

A Survey on Mobile Cloud Computing

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ABSTRACT

Today, during global economic downturn, exponential growth of businesses and e-commerce deeply require better and innovative technique to reduce cost with increasing value. Now a days due to the requirement of anytime anything from anywhere, the volume of data accessibility increases, which gave birth to the cloud computing. More or less Cloud computing describes highly scalable computing resources supplied as an outer service through internet on pay-as-usability basis. Main call for Cloud computing is that users only utilize what they required and only pay for what they really use. Cloud computing is used to provide services to a local client through internet on on-demand basis.

With increasing use of mobile devices, the requirement of Cloud Computing in mobile devices arises. The emanation of Cloud Computing with Mobile web gave birth to Mobile Cloud Computing (MCC). Mobile devices do not need to have powerful configuration because all computations can be performed outside the mobile devices.

This paper gives summary of Mobile cloud computing (MCC), which includes introduction, architecture, applications and benefits of MCC. It also covers what are the issues and approaches for MCC and future research directions of Mobile Cloud Computing.

Keywords

Mobile Cloud Computing (MCC), Cloud Computing (CC), Mobile web.

1. INTRODUCTION

Today, the market of mobile phones is growing at a very high speed. Everyone has a mobile phone which provides the facility to move anywhere and access the data anytime. There are some limitations in mobile phones with respect to the desktop these are limited battery life, storage capacity, bandwidth etc. With the emergence of Cloud computing in mobile web mobile users can use infrastructure, platform, software provided by cloud providers on on-demand basis. Emergence of Cloud Computing with mobile devices gave birth to Mobile Cloud Computing.

Mobile Cloud Computing refers to an infrastructure where data processing and storage can happen outside the mobile device. Mobile device does not need to have large storage capacity and powerful CPU speed. All data processing is performed outside the mobile devices on a centralized computing platform located in clouds. According to research by the year 2011 the number of mobile subscribers in all over the world is 5.6 billion. ABI Research predicts that there will be about 1 billion end users accessing 'mobile cloud' by 2014[1]. Now company users do not need to spend a lot of money on hardware and software, they can share it on the cloud. The operating system of mobile phones does not have any impact on the application because cloud computing applications go via a browser. Besides of all these advantages there are some issues in using MCC related to the bandwidth, access schemes, security etc.

This paper is organized in many sections. Section II of this paper includes the architecture of MCC. Section III shows some applications of MCC. Section IV explains advantages of MCC. Section V describes possible issues arise in MCC and possible approaches of these. Section VI describes future research work and finally conclusion in section VII.

2. ARCHITECTURE OF MOBILE CLOUD COMPUTING

The general architecture of MCC is shown in Fig. 1 which shows the connection between mobile devices and cloud providers.

Mobile Devices: These are the mobile devices like mobile phones, PDA's etc who want MCC. These devices are connected to the network through base stations. These base stations can be Base Transceiver Station (BTS), access Point or Satellite.

Network Operator: It has Base Station through which mobile devices are connected. These Base Stations are connected to the central processors which process the mobile user's request. Mobile network operator provides service of AAA (Authentication, Authorization and Accounting) to mobile users. Now request is send to cloud through internet.

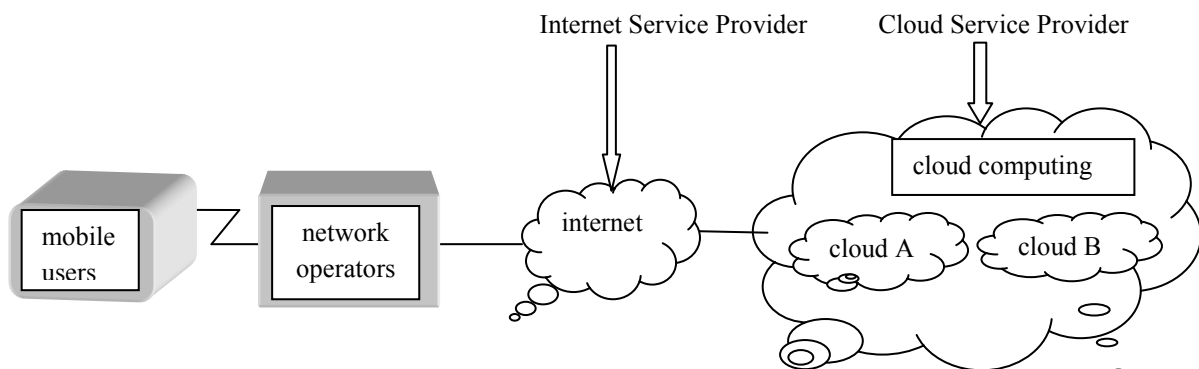


Fig 1: General architecture of MCC

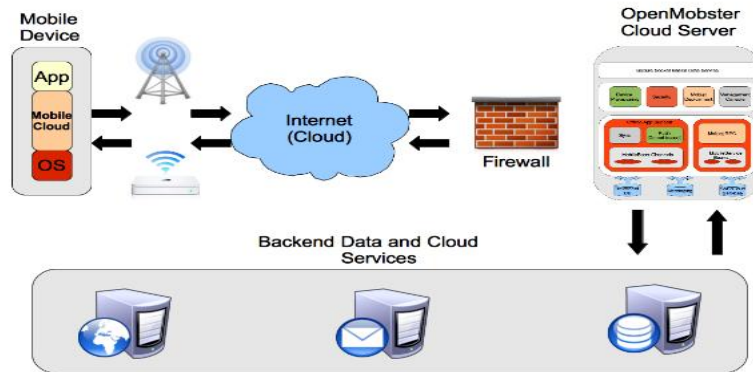


Fig 2: Architecture of openmobster[7]

Cloud Service Provider: It provides service to the user on on-demand basis. Services provided by cloud providers can be PaaS (Platform as a Service), IaaS (Infrastructure as a Service), or SaaS (Software as a Service). Here is an Open Source Project for Mobile Cloud platform called Openmobster[7]

Various services are needed by mobile clients and cloud server. This openmobster Platform provides a number of services. Some of the services provided by the platform are:

- A. Sync Platform: App's local storage stores all the cloud data so that apps can function continuously in both online as well as offline modes.
- B. Push notifications: If any app state changes, then these changes are proactively pushed to the app from cloud server using pure network/socket based approach. It does not use methods like sending sms alerts or email alerts.
- C. Location Aware apps: Components of an app are encapsulated by location specific information so that these components can combine their business data with location data for building any location apps.
- D. Simple mobile RPC (Remote Procedure Call): All services are invoked through simple RPC mechanism. RPC API mechanism is used for making calls.
- E. Management Console: It is used to administrate cloud server to provide security and account provisioning features.

3. APPLICATIONS OF MCC

Today a mobile user requires a lot of services which he can perform while moving. Use of cloud computing in mobile devices can fulfill these requirements of mobile users. Now MCC is emerging day by day, there are many areas where MCC is used. MCC can be used in performing mobile accounting, mobile payment or in mobile healthcare. It can also be used to listen music anytime from anywhere. Some of the applications of MCC are described here.

- A. Cloud email: Today all mobile users are using Gmail (a free email service provided by Google) on their mobile devices. This is a live example of MCC

because all emails of a user are stored on a server (outside the mobile phone) and all processing is performed on the cloud.

- B. Mobile commerce: Mobile commerce (m-commerce) applications can be mobile shopping, finance, accounting, advertising etc. All these require mobility like mobile transactions, payments, mobile ticketing etc. Using mobile commerce on mobile devices has to face a lot of challenges (like low network bandwidth, security etc) but the emergence of CC to mobile reduces these challenges. In [14] a 3G platform based on cloud computing is proposed which has advantages of both 3G and cloud computing.
- C. Cloud music: Providing facility of "Music Anywhere" to customers on their mobile device is an example where Mobile cloud computing is used.
- D. Mobile healthcare: The emergence of telecommunication in medical field makes the diagnosis and treatment of people easy. Now monitoring the health of patient and to provide him treatment on time is possible. This also has some issues related to physical storage, privacy of user data, security etc. But with help of cloud computing these issues are reduced now. Mobile healthcare provides various services on on-demand basis to hospitals. [2] Proposes Healthcloud, which is a prototype implementation of mobile healthcare based on cloud computing and mobile client running Android Operating System[6].
- E. Mobile gaming: MCC provides the facility of game playing on mobile devices to mobile users. Mobile gaming requires large computing resources but with help of MCC all computations are performed on clouds so mobile devices do not need to have these high computing resources (example graphic rendering). The concept of offloading is used in mobile gaming.
- F. Mobile learning: Mobile learning (m-learning) provides the facility to learn anything from anywhere. It is combination of both e-learning and mobility. M-learning also has some challenges in terms of high cost of devices and network, low storage capacity, low

network transmission rate. The use of cloud computing in m-learning has solved these challenges. Like now all data storage and processing is happened on the cloud so it provides learners a number of services at low cost, at faster processing speed on on-demand basis.

- G. Voice-based searching: User can search anything without typing it through speech recognition. [4] Introduces AT & T speech mashup model that combine web service with cloud computing environment to fulfill the speech recognition demand of users.

4. BENEFITS OF MOBILE CLOUD COMPUTING

Emergence of cloud computing with mobile web provides a lot of benefits to mobile users. Now a user can go anywhere and can use any service which is not located on his mobile device. MCC removes the problem of limited resources available on mobile devices and reduced the cost of using any application. Some of the benefits of MCC are described here.

- A. Breakthrough terminal hardware limit: One of the key benefits of MCC is that now users do not need to tether on desktop PC in their home or office. They can access all cloud based applications from any location, until they have a web browser. Mobile devices do not need to have high configurations like high speed CPU or large storage capacity.
- B. Improved battery life time: Cloud can be used for “power crunching” and then transmit the data to handset’s browsers. All computations will be take place on the clouds. An example is chess playing all computations will be performed outside the mobile device so reduces the energy. This is like using email accounts or social networks from mobile device.
- C. Improving data storage capacity: Mobile devices do not need to have a very large storage capacity. All data can be stored on the cloud and can be accessible from anywhere like A business person does not need to go to his office to collect any document from his PC, he can access it from the cloud and this document can be shared easily with others since all data is updated in real time and distributed automatically. As an example Amazon Simple Storage Service (Amazon S3) that supports file storage service for internet. It is designed to make web-scale computing easier for developers.
- D. Easy of data access: Now with MCC data accessing become very easy. Through social networking, users can easily share their videos and pictures. Mobile phone sharing service facilitates mobile users to upload images easily to the clouds immediately after capturing it. One example of using cloud in image sharing is social networking site called Facebook.
- E. On demand service to reduce cost: A mobile user does not need to install all applications before using it. User can use any application/service on on-demand basis without having it on its mobile phone through cloud providers which reduces the cost of having all applications on his device.
- F. Improving reliability: An effective way of improving reliability is to store data and running applications outside the device that is on the cloud because now each data has a backup on many computers so reduces the chance of data or application loss on mobile devices. MCC can be designed as a data security tool for service providers as well as for users.

- G. Integration of services: As different services are provided by different service providers. These all services can be integrated through cloud and internet to meet the requirements of a user.

5. ISSUES AND APPROACHES FOR MOBILE CLOUD COMPUTING

Mobile cloud computing is like marriage between two technologies named Cloud computing and mobile web. So there is an overlap between these two. As cloud is extremely powerful to perform computations while computing ability of mobile devices has a limit so many issues occur to show how to balance the differences between these two. So there are some issues in implementing cloud computing for mobile. These issues can be related to limited resources, related to network, related to security of mobile users and clouds [5]. Some issues are explained in this paper as follows:

5.1 Limited Resources

Having limited resources in mobile device make use of cloud computing in mobile devices difficult. There are 2 basic limitations related to limited resources available. These are as follows:

5.1.1 Computing power is limited

The speed of processors in mobile devices is very slow in comparison with desktop computers. To use high speed processor in mobile devices require more power consumption.

So there is a need to make the balance between processor speed and battery power. One solution of this is to perform all computations on server side but sometimes it is not feasible to do all processing on server side. Energy can be saved by offloading concept [12]. Even then there are some problems related to security, privacy and reliability.

5.1.2 Limited Battery

Limited battery power of mobile devices is a barrier for interacting via wireless network because it requires high battery consumption.

[13] Proposes a protocol to ensure storage integrity for MCC. This proposed protocol applies an incremental cryptography for dynamic data structures, it also reduces energy consumption.

5.2 Network Related Issues

All processing in MCC is performed on the network. So there are some issues related to the network like Bandwidth, latency, availability, heterogeneity.

5.2.1 Latency and Bandwidth

Latency is delay in data processing on the network. Latency is a problem in MCC because MCC depends on the network. Bandwidth also affects Mobile Cloud. Having low tower signal reception may lead to low bandwidth and high latency in the network.

Wi-Fi is an example which improves latency but it decreases bandwidth when many mobile devices are present.

Introduction of 4G will help to improve the bandwidth and latency [10].

Cloudlets may also help to improve this issue. Cloudlet is a trusted small computer or cluster of computers which can reside near the user and connected to the internet. So when user does not want to offload to cloud due to delay or cost, can use a nearby cloudlet. It downloads user data from a

centralized location to permit mobile users to local access and thus reduce latency. When work of user finished, data can go back to the centralized location. So demand of mobile users for interactive real time response by low-latency, one-hop, and high-bandwidth wireless access to the cloudlet can meet. If no cloudlet is present at that time then the mobile device may use default mode which will send all the requirements of user to the distant cloud [9].

5.2.2 Availability

Network availability is one of the issue in MCC. It requires a mobile device to always be connected with internet to use cloud computing which is not possible due to lack of mobile service coverage or internet connectivity. Wi-Fi is one solution of it to provide better and always network connectivity even then there is problem when mobile device does not have network coverage or Wi-Fi on that area. This problem of network availability is under research work.

5.3 Security

Most of mobile devices have almost same functionalities like a desktop computer. So mobile devices also have to be face a number of problems related to security and privacy. To overcome this problem threat detection services are now performed at clouds but this also has to face a lot of challenges. Some security issues are as follows:

5.3.1 Security of Mobile Devices and Users

There are so many security threats like viruses, hacking, Trojan horses in mobile devices also. The use of global positioning system (GPS) in mobile devices gives birth to the privacy issues.

- (i) Device Security: Mobile devices are very easy to be stolen in comparison with desktop computers. So there is a threat related to data confidentiality because all data is stored in the cloud somewhere unknown to user various security threats like malware, worms, hacking are possible with mobile devices. New smart phones coming in the market have special security applications to foreclose fraud usage. Android v2.2 is coming to enterprise cloud system realm which contains many required security policy [8].
- (ii) Privacy of mobile user: Now, a day's many mobile users are using Location based services (LBS). LBS have to face an issue related to privacy of user because it provides the information about current location of the user. This problem becomes very huge if information of user is leaked to any untrusted person. Location Trusted Server (LTS)[11] has addresses this issue. LTS is shown in fig.3. When a client wants to use LBS service, it will send its location to LTS. Now it is work of LTS to hide user information by 'spatial cloaking'. When cloaked region is generated, LTS forwards spatial cloaking to LBS service provider. Service provider after processing queries send back the query result to LTS which sends result to user.

5.3.2 Securing Data on Cloud

All the data of mobile user is stored on the cloud so there are some problems related to integrity, confidentiality and authentication of data. The data of user can be altered by any untrusted person so work should be done in careful manner. Various solutions have been provided for security of data on cloud and many are under research work.

6. FUTURE RESEARCH WORK

We have seen many issues related to MCC and various possible architectures to solve these issues. Still there are many issues which are possible in MCC and various research directions in development of MCC. Some issues like Mobile devices has limited storage and processing capacity so work in direction of to how efficient use of these limited resources can be performed for cloud computing can be done. Various operating systems are available for mobile devices like Android, Symbian, Chrome etc. So work related to does a general access platform for mobile cloud computing is possible on top of these various operating system platform can be done. In future the research related to security can be done as there are various security threats both inside and outside the cloud. Various architectures of MCC can be explored. Also cost policy is required to be improved with growth of MCC. Work related to access schemes can be done in future. Low bandwidth of network is a field in which new work can be performed because number of mobile and cloud users are increasing day by day. Research related to Quality of Service (QOS) can be done to provide required quality of requesting services to the users.

7. CONCLUSION

The concept of cloud computing provides a great opportunity to users to use their services on on-demand basis. The requirement of mobility in cloud computing gave birth to Mobile cloud computing. MCC provides more possibilities for access services in convenient manner. It is expected that after some years a number of mobile users will going to use cloud computing on their mobile devices. MCC is the technology for future which combines the advantages of both mobile computing and cloud computing. Mobile Cloud Computing refers to an infrastructure where data processing and storage can happen outside the mobile device. Mobile devices do not need to have powerful configurations like high speed processor or large storage space because all processing is performed on the cloud that is outside the mobile device. This paper has provided an overall summary of MCC. It discussed about what is MCC, the general architecture of MCC, an open source platform for MCC, applications and benefits of MCC. Application shows the fields where MCC can be used like in mobile learning, mobile commerce, cloud email etc. Then the issues which are possible when dealing with MCC have been discussed and approaches to solve these have been discussed. Finally future research work has been shown which shows in which directions the work in future can be done.

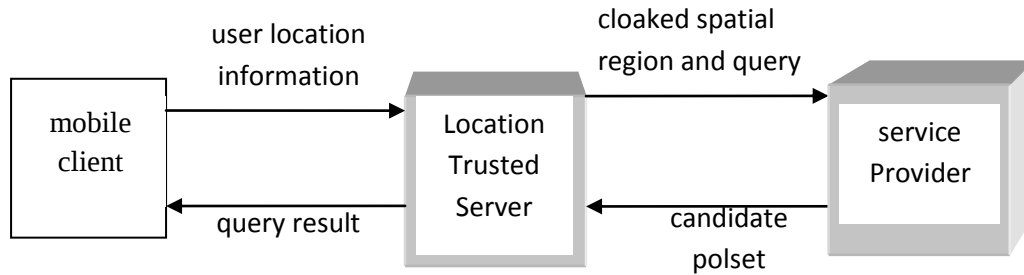


Fig 3: Overall Architecture of Spatial

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