

MOBILE CLOUD COMPUTING AS FUTURE FOR MOBILE APPLICATIONS - IMPLEMENTATION METHODS AND CHALLENGING ISSUES

Shahryar Shafique Qureshi¹, Toufee Ahmad¹, Khalid Rafique², Shuja-ul-islam³

¹ Beijing Key Laboratory of Network System and Network Culture

² School of Economic and Management Sciences

Beijing University of Posts and Telecommunications, Beijing, China.

³ Southwest Jiaotong University, Chengdu, China.

its.shahryar@gmail.com, khalidrafiquepk@gmail.com

Abstract

In recent years cloud computing has gained a momentum and is transforming the internet computing infrastructure. Also the mobile applications and mobile devices are developing rapidly. Cloud computing is anticipated to bring an innovation in mobile computing, where the mobile devices can use clouds for data processing, storage and other intensive operations. Already there are some mobile cloud applications for example Google's Map, Gmail for iPhone and Cisco's WebEx on iPad, however these applications are using the Software as a Service model. In this paper we introduce state-of-the-art Mobile Cloud Computing and its implementation methods. We also investigate some critical issues to be solved and point-out further future research directions.

Keywords: cloud computing; mobile cloud computing; mobile devices; mobile applications; security issues.

1 Introduction

The IT industry is always full of a never ending buzz, as from the very beginning since 1946 when the first computer was invented and till now the technology has revolutionized many times. Researchers foreseen at that time, mainframe computer to be the future of computing, when large scale machines and mainframe computers were used to perform different tasks and applications. Nowadays we do the same tasks but in a much cheaper and portable fashion – using desktop computer and servers tied together to create a so called Cloud Computing System. Cloud computing [1-3] is now the hottest research area in IT industry. Cloud computing provides resources and computing infrastructure on demand basis to consumers. The consumers can use applications and services on the clouds through internet. Nowadays cloud computing is not only limited to

the personal computer, it also an influence and intense impact on the mobile technology. Electronic devices like, smart phones, tablets, netbook and cloud computing resources are converging in a new rapid emerging field of Mobile Cloud Computing (MCC). The demand for the mobile applications is also increasing which require more resources to be provided to make user experience more better. In the cloud platform resources for example Google AppEngine, Amazon EC2 and Microsoft Azure can see mobile cloud computing as new paradigm for mobile applications.

Mobile cloud computing is defined as extension of cloud computing with a new ad-hoc infrastructure based on a mobile device [4]. In scenario of mobile cloud computing there are two viewpoints. One is a simple viewpoint and other is mobile device viewpoint. Simple viewpoint refers that both data storage and data processing is carried outside the mobile devices. Cloud resources are utilized for processing and storage purpose. The advantage of this concept is that mobile cloud computing applications are not constrained to a certain kind of mobile devices or operation systems. Also no need to worry for the storage capacity and computation speed limitations. While the mobile device view point refers that both data storage and data processing is done in the mobile device. The reason is that nowadays mobile devices (smart phones, tablets etc) are more intelligent and highly developed. The advantage of such viewpoint is to provide user an ownership (to store and maintain data on personal mobile device).

This section started with some introductory remarks to cloud computing and mobile cloud computing. The rest of the paper is organized as follows. Section 2 describe the concept of mobile cloud computing and provide a brief explanation that why it is needed. In section 3, two mobile cloud computing solutions i.e. general purpose mobile cloud computing and application specific

mobile cloud computing are discussed. Advantages for both solutions are also given. Section 4 highlight some potential issues in the field of mobile cloud computing. In the end concluding remarks and future research directions are given in section 5.

2 Mobile cloud computing

Mobile cloud computing was defined on 5th March 2010 entry in the Open Gardens blog as “The availability of cloud computing services in a mobile ecosystem. This incorporates many elements, including consumer, enterprise, femtocells, transcoding, end-to-end security, home gateways, and mobile broadband-enabled services” [5].

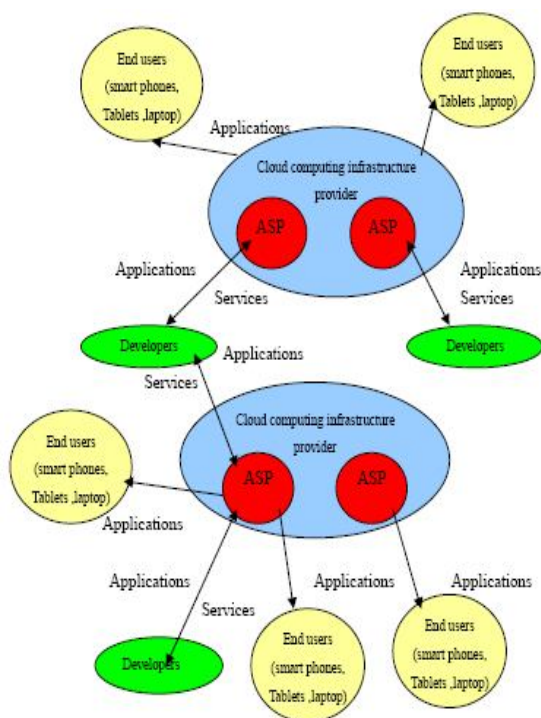


Fig 1. Mobile cloud computing constituents. Mobile cloud computing is made up of a complex network and relationships of and in between Infrastructure Providers, Application/Services Providers (ASP), End users and developers, and are connected through internet.

2.1 Why mobile cloud computing?

“Information at your finger tips anywhere at any time has been driving vision of mobile cloud computing”, so that users can have a better experience to access information and enjoy many applications in mobile cloud computing environment through mobile devices. Mobile cloud computing exploits user’s information e.g. location, context, accessed services and network intelligence. Also mobile cloud computing can be a solution to the limitations in cloud computing, such as, limited

bandwidth capacity and poor network connectivity. So to overcome this limitation a solution is to instantiate customized service software on a nearby cloudlet [6] and then to use the service over a wireless network.

For the past two decades the number of mobile users has been increased on large amount and so are the smart phones. In this modern era of technology almost all mobile devices have superior memory capacity, display, battery, network connectivity and other features, which allows the user to access various application and services on the mobile cloud.

3 Mobile cloud computing solutions

There are several methods which provide solutions for mobile cloud computing and we categorize them into two families i.e. General purpose mobile cloud computing and Application specific mobile cloud computing. Both of them have advantages and disadvantages and are not mutually exclusive.

3.1 General purpose mobile cloud computing (GPMCC)

In GPMCC a general system is constructed which uses the cloud infrastructure to help improve mobile device performance. It is important to gain the label is for a mobile device through internet in order to use specific resource or application in an on-demand manner. Many individual applications can be used to do this, but why not to use these resources in more general purpose fashion so that limited computational power of mobile devices is alleviated. So some general tasks which are locally computed on the mobile device are outsourced to the cloud as they happen. By this way computer resources of the remote computers is leveraged and no need to develop specific applications for that purpose.

3.1.1 Augmented execution for smart phones using clone clouds

Chun et.al. [7] introduce the idea of improving the performance of hardware limited smart phones by using their proposed clone cloud architecture. They created virtual clones of the smart phone execution environment in cloud (computer, laptop or servers) and transfer task execution to those virtual devices. So they off load execution from smart phone to a computational infrastructure hosting a cloud of smart phone clones. Incase the smart phone is lost or damaged the clone can be used as a backup. Another advantage is that hardware limitation of smart phone is overcome – task is transferred to high computation devices in the cloud. It also makes the developer job easy as there is no or few modifications needed to their applications.

3.2 Application specific mobile cloud computing (ASMCC)

In ASMCC specific applications are developed for mobile devices which employs cloud computing. Applications e.g. e-mail or chatting needs ASMCC because internet is used as the communication resource and not only for storage or additional computational power. ASMCC has the ability to make mobile devices a more powerful computing devices and provide use of many applications. Below are some methods for some specific applications in mobile cloud computing.

Mobile service clouds

Samimi et. al in [8] introduced service clouds for mobile cloud computing and named it Mobile service clouds. Their model enables dynamic instantiation, composition, configuration and reconfiguration of services to be used by the mobile user.

3.2.2 Elastic application weblets

Zhang et. al in [9] created elastic applications which augmented smart phones, utilizing elastic computing resources from cloud. An elastic application can have one or more weblets in it. The weblets of single application can communicate independently or with other weblets. Weblets can be exchange between mobile devices and clouds. Their approach also provides a solution for authentication, secure session management, secure migration between weblets running mobile devices and those on clouds.

3.2.3 Restful web services

Jason Christensen in [10] proposed a method for creating mobile applications using cloud computing and RESTful web services. RESTful web services are much more simpler and easy to use. The main goal is to offload computational capacity, storage and security (of mobile device) to cloud by utilizing the RESTful web services.

4 Some potential barriers and issues

As we already have mentioned in our paper that mobile cloud computing is an extended branch of cloud computing, so definitely there are some potential issues that appears to be barriers to this dynamic shift (from cloud computing to mobile cloud computing). The cloud is computationally powerful while the mobile devices have limited computational resources. So we have to balance both. We first spotlight some critical barriers:

4.1 Barriers

- Three service models are supported in cloud computing i.e. Software as a service (SaaS), Platform as a Service (PaaS) and Information as a Service (IaaS). But so far in mobile cloud computing only SaaS is implemented because mobile devices have insufficient storage capacity, battery, poor display and computing power.
- Absence of standards [11] or lack of open standards is an another barrier for mobile cloud computing and leads to problems like limited scalability, unreliable availability of service and service provider lock-in.

4.2 Potential issues

4.2.1 Resource poverty of mobile devices

One of the major issue in mobile cloud computing is limited resources in mobile devices. Generally the mobile devices have less computational power, limited storage capacity, poor display and battery constraints as compared to the personal computers. Figure 2 shows the performance comparison of mobile and fixed devices. A solution for this issue is presented in [12] by introducing offloading computation. But privacy, security, reliability and handling issues should be considered into the cost of energy. More energy is wasted in solving these problems.

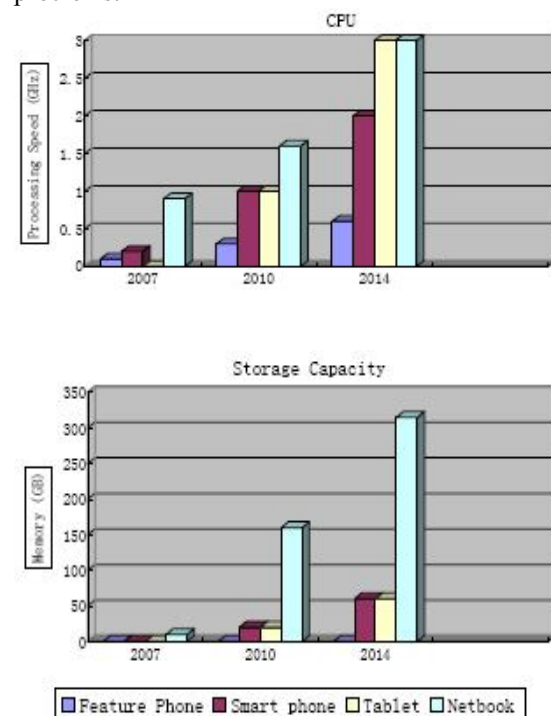


Figure 2 Shows the performance comparison of mobile and fixed devices

4.2.2 Network bandwidth and latency

Another issue in mobile cloud computing is limited bandwidth and high latency of network. Bandwidth for 3G cellular system may be limited by cell tower bandwidth in some area [5] with low power signal reception leads to lower bandwidth and higher latency. Wi-Fi is a solution improve network latency but if the number of mobile users is too much then the bandwidth is decreased. The upgradation to 4G wireless network can be a solution to the bandwidth and latency limitations. Another solution can be using Cloudlets.

4.2.3 Network availability and intermittency

Constant and speedy internet connectivity must be ensured in mobile cloud computing. The mobile device is being always connected to the cloud anywhere or anytime the user wants to be connected. New technology HTML5 has come with a solution by enabling data caching through a mobile device and this make it possible for a cloud application to continue working incase of interrupted connectivity.

4.2.4 Security concerns

The advancement in technology has also brought new security risks with in it. Everyone wants the protection of his/her data and is curious about it. In mobile cloud computing the security issue has two aspects. One is mobile device security and the other is cloud security. Mobile devices utilizes the clouds for computing resources and applications. Nowadays smart phones have built in special security features to protect them from miss usage. Google Device Policy Application [13] has the facility for users to remotely lock or clear the information of a stolen or lost mobile device. Some counter measures e.g. Cloud access protection and Embedded device identity protection can be adopted for better security of smart phones and clouds [14]

5 Future research and conclusions

In this paper we have presented a comprehensive overview of mobile cloud computing. The solutions for mobile cloud computing are discussed, so that the readers can have a better understanding of the mobile cloud computing. We also have highlighted some critical issues and problems that exist in mobile cloud computing and critic the solutions for those issues.

Mobile cloud computing is a new model and architecture which still has an opportunity for future research expansion in following areas:

- Security issues are still alarming and there should be a proper solution for it.

- The mobile cloud architecture for heterogeneous wireless network should be investigated.
- Research is required to establish a single access platform for mobile cloud computing on the top of various operating systems platforms (e.g. Andriod, Symbian, Apple iOS, Chrome, MeeGo, Windows Phone 7) [15].

Mobile cloud computing is the most emerging branch of cloud computing and a well accepted technology with fast growth. The goal is to utilize cloud computing techniques for storage and processing of data in mobile devices. Mobile cloud computing will provide benefits to the mobile device users and applications enterprises. Mobile industry has expanded swiftly and constantly. The number of mobile users ahs been increased rapidly and also smart phones and other sophisticated mobile devices are in the range of almost every individual. The internet usage and mobility concern has reached to hype, so we foresee mobile cloud computing as next big thing in IT industry.

References

- [1] M. Armbrust et al., "A view of cloud computing," *Communications of the ACM*, vol. 53, no.4, pp. 50-58, Apr. 2010.
- [2] R. Buyya et al., "Cloud computing and emerging IT platforms: Vision, hype, and reality for delivering computing as the 5th utility" *Future Generation Computer Systems*, vol. 25, no. 6, pp. 599-606, Jun. 2009.
- [3] Cloud Computing, Wikipedia. [Online]. Available:http://en.wikipedia.org/wiki/Cloud_computing
- [4] E. Marinelli, "Hyrax: cloud computing on mobile devices using MapReduce" Master thesis, Carnegie Mellon University, 2009.
- [5] P. Cox, "Mobile Cloud Computing: Devices, Trends, Issues, and the Enabling Technologies", in *IBM developerWorks*, March 2011.
- [6] M. Satyanarayanan, P. Bahl, R. Cáceres, and N. Davies, "The case for VM-based cloudlets in mobile computing," *IEEE Pervasive Computing*, vol. 8, no. 4, pp.14-23, Oct. 2009.
- [7] Chun et al., "Augmented Smartphone Applications Through Clone Cloud Execution," <http://berkeley.intel-research.net/bgchun/clonecloud-hotos09.pdf>.
- [8] Samimi et al., "Mobile Service Clouds: A Self-Managing Infrastructure for Autonomic Mobile Computing Services," *Self-Managed Networks, Systems, and Services*, 2006.
- [9] Zhang et al., "Securing elastic applications on mobile devices for cloud computing," *Proceedings of the 2009 ACM workshop on Cloud computing security*, 2009.

- [10] Christensen, "Using RESTful web-services and cloud computing to create next generation mobile applications," Conference on Object Oriented Programming Systems Languages and Applications, March 2010.
- [11] Chetan S., Gautam Kumar, K. Dinesh, Mathew K. and Abhimanyu M.A: "Cloud Computing for Mobile World".
- [12] S. Yang and C. Hsu, "An ontology-supported ubiquitous interface agent for cloud computing, "Example on Bluetooth wireless technique with Java programming", in International Conference on Machine Learning and Cybernetics, pp. 2971-2978, September 2010.
- [13] Device policy for Andriod: Overview for Users.[Online].Available:<http://www.google.com/support/mobile/bin/answer.py?hl=en&answer=190930>
- [14] Mobile cloud computing and smart phone security.[Online].Available:<http://cloudcomputingtopics.com/2011/04/mobile-cloud-computing-and-smartphone-security/>
- [15] ZTE Special Topic on mobile cloud computing and application.[Online].Available: <http://www.zte.com.cn/endata/magazine/ztecommunications/2011Year/no1/201103/P020110318511856092974.pdf>