Mobile computing: issues and challenges

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MOBILE COMPUTING: ISSUES AND CHALLENGES

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Abstract*— Mobile Cloud Computing (MCC) is an emerging field. Due to the wide usage of mobile devices and variety of applications, mobile cloud computing becomes a necessary part for mobile devices, due to reliability and portability as data processing and storage take place outside of the mobile. It is useful in a sense to save battery and computation power of mobile devices which is a serious issue in high power mobile devices. Mobile cloud computing provide mobile users a service where they can use cloud services on their mobiles and perform computations. As mobile Cloud computing is still in early stage of development, it is useful to build a thorough understanding about existing models and future trends. The purpose of this survey is to analyze and point out the major challenges and risk involved in the mobile cloud computing as well as present new trends in this field.

Keywords*— Mobile cloud computing; virtualization; personal cloud

I. INTRODUCTION

Cloud computing (CC) becomes an important research area over the past few years as it allowed software to be operated on internet enabled devices. Cloud computing provide utility to the user such that they can access application around the world on demand. Cloud consists of datacenter that provide services and maintained by the providers. An organization such as Amazon, Microsoft and Google shifted their datacenter and services on the cloud around the world on different locations [1]. As usage of mobile devices is increasing day by day with increase in their computation power but at the same time there are certain issues of mobile devices like battery Power management, memory requirements and limited computation power. As in cloud computing resources are virtualized and divided over servers and a data center, MCC is inherited these properties. According to research from juniper cloud computing base mobile applications are expected to rise 88% annually from 2009 to 2014 [15].

This paper presents the cloud computing, infrastructure in cloud current research trends and issues related to MCC. The MCC consists of cloud, mobile, computing device and wireless channels, and resource providers [2]. Aim of MCC is to provide users an ease so that they can get everything on their mobile devices with reliability [3]. In its simplest form, mobile cloud computing is a structure where storage and processing of computing takes place outside mobile device; whereas, resources can be explored on the mobile. There are many cloud computing applications; some of them are discus in the paper [4].

One of the most prominent uses of mobile cloud computing is in e-commerce. MCC has impact on medical domain as well; one can easily take help from doctors siting thousands of miles away.

Cloud computing has impact on mobile banking and mobile games etc. [5] With the advent of smartphones and their support for large applications like video games, image processing and e-banking etc. Their complexity and demand of computational resources is increased. There is still certain application that demands a big computational power and phones respond very slow [6]. To solve this problem industry have to think about and change software or hardware to fulfill it requirements [7]. Hardware resources cannot be enhanced due to design issues but software can be done. Computation transformation is a technique where we can shift our computation task on the cloud. Transformation of the computation on the cloud enhances the performance of the application and solves the issue of battery consumption and allow us to run application that are unable to run on mobile devices [8].

There are many publications that point out the significance of MCC. In [15] author presents two models and presents a technique to efficiently access the resources. In [9] and [10] authors presented the challenges in the field of mobile cloud. This paper also presents the differences between cloud and mobile cloud architecture and factors affecting the MCC on the cloud. Next section present architecture; where section III presents literature review, MCC models are presented in section IV, comparison of mobile cloud models are presented in and provide pros and cons. At the end, paper is concluded with critical review and future areas and improvements.

II. MOBILE CLOUD COMPUTING ARCHITECTURE AND OFFLOADING

The main aim of cloud computing is to provide cost effective services to users. Using cloud services, small scale businesses can access resources and find more opportunities to grow. They provide ease of use to mobile users and enhance their computation power, save their battery life, provide communication channel and efficiency in completing their tasks. There are certain threats that both the technologies are facing.

In MCC latency in network, communication service issues, bandwidth latency and mobile devices battery power are major concern that needs to be solved. Cloud provides a model that provides services in the form of infrastructure as a service (IAAS), platform as a service (PAAS) and software as a service (SAAS). Figure 1 shows the architecture of MCC. In this architecture, mobile devices can gain cloud services in two ways 1). Access cloud services directly by their mobile network 2). Access cloud through access points as shown below. Using Mobile network they are connected to base stations [11] or using the satellite connection. Telecom networks are connected to the internet and provide connectivity to the users so that they can access cloud services using mobile.

Main architecture consists of mobile users, mobile operators, Internet Service Providers (ISP) and cloud providers etc. Smartphones with Wi-Fi facility communicate with the network providers with the help of base stations or satellite channels. Request sent from mobile devices are fulfilled on central servers and network providers side. Processing take place at upper level of the architecture, generally cloud.

Network provider works as a middleware and provide services to mobile users from the cloud providers.

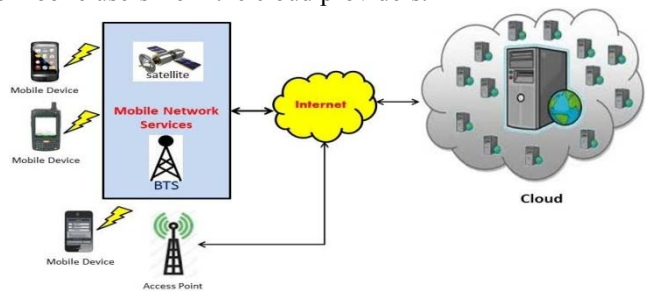

Figure 1: Mobile Cloud Computing Architecture

There are several MCC applications that are using the cloud with the help of internet directly. A more compact view of the architecture is given in figure 2.

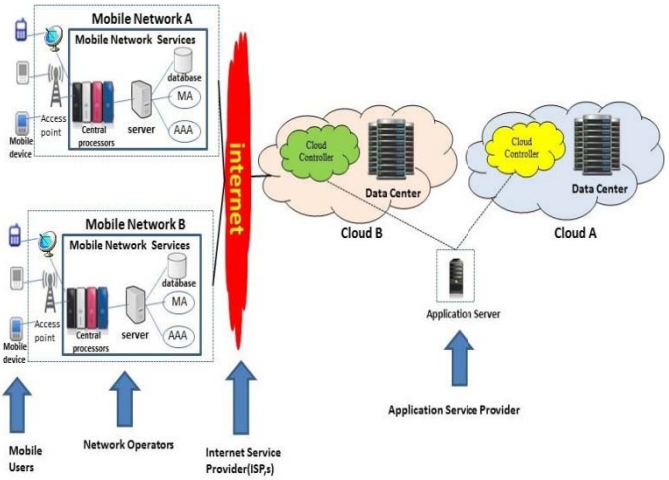

Figure 2: Detail View of Architecture

Computation Offloading is another main feature of mobile cloud. Decision making in Computation offloading on the cloud is a systematic process as shown in figure 3.

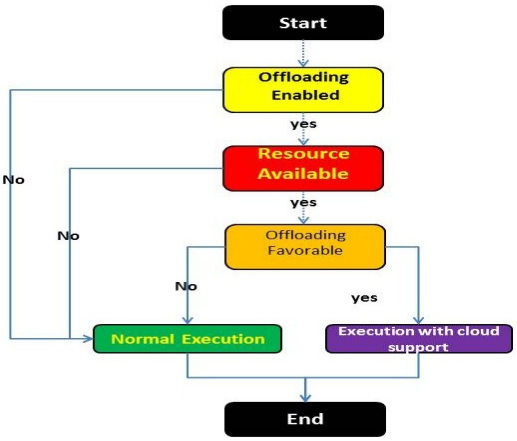

Figure 3: Offloading of Mobile Cloud Computing

At the start of the application, user permission is required. If user permits it then network connection is checked for the connection to cloud. Upon successful connection cloud resources are checked if they are available. In the next phase computation shifting is examined whether it is good idea to offload the computation based on user objectives or not. If it is feasible the transformation is performed otherwise done at local level.

III. LITERATURE REVIEW

According to surveys [15][12] there is an 18.1% increase in mobile and mobile cloud computing market over the years. The MCC provides the storage efficiency. This gives the energy efficiency and there is a less resource demand on the MCC. There are number of authors publishing their research papers in MCC field. L. Zhon and B. Wang in [13] present the role of internet in MCC. Abdullah Gani and Han Qi [14] explained the infrastructure and architecture of the MCC. They also present different challenges of the MCC. Several studies are there in which authors point out the importance of mobile cloud computing. According to a survey [12] there is a huge increase in the revenue which is generated from the mobile cloud computing and which is continuously increases in every year. According to the current "Visiongain" report, MCC market will produce $45 billion in profit up to the year 2016 [15]. MCC is used in many fields like natural language processing and image processing and also the sensor data applications, social networking, multimedia search and so many others [15]. The different characteristics of MCC are given below

1) Break through the limitations in the hardware field.
2) Easy access of the data
3) Good Balancing of Load
4) Efficient word or Task Processing
5) Remove the regional restriction

1) What actually mobile cloud computing is?

Mobile cloud computing is the infrastructure in which the processing of data and the storage of data is combined with each other. Actually mobile cloud, computing is the combination of three fields which are MCC and the other is cloud computing and the last one is wireless network computing. The below figure 4(a) explain the concept of MCC

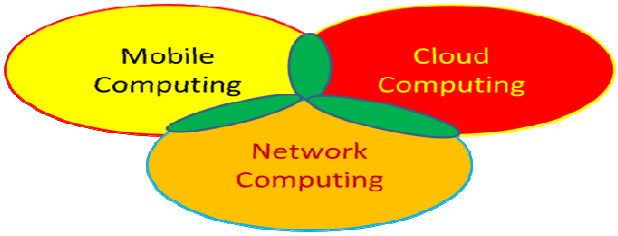

Figure 4(a): Combine Architecture Model

Different Features of Mobile Cloud Computing

Mobile cloud computing provide different facilities like scalability, mobility, flexibility, virtualization, mobile cloud service connectivity, multi-tenancy, mobile utility billing etc. The facilities are also shown in details in the given figure 4(b)

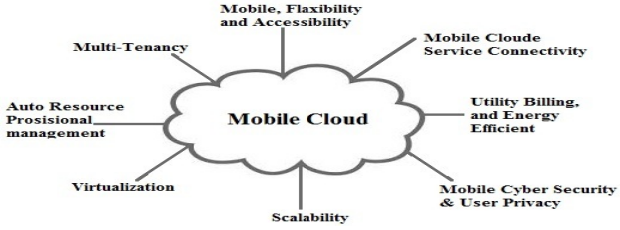

Figure 4(b): Facilities or Features of Mobile Cloud

2) Why Mobile Cloud Computing is getting Hype?

According to Gartner Group world wide mobile application store and downloads are reach to 17.7 billion downloads in the

year 2011 [25]. That is a 117 percent increase from downloads in 2010. According to a survey, this increase will reach to the 185 billion at the end of 2014 [25].

Different Motivations of MCC are, increasing battery life, processing power, Remove the limitations from the current mobile devices. Maximize and increase the resource sharing.

The different deployed models are given below

Private mobile cloud: The service provider provides the mobile cloud resources to the group of users with the help of wireless internet.

Ad-hoc mobile cloud: The services provide to the mobile users to form an ad-hoc mobile network.

Mobile community cloud: This provides the resources to its clients form many mobile social networking communities through the wireless internet.

3) Mobile Cloud Computing Research

There are a lot of research fields and subjects in the MCC. Some are given below

Engineering for MCC: Deals with the development of the MCC and applications.

Mobile Networking for MCC: This field describes the energy efficient communication and intelligent connection between the computer, devices and network.

Mobile Cloud Infrastructure: With the development of energy and cost effective mobile cloud model.

4) Generations of Mobile Cloud Computing

First Generation

First generation is based on Personal mobile cloud. Some of the advantages/features are that all the services are maintained and deployed in datacenter of the MCC. Scalability is also a very big advantage and feature of this system. Contents of mobile and application data are synchronized so this feature is related to synchronization. Mobility feature is also play a very important role in this system [16]. This figure explains the first generation of the personal mobile cloud. The complete architecture of first generation is shown in figure 5.

Figure 5: Personal Cloud infrastructures (First Generation Model)

Second Generation

Second generation is based on Cloud- Based Mobile Cloud Infrastructures. In this system, all the services are maintained and deployed in the datacenter of the MCC. One of the new and additional features of the second generation is that the On-demand service. This feature tells us that the services, contents and data are providing to the mobile cloud on the basis of demand. Second generation system also provides scalability. The complete architecture of second generation is shown in figure 6.

Figure 6: Second Generation: Mobile Cloud infrastructures

Third Generation – Services of Mobilecloud

According to the survey of the Virgin Media Business CEO, Mark Heraghty , the growth in mobile data usage has led to increase (dramatic) shifts that how mobiles are used in enterprise [17]. Third generation consist of four layers which are discussed below. The first layer is Computing cloud layer. The second layer is Network layer. The third layer is Mobile cloud layer and the fourth layer is Mobile Layer.

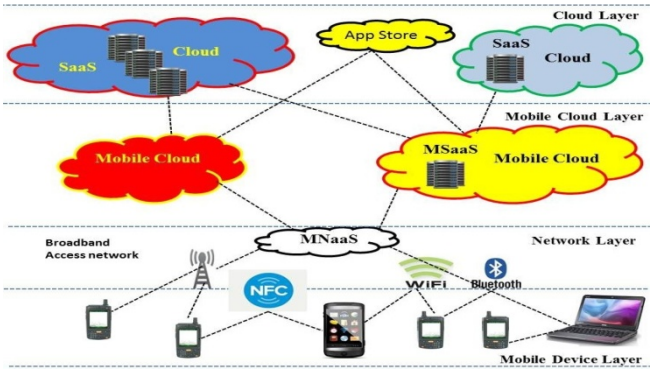

Figure 7: Third Generation: Mobile Cloud Service infrastructures

Issues and challenges of mobile cloud computing

The author in [18]presents different issues and challenges in the field of MCC and the issues are related to the different factors like end users, operations, management of data and application services and also related to the security. In this section we present different challenges and issues related to MCC. The first one is mobile cloud infrastructure. The second is privacy in MCC. The third is mobility. The fourth is green computing. And the last is mobile SaaS engineering.

In mobile cloud computing, the providers collect the personal information of the mobile users and this is equal to the gold mining and we see the long term effects. Hence we say that cloud is a silver line. At the time, the data stored in the computer hard disk or in the USB drive/device but when the computer is damage or the USB drive is lost so the data is also lost. For the permanent storage of data we use hard drives but if the hard drive is damage then the data is also loss but when we use cloud, these problems cannot occur and the data is not lost. Here we present some problems of cloud computing. The problems are mention given below.

1) The Users do not know the physical location of their data and cloud providers provide their data on demand.

2) If a problem occurs in the data, the cloud provider is responsible for that and the user do not know about the damage in the data and also the user don't know about the recovery of the data.

3) Data migration is also one of the serious problems the cloud when the user try to change the cloud provider. And the

problem is that if we change the provider then the data on previous cloud is completely clear or not so there is no guarantee for that either.

4) This is also a big issue when the cloud provider is damaged, so from where do we recover our data.

Due to these issues and problems in the cloud computing, the MCC also has these major problems which is called mobility problem. And this means that the mobile cloud computing collect the personal information from the mobile users so this information's are safe or not. So we say that the mobile cloud security and privacy problem is the major issue and problem in the mobile cloud computing.

The next major challenge faced by MCC community is the physical threats when the mobile device is lost or stolen. It is actually a physical threat to mobile device. If the user uses password or pin base security, this makes it possible that there is no body that can access the mobile device without permission.

One other major challenge in mobile cloud computing is when the Subscriber Identity Module (SIM) cards is removed from the mobile and is accessed by everyone.

Now days there are a lot of research papers publish on the mobile cloud architectures and infrastructures. Some of papers are of related to the developed the thin-client architecture for mobile. The research papers related to the thin clients are Think Air [19] and [20] and also Hyrax [21]. One is the other important area in the MCC infrastructures related to the computation offloading which is very important and describe in the research paper [22].

IV. TRENDS IN MOBILE CLOUD COMPUTING

There are different models that are designed to achieve some objective like executing large computation on cloud as local system has insufficient resources, models to achieve efficiency in energy and resources. So adopting specific model depends on objectives of the user. There are certain models that fulfill certain prospective of users and they are more useful as they considered more applications. There are four models which are as follows.

1) Performance Enhancement Model

Main objective of this model is to improve performance by using the cloud resources. Applications are offloaded on high performance cloud where computation takes less time. Here are some useful models.

a) Cloud cloning: Cloud cloning is a mechanism in which part of the application is offloaded on the cloud. It basically works on synchronization scheme.

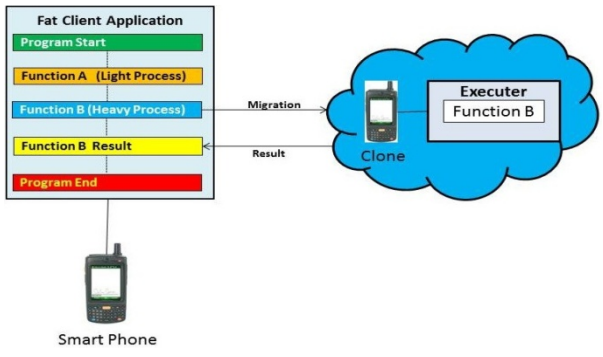

Figure 8: Cloud Cloning Model

Consistency is maintained by pointing the current clone to the unprocessed parts of application. When execution is completed, application is send back to the smartphone [23]. In this model division of application for processing is dynamic and depends on cloud resources and processing power. The detailed view of the mobile cloud cloning is shown in figure 8.

2) Energy Enhancement Model

These type of models mainly focus on minimize the energy consumption of smartphones by using cloud resource efficiently. Computation that takes time are performed using cloud by reducing overhead of applications.

a) ***(μ) Cloud***: This model takes parts of application from different sources to support reliability, portability and makes it configurable. At one time, single component is loaded on the mobile phone and execute on the cloud sometime called hybrid implementation. Components are represented as graph and edges represent their order of execution as well as dependency. Whenever a component completes execution, its output become input of the subsequent component. This process continues until components are at the end.

3) Hybrid Application Models

Hybrid models are designed to achieve multiple objectives such as performance and energy efficiency. These types of models are more suitable because multiple objectives are achieved using one model.

a) ***Think Air****:* This model support method level transformation in the smartphone into cloud. It provides quality of service by running parallel threads of clones on the smartphone. A programmer has to define resource intensive methods so that they can offload to the cloud for execution.

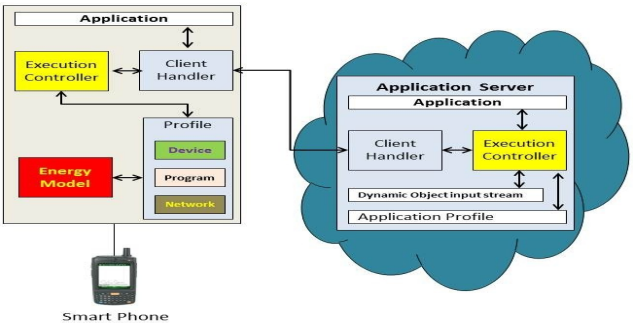

Figure 9: Think Air Model

a) Cuckoo: This is more versatile model and provides an ease of use for programming community. This is made for android platform. To develop application in cuckoo, developer must create a project and write the code. In the next step is to use existing model of android, compute intensive parts are separated and run on the cloud.

V. COMPARISON OF DIFFERENT MOBILE CLOUD MODELS

Every model contains pros and cons but one thing common in all is that they have not considered the privacy of application in the cloud. Below, in table-1, model comparisons are shown. Below table mention some requirements which are necessary to handle.

TABLE I
Model Comparison

Model	*Ba*	*S*	*Latency*	*Platform*	*Pr*	*MC*
µCloud	**Low**	**Low**	**Low**	Android	**Low**	Energy
Cuckoo	**Low**	**Low**	Medium	Android	**Low**	High
Clone Cloud	High	**Low**	**Low**	DalvikVM	**Low**	Performance
Think Air	**Low**	**Low**	**Low**	NDK(Java)	**Low**	High

Ba-Bandwidth; **Mc**-Model Category; **Pr**-Privacy; **S**-Security

VI. PROS AND CONS OF MOBILE CLOUD COMPUTING

Cloud computing provide solution for mobile cloud due to many reasons like portability, scalability and communication etc. There are many uses of mobile cloud computing. MCC provide solution to problems that were big challenges and some challenges are still under consideration. Some advantages are as follows.

1) Battery Consumption: Increasing smartphones features and heavy applications consume battery fast. Computation on the cloud saves your battery life as well as time.

***2) Memory Requirement*:** Using cloud resources to store and save applications can solve this problem. User can access the resources any time and save time and energy.

3) Privacy: Privacy is an important issue. Trusting the cloud is a problem. Encryption and decryption mechanism is used in the cloud or through communication channel. Virtual private network can be used to enable secure communication.

***4) Scalability*:** For MCC, application models development must include support for the scalability to add features and modules for application enhancement. Scalability depends on application domain and MCC model.

VI. CONCLUSION

This paper presents a survey on MCC and explains the trends and challenges in MCC. Mobile applications are evolving day by day with the increasing use of mobile phones. Mobile usage has been increased so users want to do all the functionalities on the mobile device. With the help of cloud computing new opportunities are emerging in this field and this is the hot topic in research area. Computations are increasing day by day in fields like commerce, science and technology. In the recent years MCC is focusing on enhancement of mobile limitations and make it more powerful using virtualization techniques. As discussed above, different MCC models have been presented; one thing common in all is that they are lacking privacy of the application. A security mechanism is required to ensure illegal access and protection from malicious attack. To handle this issue MCC privacy framework can be used. This mechanism provides a way to create virtual private network to monitor the user activates and authentication framework. Similarly in future, a standard should be created for mobile cloud computing and data management policies to overcome these issues to make it successful and reliable technology. This paper provides a road map for the new researchers and set some future directions in this field.

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