Cloudlet Services for Healthcare Applications in Mobile Cloud Computing

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Abstract Nowadays, the uses of mobile devices have been increasing in many aspects of our life such as playing games, sending documents, transactions, and marketing, business, and conference meetings. But this mobile device has limited the resources in terms of battery lifetime, storage, and processing capacity. The new technology known as mobile cloud computing can help users to increase utilization of mobile cloud resources. The limitation of mobile device can be overcome by MCC. The technique called as offloading can transfer the resource-intensive task to remote cloud for processing, and the result will come back to the mobile device. The mobile device connecting to remote cloud with the help of 3G (or) LTE networks causes latency-related issues bandwidth and cost. In order to overcome these problems, MCC has introduced new technology which can reduce latency problems by providing secured and efficient model based on cloudlet. In this paper, we mainly focus on healthcare applications which can be processed by new cloudlet model for reducing processing time as well as providing enough security to user's data. Initially, the user connects to the available cloudlet; if the cloudlet is not providing required resources or services, the user will redirect to remote cloud. In our model, the cloudlet is used to analyze patient medical records.

Keywords Mobile cloud computing · Cloud computing · Cloudlet model Healthcare applications · Mobile devices

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1 Introduction

Mobile devices are growing in terms of utilization in our daily life to voice conversations and video chatting with others. Especially, the smart phones became an important tool in our daily activities in e-commerce, IT industries. Even though mobile device is capable enough to handle high-end applications, it still suffers with limited resources such as short battery lifetime, storage, and processor. These changes help users to make environment where all devices share resources to run application efficiently.

The conventional computing only deals with the compute and process computation tasks. The modern technologies got birth to satisfy user requirements: big data, networking, cloud computing, fog computing, mobile cloud computing, IOT. The user will always require modern infrastructure to achieve increasing demand on both mobility and connectivity [4]. Among many technologies, mobile cloud computing became a popular model [5]. Mobile computing allows many devices interacting with other mobile devices through network technologies (Wi-Fi and 4G). The mobile devices have many advantages like portability and mobility features. The mobile computing is integrated with cloud computing technology in order to form new technology called as MCC [6]. The MCC can overcome the limitations of mobile device. In the case of implementing real MCC model, we have to take into account few challenges which cause troubles while establishing MCC environment. Mobile devices are limited by storage, battery lifetime, processing, and video streaming, augmented reality application. We should consider another important challenge in the mobility of device which is moving from one network environment to another network environment. This affects quality of performance and connectivity with remote cloud [7]. The MCC can avoid limitations of mobile device by offloading computational task into remote cloud which requires more processing power locally. As a result, the remote cloud will process it with less power consumption [8]. MCC is considered as new trend among many new technologies in coming years. Generally, the mobile devices are connecting cloud computing via various network technologies such as 3G and 4G. These technologies cause high cost, limited bandwidth, and connectivity problems as shown in Fig. 1. The important issue is nothing but security. Providing security to data from attackers over wire or wireless channel [9] is a big challenge in both cloud and mobile cloud computing. The user always expects his data to be safe and not to be affected by the attackers [10]. There are many encryption techniques to protect data from attackers [11, 12].

2 Background

The researches have been putting lot of efforts across the world for improving mobile cloud computing. The users require numerous applications in mobile device; each of these applications requires data exchange and receives as well as requires lot of pro-

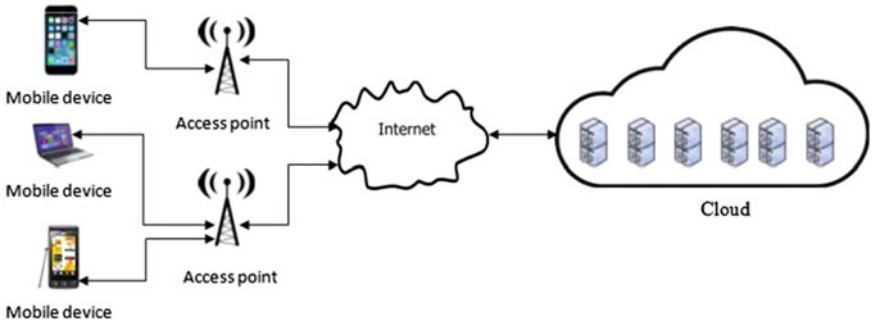

Fig. 1 Mobile computing architecture

cessing power. This paper [13] describes how the mobile computing is formed from both mobile computing and cloud computing. The author also discusses challenges, scope of MCC, and development. The sensors in network technology inspired lot of researchers in world to collect data from different useful aspects of life in clouding military, hospital, IT organization, education institutions, and crowd management [14]. The huge amount of data will be generated every day that data need to be stored efficiently all that data has to be stored in cloud server for storage and processing [15]. In paper [16], the author has analyzed main factors which cause more power consumption in mobile devices while using remote cloud. This provided an example on how to save energy between mobile device and remote cloud. They have discussed main characteristics of modern mobile device. The jobs from users can be scheduled among VMs inside cloudlet which was discussed in [17]. The key metrics are overhead of VM life cycle, scheduling of VM, job allocation to VM. The author in [15] has discussed the importance of scheduling of VMs in cloud environment in order to reduce execution time by using Cloudsim cloud environment tool. This paper proposes architecture was fine-grained cloudlet to manage all applications inside cloudlet. The cloudlet can be chosen dynamically not like previous model. The cloudlet is fixed near wireless access point. In this paper [19], the author had proposed mobile cloud computing model which is different from other previously published model in terms of scalability features. These paper experimental results have covered intended numbers of cloudlets available in covered area. The mobile device is known to acquire more power while running excessive applications. The author is motivated by the fact that optimizing power is important in MCC. In this paper [20], the author had produced mathematical model to optimize power consumption in MCC. The author in [21] had conducted experiment on mobile device by analyzing each and every component and cloudlet each component participation in total power consumption.

3 Introducing Cloudlet to Overcome Limitations of Mobile Devices

Although there are many designs proposed in mobile cloud computing, the basic design allows mobile device and network devices to connect directly by using networks which are wireless such as 3G, 4G, and LTE. Here in Fig. 2, the mobile user sends his request to the cloud. It is checked whether the sent request is valid or not. If the sent request is valid, then the request will be processed by the cloud and the result will be sent to the mobile user. As this process in mobile cloud computing has some limitations, a new technology called cloudlet model which can perform the jobs of mobile in particular range is introduced to overcome these limitations. This cloudlet model provides network remotely to the end user with less delay and higher throughput [19]. Generally, in mobile cloud computing, the users will connect to the networks like 3G, 4G, and LTE. But in cloudlet model where there are many cloudlets distributed have connection with each other through Wi-Fi. And these cloudlet levels are connected to master cloudlet. Shows in Fig. 3 the job of the master cloudlet is maintenance. This master cloudlet has the connection with cloud server.

In this proposed model, mobile user offloads tasks to the cloudlets connected to the master cloudlet through the wireless network. The master cloudlet processes the task and sends it to the end user.

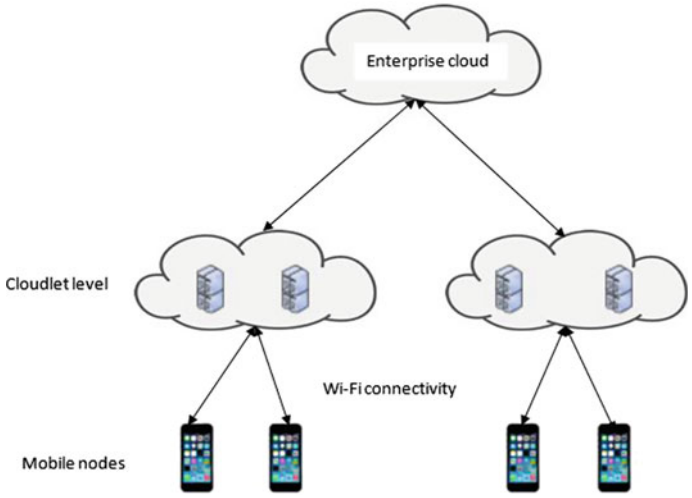

Fig. 2 Cloudlet architecture in MCC

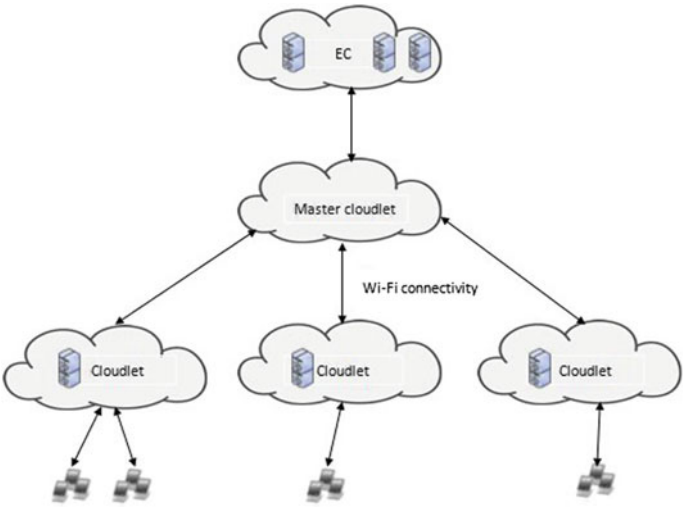

Fig. 3 Proposed cloudlet framework in MCC

4 Simulation Results

For implementing and testing our cloudlet model in mobile cloud computing, we use mobile cloud simulator (MCCSIM). In order to predict original nature of the mobile cloud environment, this tool offers to design evaluate power consuming and delay parameters. Also, it provides flexible environment to implement intended number of cloudlets dynamically through graphical user interface. We compare power consumption and delay our proposed cloudlet based on MCC model with without cloudlet in MCC. In our simulation, the no. of cloudlets is distributed evenly so that the users can access them easily. We have considered three scenarios in simulation environment which are as follows: when the mobile device directly connected to the remote cloud through 3G, (2) when the mobile device connected to remote cloudlet through master cloudlet, (3) when mobile connected to remote cloud through cloudlets which are connected to master cloudlet (Table 1; Figs. 4 and 5).

Table 1 Simulation parameters in MCCSIM

Testing time	Testing area	No. of mobile users	Mobility speed	Packet rate	Network technology	Cloudlet capacity
600 s	800 × 600 m	2000	2 m/s	0.1 Hz	3G or 4G	200

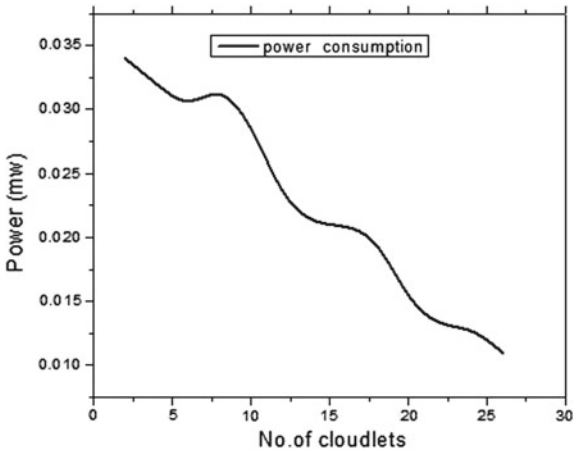

Fig. 4 Power consumption in proposed model using cloudlet in MCC

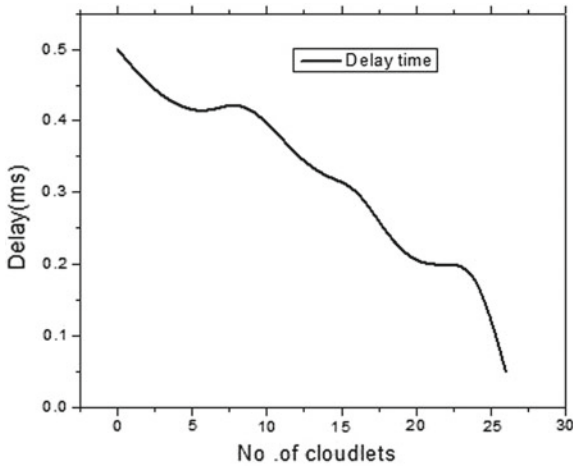

Fig. 5 Delay in proposed model using cloudlet in MCC

4.1 The Cloudlet Uses in e-Healthcare Systems

In e-healthcare systems, the cloud computing and cloudlet technologies are required. The cloudlet technology is available to analyze patient records and also process extract recommended features from patient database. In this system, we discussed the state of the art on healthcare systems in cloud computing the application growth on healthcare is growing day by day. Also, this application requires lot of computation and communication resources. The application requires access huge amount of data from organizations within and outside of the boundaries. The data pattern is typically dynamic. It only supports granularity interaction. In cloud environment [23], the future application will have to support heterogeneous platform inside (or) outside organization [24]. There is no wonder to say that the advantages of cloud

computing can be helpful for the organization including healthcare systems. The healthcare organization depends on cloud environment for processing and storage of huge amount of data. Another important challenge is risk management. The cost of maintained health data is stored in cloud because of sensitivity of health data. The cost of health maintained data and also provide privacy and security laws is gradually growing. Taking decision for storing data about healthcare and other organizations into cloud requires lot of confidence. In this paper, the author had proposed transport load and capacity sharing. The healthcare systems in smart city meet demands by adapting cloud computing. The cloud computing is beneficial because of the distribution of cloudlet across the world. The study on grid computing shared poor accessing remotely. How it useful in healthcare applications deployment is presented. Though the paper is focused on grid computing, it also suits for cloud computing technology, multiple organizations, and application scenarios for deployment of grid computing based on different classes of organization as well as various types of applications. The requirements of healthcare system are identified and analyzed based on the result of iteration in terms of throughput. This platform identifies the computational and communicational requirements of healthcare system application. This analysis is important because the network traffic connecting healthcare system is dominated by analytical applications which require zero network latencies. The individual request is not heavy in terms of data but causes heavy traffic in feature communication. The cloudlet concept can be applied on this communication and computation concept in order to analyze the performance of cloud computing healthcare application. The author had discussed adaption of cloud solutions in healthcare systems in order to make health service provider move forward and also discussed privacy, security, risk management, and workflow challenges. There are many papers in cloud computing which focus on healthcare applications including foundation for health care, impact of cloud computing on healthcare.

5 Conclusion

Mobile cloud computing is a new technology which is used in different sectors. Various architectures have been proposed from last few years. The new concept cloudlet was introduced in MCC. The mobile users send application to the nearest cloudlet, and then, the cloudlet communicates with remote cloud. The cloudlet can deal with service request and responses between mobile users and remote cloud. The cloudlet can make process faster and also reduce energy consumption in mobile device. If there is no cloudlet concept, then the mobile user directly depends upon the remote cloud which drains mobile user battery completely. This challenge is overcome by cloudlet and also energy optimization.

The proposed model deals with many applications in our daily life including education, business, e-commerce, crowd management, and e-health care system. In this paper, we have considered healthcare system as a case study. This technology provides protection for healthcare data in order to stop attackers using sensitive

data from cloud. Finally, we analyze the performance of our proposed model with non-cloudlet based on mobile cloud computing.

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