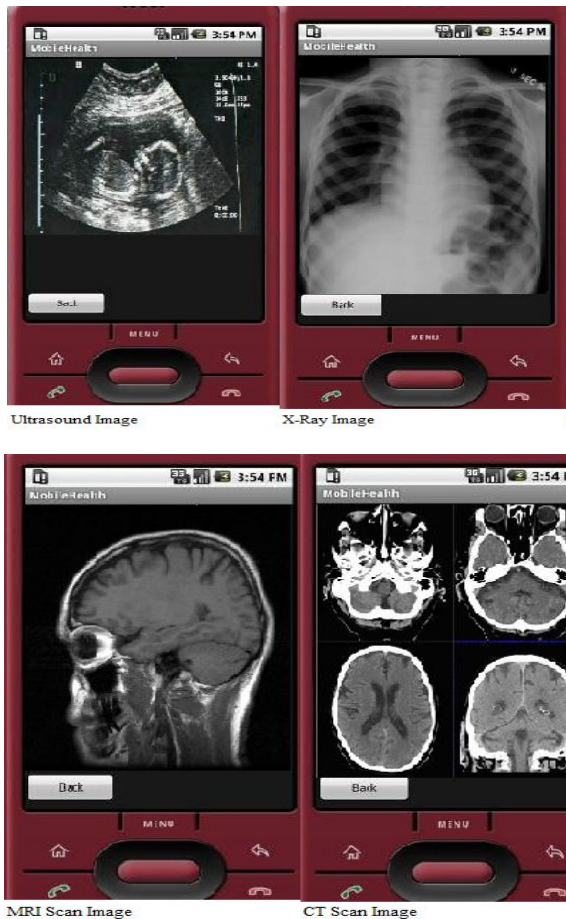


Fig 6. Image of Ultrasound, X-Ray, MRI scan, CT scan

➤ Mobile Health Record(MHR)

As seen earlier the technological advances is forcing us to shift from Cloud computing to Mobile cloud computing, in a similar way the shift from Electronic Health Record (HER) to Mobile Health Record (MHR)[1] is inevitable once Smartphone become prominent interfaces for interconnecting patients to the healthcare space. MHR plays a vital part of efforts in promoting healthcare quality, safety of patients. . The MHRs have enhanced efficiency by alerting clinicians to duplicate orders, enabling faster prescribing and other orders, and reducing transcription, medical records, and claims expenses. MHR is the subset of HER.

➤ Managing Chronic Diseases through mobile devices

The greatest challenge among many locales in health care is the management of chronic disease. Reference [14] focuses on how mobile devices and remote monitoring helps in

managing chronic diseases thereby reduces the health care costs by avoiding frequent visits to doctor's office for routine care. Rather than having to wait for a patient to discover there is a problem, monitors identify deteriorating conditions in real time, and alert physicians. The classical process of face to face treatment was expensive, time consuming and inconvenient where patients had to visit a doctor's lab , take a test, wait for results to be delivered.



Fig 7. Wireless ICT Pace maker using BAN

➤ Service for Elderly and Expectant Mothers

Most common problem among the elderly patients is either to forget to take the prescribed medicine/drug or they don't take it on time or they don't take suggested dosage by their physician. Mobile technology has the potential to help with this and communications problems. The inconvenience for Patients to visit doctors' offices to be reminded to take their medicine is no more with the use of mHealth. Reminders will be sent to patients via email, automated phone calls, or sms. A mobile application for pregnant women "Text4Baby" sends text messages on how to handle various stages of pregnancy and problems that come up. Reference [14] focuses how mobile technology is helpful for pregnant ladies and for elderly patients.

➤ Extending Rural Access

Reference [14] discusses how mobile technology is a boon to rural citizens. One of the greatest challenge in every country around the world is the access to medical care in rural areas, as most of the health care providers and specialists are located in densely-populated areas because that is the place where hospitals and advanced equipment are found. With the MCCmH advancement in healthcare even the rural citizens are benefited as much as the urban one's in the area of medical care access.

VII. MCC Issues and Approaches

• Client side Mobile communication issues:

Due to intrinsic nature & constraints of wireless network and devices, mobile cloud computing may face challenges during transmission. Advance application with rich internet and immersive applications contribute a direct challenge for transmission as an example application which demand high internet requirement included – Gaming online, augmented reality which not just require high

processing but also demands minimal latency for network connectivity, and will continue to be locally processed by high end tablets and or powerful smart phones.

Due to the prolonged execution & restriction of mobile broadband for a given high end application running on cloud can cause network latency which makes certain application and or services not suitable for mobile cloud computing.

Mobile cloud computing can be deployable on varied network access – on radio access technologies like Wireless-LAN, 2G, EDGE, 3G, GPRS, Hybrid Edge WiMax, which poses restriction on accessibility and hence introduces more latency, also Mobile cloud computing has issues with scalability of service, when many clients are accessing health data with multimedia during peak hours, it tends to introduce delays of availability and accessibility.

Another challenge for communication can be due to multiple platforms on mobile network which affects Platform switching. Interoperability between platforms and managing huge data (BigData – Mass health and medical management and its transmission across various mobile network and cloud poses a challenge for efficiency.

Some of the features that can be overcome by desirable features for Mobile Cloud Computing on a wireless connection are:

- “Always-on” Mobile Cloud Computing requires connectivity for a low data rate cloud control signaling channel that is available always.
- “On-demand” Mobile Cloud Computing requires available wireless connectivity to be powered with a scalable link bandwidth for a demanding requirement by high end applications.
- “Energy-efficiency” & “Cost-efficiency” Mobile Cloud Computing requires a energy efficient and considers cost in to account as mobile devices has limited energy and mobility services are costlier.

A guarantee of a wireless connectivity that meets the requirements of Mobile Cloud Computing that takes care of Availability, On-Demand scalability, Energy and cost efficiency are the most critical challenges for a Mobile Cloud Computing.

• Cloud Computing Issues at provider :

Mobile offloading is one of the primary features of MCC. It helps improve battery lifetime and increase the application performance. What is perhaps more challenging is issues of efficiency and the dynamic offloading under various platform changes and various environments. Privacy and Secrecy of private and application data is a key to establish and maintain trust for an mobile platform in particularly for an Mobile cloud computing.

Security issues in Mobile Cloud Computing are showcased in two categories:

- Security of mobile user &

- Data Security

Security for mobile includes application security, issues can be overcome by installation of security mobile applications like AVG, McAfee, Computer Associates, Kaspersky which are antivirus programs for mobile devices are the simplest ways of security implementation for detecting security threats and malicious codes like virus and worms on a mobile device, but one should bare the limitations and constraints of mobile device processing and power consumption are far limited than a resourceful device.

However, its challenging to keep running the antivirus application constantly on mobile devices presents approach of moving the threat detection computing to cloud, which provides in-cloud services for virus and malware detection and has platform which consists of host agent and also network service components to accomplish.

A host agent (mobile device) consists of limited processor that runs lightweight programs like file inspection on the mobile device. During inspection if a file is not available in the cache, this will be cross verified with cloud network. Also cloud antivirus (CloudAV) provides service responsible for verification, determination and correction. These capabilities can be achieved by network services running multiple antivirus engines which runs in a parallel engines which are hosted in virtualized containers. Implementing mobile CloudAV platform for mobile environment requires agent to be improved and customized.

As for Privacy using Location based services (LBS) are increased as more and more GPS devices are increased, however, LBS are susceptible to privacy issues as private data is shared like user location. However it can get worse if the attacker knows private information, but such issues can be avoided using Location Trusted Servers also called as LTS.

While LTS on receiving mobile users’ requests, LTS gathers their location information in a certain area and cloaks the information called “cloaked region” based on “k-anonymity” concept to protect and conceal user’s information.

The “cloaked region” is sent to LBS to know only general information about the users however; it does not reveal their identity.

Hence gathering the information of other users shall be done on cloud which shall reduce cost and helps improving speed and scalability. While launching the application program on sender’s mobile device, the program will request cloud for providing information about surrounding users. On completion of this the mobile client will generate “cloaked region” by itself and send “cloaked region” to the LBS. This way, both LTS and LBS would not know the sender’s information

VIII. CONCLUSION

MCC opens up path for research in hybrid mobile-cloud systems. The deployment of mHealth in the mobile cloud



has a number of benefits and challenges, which have been discussed in this paper. We presented an introductory summary to mobile cloud computing and summarized the advantages and challenges concerning mobile cloud computing. Then we discussed the idea of mHealth deployed in mobile cloud computing. We concluded a set of recommendations for the issues faced in MCC. We believe providing supports for the security and privacy for Smartphone is going to be challenging and vital, in particular to mHealth. This includes supporting local, distributed, centralized data as well as data on the move. The recommendations will help the healthcare community; mobile user's and network providers to provide cost effective and fast retrieval of health care related information and also easy means of interaction between hospital administrations and the patients. With the introduction of mobile health care system, the benefit for patients and hospital is to greater extent. It not only provides better quality of patient care, also reduces administrative and medical cost for both patients and hospitals.

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