

Understanding Mobile Cloud Computing with Upcoming Trends

Ananya Bose

Master of Computer Applications, Mumbai University

Abstract— Mobile Cloud Computing is a topic which is widely researched on and is of great importance. With the increase in use of mobile users day by day we can witness evolution in the mobile technology and its services. To efficiently deliver mobile services over the network, Mobile Cloud Computing (MCC) integrates the concept of cloud computing into the mobile environment. So we need to keep a track of the news trends in MCC. In this paper, the new trends and also the connection between MCC and android applications would be explored and analyzed.

Keywords— Mobile Cloud Computing (MCC), trends, mobile users, android apps, security

I. INTRODUCTION

Before we start to explore the trends in Mobile Cloud Computing (MCC) and also the connection between MCC and android apps we must understand what exactly is MCC. A combination of mobile computing and cloud computing is Mobile Cloud Computing (MCC). Extensive Research is being done on Mobile Cloud Computing by scientists and the industry which symbolizes its significance. To understand MCC we must first understand the concept of cloud computing. The concept where through an internet based clustered system all the required services are provided is called cloud computing. These services can be fulfilled as per demand. Resources in mobile cloud computing networks are virtualized and assigned in a group of numerous distributed computers rather than in traditional local computers or servers, and are provided to mobile devices such as smartphones, portable terminal, and so on. (see Fig. 1)[1].

The Mobile Cloud Computing Forum defines MCC as “Mobile Cloud computing at its simplest refers to an infrastructure where both the data storage and the data processing happen outside of the mobile device. Mobile cloud applications move the computing power and data storage away from mobile phones and into the cloud, bringing applications and mobile computing to not just smart phone users but a much broader range of mobile subscribers”[7].

In simple words mobile cloud computing provides the cloud services on the platform of mobile devices. It is a very interesting topic to explore with major players in this field like Google, Microsoft, Amazon and so on.

Over the past years we have seen how the enterprises are shifting on mobile cloud, how almost every part of business and utilities are present on mobile platform which the result of the great evolution and transformation the MCC has gone through over the years. MCC has not only evolved technically but also its impact on users, the consumers,

the producers has also evolved by time. This is why its becomes so important to analyze the new trends in MCC because in a way they are affecting us real time.

Practically if u see the main advantage of MCC that the end consumer can have access to more features on the phone and also it helps to save lot money in business

A. Advantages of mobile cloud computing are

1) *Flexibility* :It is flexible in terms of accessing the services from anywhere

2) *Cost Effective*:It is very cost effective both to the vendor or business persons as well as to the clients It saves time and reduces the expenditure of the hardware and software required to consume a service.

3) *Real Time Data Access*:This is very important feature as you can access real time data simultaneously easily

The challenges faced by or disadvantages of MCC are

- 1) network issues: internet connection is must
- 2) limited resources: smaller the devices the limited resources so providing efficient services is of a big concern with it
- 3) security : security of mobile cloud is of great significance and also a major concern to protect sensitive data over the internet

To analyze the major security issues of cloud computing we need to understand the concept of cloud computing and mobile computing and mobile cloud computing architecture

4) *Scalability*

The cloud service providers can expand their cloud services with less effort and modification to infrastructure. Applications and services can be easily added without any resource usage concerns



Fig. 1 Mobile Cloud Computing(MCC)[1]

II. BACKGROUND

Before studying MCC Architecture we must understand cloud computing and mobile computing and after which we can understand trends in a much better way.

A. Cloud Computing

A more formal definition that encapsulates the key benefits of cloud computing from a business perspective as well as its unique features from a technological perspective given by Sean Martson et al. in their research paper is as follows:

“It is an information technology service model where computing services (both hardware and software) are delivered on demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality-of-service levels are shared, dynamically scalable, rapidly provisioned, virtualized and released with minimal service provider interaction. Users pay for the service as an operating expense without incurring any significant initial capital expenditure, with the cloud services employing a metering system that divides the computing resource in appropriate blocks.[16]”

Cloud computing (CC) has been widely recognized as the next generation's computing infrastructure. CC offers some advantages by allowing users to use infrastructure (e.g. servers, networks, and storages), platforms (e.g. middleware services and operating systems), and software (e.g. application programs)[13] In simple words cloud computing is providing services over the network. The Fig.2 describes the advantages of cloud computing.

B. Mobile Computing

Wikipedia describes mobile computing as follows: Mobile computing involves mobile communication, mobile hardware, and mobile software. Communication issues include ad hoc and infrastructure networks as well as communication properties, protocols, data formats and concrete technologies. Hardware includes mobile devices or device components. Mobile software deals with the characteristics and requirements of mobile applications.



Fig.2 advantages of cloud computing

III. MCC MODELS

A. Service Models of MCC

1) *Infrastructure as a Service (IaaS)*: involves outsourcing the equipment used to support operations, including storage, hardware, servers and networking components[15].

Virtualization is extensively used in IaaS cloud in order to integrate or decompose physical resources. Clients are able to deploy and run arbitrary software, which can include operating systems and applications. The client does not manage or control the underlying cloud infrastructure but has control over the operating systems; storage, deployed applications and possibility limited control of selected networking components (e.g. host firewalls)[2]. Examples of IaaS include Amazon Elastic Compute Cloud (EC2), Joyent, Rackspace, and IBM Computing on Demand[10].

2) *Platform as a Service (PaaS)*: PaaS is a development h allows client to develop cloud services and applications directly on the PaaS cloud. PaaS offers a development platform that hosts both completed and in-progress cloud applications. An example of PaaS is Google AppEngine[2].

3) *Software as a Service (SaaS)*: Client releases their application on a hosting environment which can be accessed through network from various clients by application users. The client does not manage or control the underlying cloud infrastructure with the possible exception of limited user-specific application configuration settings. Google Apps and Microsoft Office 365 are the examples for SaaS[2].

The figure Fig.3 describes us the delivery models of MCC

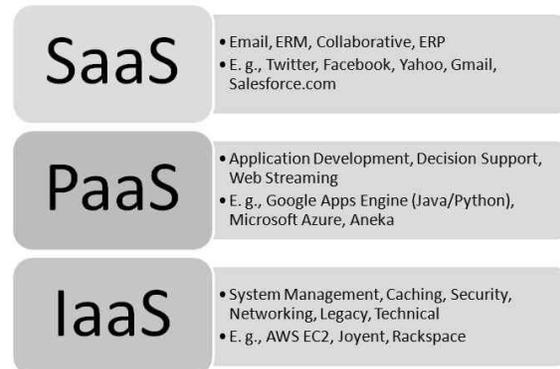


Fig.3 Service cloud models

A. Cloud Deployment Models

There are main three different deployment models and each model has its own benefits and cons as in [11]. Apart from these there is also community cloud which is rarely used. Figure Fig.4 depicts all these deployment models

1) *Private cloud*: This cloud is setup specifically for an organization within its own data center. The organizations manage all the cloud resources which are owned by them. The private cloud offers more security as compared to other two.

2) *Public cloud*: This cloud is available to all the external users through internet who can register with cloud and can use cloud resources on a pay-per-use model. This cloud is not secure like private cloud because it is accessible to the internet users.

3) *Hybrid cloud*: This is a type of private cloud which uses the resources of one or more public clouds. It is a mix of both private and public cloud.

4) *Community Cloud*: Several organizations jointly construct and share the same cloud infrastructure as well as policies, requirements, values and concerns. The cloud community forms into a degree of economic scalability and democratic equilibrium. The cloud infrastructure could be hosted by a third-party vendor or within one of the organization in the community[2].

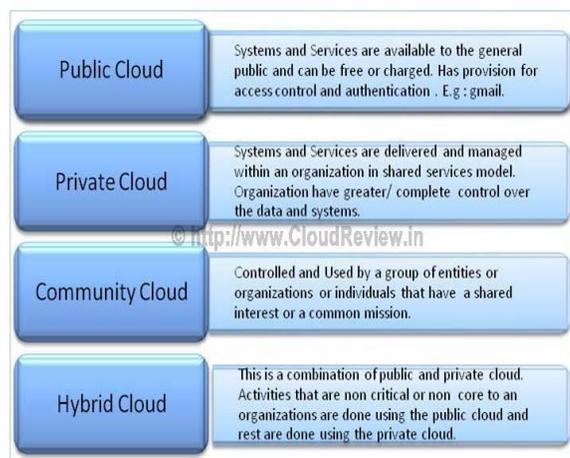


Fig.4 Cloud Delivery Models

IV. MCC ARCHITECTURE

The below figure Fig.5 describes the general architecture of MCC as by [4]. The figure shows that there are two different mobile networks A and B. Each mobile network consists of different mobile user devices which are connected to it through wireless access point, BTS or satellite. Different network services like database, Home Agent (HA), Authentication, Authorization and Accounting (AAA) is running on the servers available in the mobile network. The user’s request (credentials) is processed by the central processors who are directly connected with the servers.

Current cloud computing providers typically allow customers to rent computation and storage such that customers can start instances of their cloud applications as VMs within the provider’s cloud of servers.

Cloud providers may provide additional services, such as backup and traffic accounting, to ease the process of managing VM instances.[5]

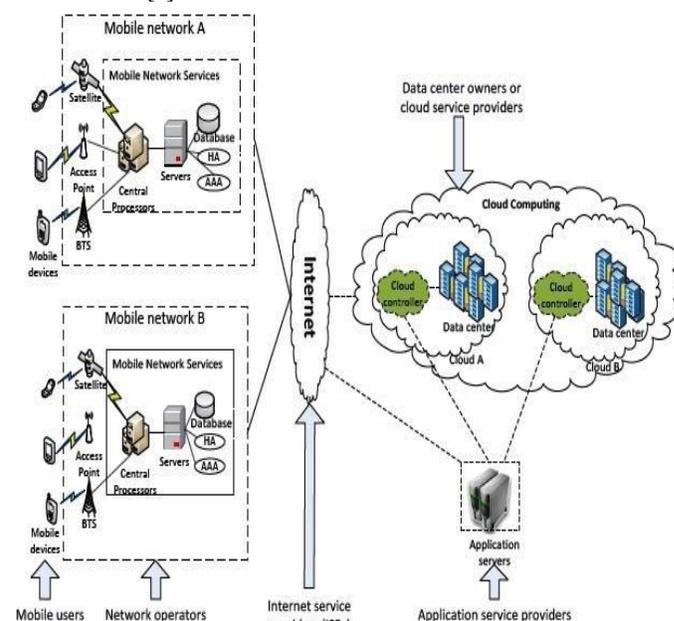


Fig.5 Components of MCC Architecture

The below figure Fig.6 includes components of MCC architecture which are required for providing and consuming services.

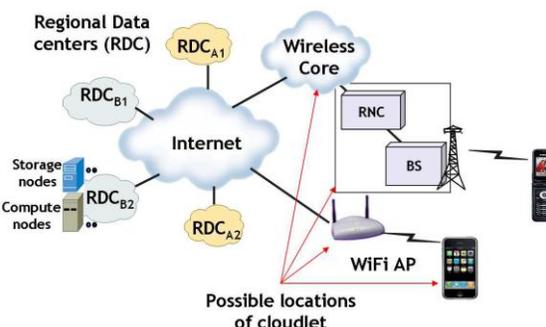


Fig.6 Components of MCC Architecture

V. CHALLENGES

Cloud Mobile Media (CMM) applications, unlike other cloud applications, will need to overcome the challenges of the wireless network, including limited bandwidth and impact on user experience. Moreover, many of the CMM applications will be very compute and network bandwidth intensive, and hence will have major implications on cloud and network costs incurred per user, and the ability to scale to millions of users as mobile cloud computing becomes popular[6] Hence, there is a complex set of challenges for MCC ,

some of these challenges such as seamless connectivity, vendor lock-in, and security and privacy are common with mobile computing and cloud computing[2]

The other challenges faced by MCC are:

1) Performance

The major issue in performance can be for transaction oriented services. Also, users who are at a long distance from cloud providers may experience high latency and delays.

2) Mobility Management

Accessing heterogeneous networks can be a challenge. Integration and interoperation of converged heterogeneous networks in MCC demand lightweight, resource and cost-effective, sustainable, and user-friendly approaches with optimized performance to address seamless mobility. Realizing such vital need with least signal traffic and latency can significantly enrich quality of cloud-mobile user experience.[2]

3) Reliability

Cloud computing still does not always offer round the clock reliability. There were cases where cloud computing services suffered few hours' outages. In the present and future days to expect more cloud computing providers, richer services, established standards and best practices.[7]

4) Elasticity

Cloud providers confront situations in which there are more demands than available resources. Adverse impact of cloud-resource unavailability and service interruption for MCC clients is more severe than stationary clients connected to the wall power and fixed network. Several challenging tasks need to be realized since service unavailability and interruption prolong execution time, increase monitoring overhead, and deplete smartphones local resources, especially battery.

5) Security

Most of mobile devices have almost same functionalities like a desktop computer. So mobile devices also have to face a number of problems related to security and privacy. 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.[8]

6) Bandwidth Costs

Cloud computing, companies incur higher network bandwidth charges even though they are saving money on hardware and software. Bandwidth cost may be low for smaller Internet-based applications, which are not data intensive, but could significantly grow for data-intensive applications[7].

7) Control

IT departments are concerned with the issue as to who has the control over the cloud as it is accessible to all. Cloud computing providers do not

8) Inherent Challenges of Wireless Network

Wireless network is base for carrying out cloud computing and it has its own intrinsic nature and constraints. These challenges complicate its

design for mobile devices even more in comparison to the fixed cloud computing [17]

9) Resource poverty of Mobile Devices

Mobile when compared to a fixed device, in general mobile devices have 3 times less processing power, 8 times less memory, 5 times less storage capacity, 10 times less network bandwidth[17].

10) Heterogeneity

There are types of networks which are used simultaneously in mobile environment such as WCDMA, GPRS, WiMAX, CDMA2000, and WLAN. As a result, handling like heterogeneous network connectivity becomes very hard while satisfying mobile cloud computing requirements such as connectivity which is always on, on-demand scalable connectivity, and the energy efficiency of mobile devices. This problem can be solved

VI. SECURITY IN MOBILE CLOUD COMPUTING

One of the key aspects of MCC is security so as discussed earlier it is also one of the important challenges of MCC. The following figure Fig.7 describes the security architecture of MCC. As discussed earlier MCC is an integration of mobile computing and cloud computing so the issues are divided as user security issues and cloud security issues. Following are the issues in Security of Cloud Computing.

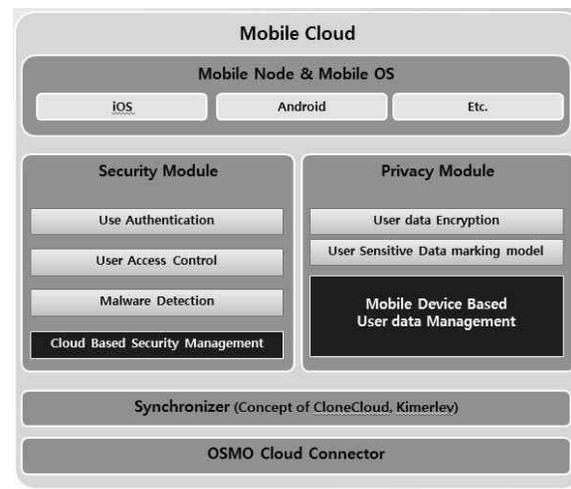


Fig.7 Security Architecture of MCC[10]

A. Privacy and Confidentiality

Once the client uses the cloud services and stores client's data to the cloud there should be some guarantee that access to that data will only be limited to the authorized access. Inappropriate access to customer sensitive data by cloud personnel is another risk that can pose potential threat to cloud data. Assurances should be provided to the clients and proper practices and privacy policies and procedures should be in place to assure the cloud users of the data safety.[9]

B. Availability of data

Since data is available on cloud leaking of sensitive data is a threat to the security of MCC. The other concerns with data are[4]:

1. Data theft risk
2. Privacy of data belongs to customers
3. Violation of privacy rights
4. Loss of physical security
5. Handling of encryption and decryption keys
6. Security and auditing issues of virtual machines
7. Lack of standard to ensure data integrity
8. Services incompatibility because of different vendors involvement

C. Data Ownership

With cloud computing it becomes possible to store purchased media files, such as audio, video or e-books remotely rather than locally. This can lead concerns regarding the true ownership of the data. If a user purchases media using a given service and the media itself is stored remotely there is a risk of losing access to the purchased media. The service used could go out of business, for example, or could deny access to the user for some other reason.[12]

D. Security issues in MCC service models

Following are the security models described in[11]

1)IaaS model security issues:

1. Virtual Machine Security
2. Virtual Machines images repository security
3. Virtual network security

2)PaaS model security issues:

1. Structured Query Language related
2. Application Programming Interface Security

3)SaaS model security issues:

1. Data Security Management
2. Web Application Vulnerability and Scanning

E.Malicious Attacks

Mobile Cloud applications are no exceptions to be attacked by viruses or security threats. All networks are susceptible to one or more malicious attacks since mobile cloud services use networks to provide its services. As more as external Web sites are being accessed malicious actors will have more opportunities to access the network and operational data of that organization)

VII.TRENDS IN MCC

We have now got an overview of what is MCC and its architecture so now let us discuss the latest trends which are upcoming and also been recently implemented.

1) Security

The most important trend which everyone should be interested in is security of MCC. The latest example of security would be encryption of messages on WHATS APP. Everyone in the mobile industry is trying its best to provide the best security to data of the users on mobile

platform. Similarly many improvements are coming up in 2016 for generation of cloud environment.

2) Increase of Business on Mobile

As we all know e-commerce is shifting on mobile and has lot of improvements day by day. We are seeing new trends in business which are through mobile apps which is evolving day by day and would go to a next level in the upcoming years. Many mobile apps such as Amazon, Myntra, BookMyshow and so on are example of it

3) Enterprise Mobile Management

Enterprise Mobile Management(EMM) will consist of management of mobile devices. EMM would be in lot of demand soon

4) Mobile Cloud Content Management

With more and more data over the cloud and important task would be manage its content so that what content should be shown to app users would be of great concern and necessary to keep a tab of.

VIII. ANDROID AND MCC

Wikipedia defines Android as a mobile operating system (OS) currently developed by Google, based on the Linux kernel and designed primarily for touchscreen mobile devices such as smartphones and tablets[21]

Now a question would arise why cloud is required for android in simple words the infrastructure of android is taken care by the cloud services itself unlike in the traditional android where infrastructure has to be taken care at the backend. As explained in the figure Fig.8 and Fig.9

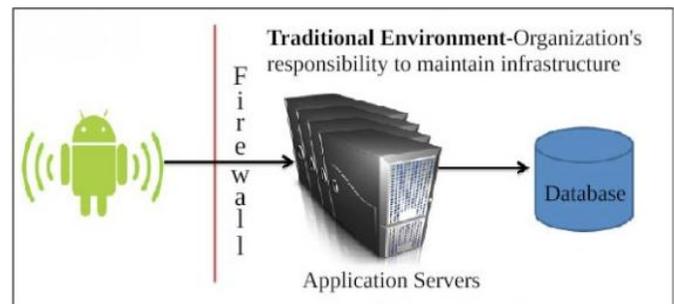


Fig.8 Android in Traditional environment [20]

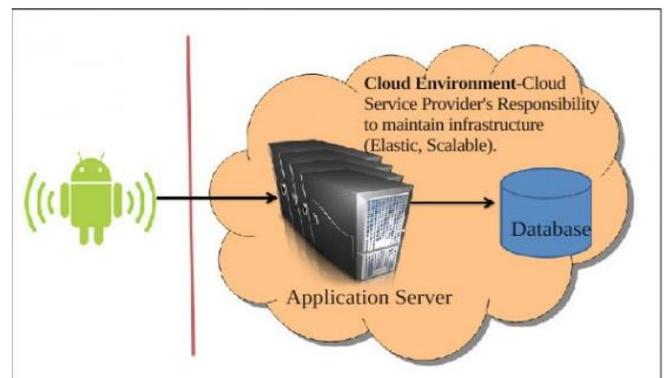


Fig.9 Android in cloud environment [20]

VIII MCC RESEARCH ISSUES

Some Open issues discussed in [1] are:

A. Data delivery

Due to the feature of resource-constraints, mobile devices have potential challenges in cloud accessing, consistent accessing, data transmission, and so on. Such challenges can be solved using: special application (service) and middle-ware (provide a platform for all mobile cloud computing systems).

B. Task division

Researchers divide tasks (applications) from mobile devices into multiple sub-tasks and deliver some of them to run in cloud, which is a good solution to the resource limited mobile devices. However, we do not have an optimal strategy or algorithm on how to divide these tasks, which one should be processed by cloud and which one by devices.

C. Better service

The original purpose of mobile cloud computing is providing PC-liked services to mobile terminals. However, as the existing different features between mobile devices and PCs, we cannot directly transplant the services from PCs' platform to mobile devices. Therefore, further research should try to identify the method on how to provide suitable and friendly interactive services for mobile devices.

D.To develop efficient cloudlet design with minimum cloudlet installation cost and more computing power and less network latency

E.To provide software libraries with clearly defined API support for mobile cloud application developer.

F.To design platform independent security algorithm

G.To reduce the cost of security framework by removing trusted party agent between cloud and client

IX .APPLICATIONS OF MCC

The various applications of Mobile Cloud Computing(MCC) are[11]

A. Mobile Commerce

Mobile commerce (m-commerce) is a business model for commerce using mobile devices. The m-commerce applications generally fulfil some tasks that require mobility (e.g., mobile transactions and payments, mobile messaging, and mobile ticketing).

B. Mobile Learning

The hybrid of electronic learning and mobility gave birth to mobile learning (m-learning). However, issues like high price of mobile

devices and bandwidth, low network transmission rate and lack of electronic educational resources are proving to be main obstacle in the way of m-learning. But the cloud provides large storage and high processing capabilities, which introduce the idea of cloud based m-learning and eliminate the barriers of m-learning.

C. Mobile Healthcare

The mobile medical applications have so many limitations like, small storage capacity, privacy and security of data etc. However, MCC eliminates the issues of traditional medical applications used for medical treatment. Therefore, the m-healthcare helps the mobile users to access medical resources in efficient way because of the availability of on-demand services on the cloud.

D. Mobile Gaming

Mobile gaming (m-gaming) is one the most popular service for the cloud service providers in terms of revenue generation. Usually, all the mobile games require high computing resources like, graphic rendering. However, in the cloud the m-game can off-load game engine which requires graphic rendering to the cloud server. This way, mobile users can only interact with the screen displays on their devices while all other computation is being performed at the cloud servers.

X.CONCLUSION

Overall we can conclude that even with so many challenges for MCC is functioning is not hampered. Everyday researches are being made to invent new solutions for mobile cloud computing so as to know its potential to the extent to which we can explore. Also with the trends which are implemented and coming up would bring the user with a wonderful experience and also allow business to expand which would lead them to gain profit. With this type of competition to explore MCC trends we gain a lot in technology as well as in terms of mobile user.

ACKNOWLEDGMENT

This paper is part of academic research on Mobile Cloud Computing made in partial fulfilment of the course of Masters in Computer Applications.

REFERENCES

- 1] <http://arxiv.org/ftp/arxiv/papers/1206/1206.1118.pdf>
- 2] <http://www.ijrsret.org/pdf/120797.pdf>
- 3] <https://techzine.alcatel-lucent.com/mobile-cloud-computing-challenges>
- 4] http://www.sersc.org/journals/IJGDC/vol6_no6/4.pdf
- 5] http://www.cs.columbia.edu/~lierranli/coms6998-7Spring2014/papers/mcloud_mcs2012.pdf
- 6] http://www.academia.edu/3175838/A_Survey_on_Mobile_Cloud_Computing_Concept_Applications_and_Challenges

- 7] <https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&cad=rja&uact=8&ved=0ahUKEwiVo-egmtLKAhXRc44KHU7oAysQFgg7MAQ&url=http%3A%2F%2Fwww.iiste.org%2FJournals%2Findex.php%2FJIEA%2Farticle%2Fdownload%2F2571%2F2587&usq=AFQjCNENvOif1s6R0zz3mMP7u81O9Y9ntw&sig2=2N72xjJaqp4En2l4bk0eUA&bvm=bv.113034660,d.c2E>
- 8] <http://www.ijcsit.com/docs/Volume%205/vol5issue05/ijcsit20140505137.pdf>
- 9] http://ijsk.org/uploads/3/1/1/7/3117743/2_mobile_cloud_computing.pdf
- 10] http://www.sersc.org/journals/JSE/vol9_no2_2012/2.pdf
- 11] http://www.sersc.org/journals/IJGDC/vol6_no6/4.pdf
- 12] <http://www.cse.wustl.edu/~jain/cse574-10/ftp/cloud/index.html>
- 13] <http://www.ijcsit.com/docs/Volume%205/vol5issue05/ijcsit20140505137.pdf>
- 14] https://en.wikipedia.org/wiki/Mobile_computing
- 15] <http://searchcloudcomputing.techtarget.com/definition/SPI-model>
- 16] http://www.ijareeie.com/upload/september/4_Mobile%20Cloud%20Computing.pdf
- 17] <http://www.ijsrp.org/research-paper-0812/ijsrp-p0865.pdf>
- 18] https://www.academia.edu/7193691/Mobile_Cloud_Computing_Issues_from_a_Security_Perspective
- 19] <http://www.slideshare.net/prasaugus/prassanna-session-i>
- 20] <http://opensourceforu.ifytimes.com/2014/02/connect-cloud-computing-android-apps/>
- 21] [https://en.wikipedia.org/wiki/Android_\(operating_system\)](https://en.wikipedia.org/wiki/Android_(operating_system))