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Data Synchronization between Mobile and Cloud

Sumandeep Kaur*, Sugandha Sharma
Dept. of Computer Sciences & Engineering
Chandigarh University, Gharuan
Mohali (Punjab), India

Mayank Arora
Dept. of Computer Sciences & Engg.
CCET, Panjab University
Chandigarh, India

Abstract-This article shows a review of the Mobile Cloud Computing, determining the meaning of Cloud computing and Mobile Cloud Computing. In this paper, the focus has been made on enhancing the capabilities of smartphones by using Cloud computing and virtualization techniques to shift the workload from merely a smartphone to a resource rich computational Cloud environment. It is proposed to make the synchronisation process more aware of the user's requirements and priorities as well as the best synchronisation environment in order to make the offloading process more efficient.

Keywords - Cloud computing, Mobile cloud computing, Offloading, Synchronization etc.

I. INTRODUCTION

Cloud Computing is used to provide computing services on the demand of user. The usage of cloud computing is increasing day by day. Cloud Computing means how to store information and run applications on mobile devices. With increasing use of mobile devices, the requirement of Cloud Computing in mobile devices arises. It provides users to access resources through Internet from anywhere [1].
Many companies have adopted cloud technology either for themselves or providing services to the general public. Some examples as of 2010 include the following:

• **Google** -Google has a public cloud that is used for delivering many different services to its users. An application service such as email access, maps, and goggle docs is provided. Hardware is provided using Google Drive. Platform is provided via Google App Engine.
• **Microsoft** -Microsoft has Microsoft SharePoint online service that allows for content and business intelligence tools to be moved into the cloud, and Microsoft currently makes its office applications available in a cloud through office 360.
• **Salesforce.com** –It provide a rich set of application running on its cloud servers for the developer and the general public. They provide software as a service

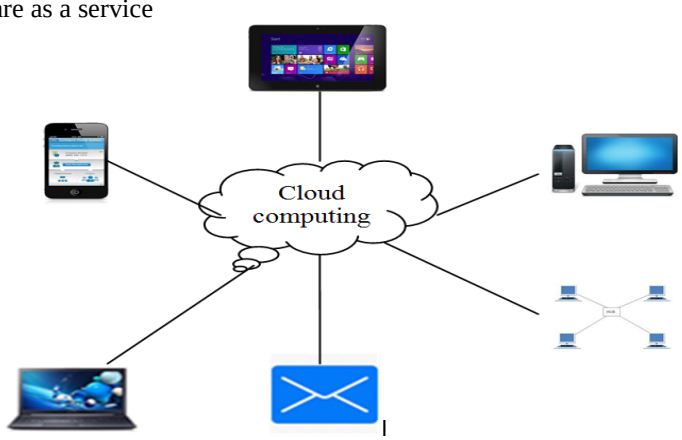


Fig 1- Cloud computing[3]

Cloud computing is typically classified in two ways[5]-

1. **Location of the cloud computing**
2. **Type of service offered**

1. Location of cloud computing-

Cloud computing can be classified in following ways:

A) Private Cloud:-Private Cloud is Cloud infrastructure which is accessible in single organization or single company. example - like IBM company has its own cloud only IBM company employee can use service of cloud.
B) Public Cloud:-This Cloud infrastructure is openly accessible by different people .This cloud can be used, managed, and operated by a business, academic, commercial or government organization, or some combination of them[2].

C) Hybrid Cloud:- Hybrid cloud is a composition of two or more clouds (private, community or public) that remain separate entities but are bound together, offering the benefits of multiple deployment models [3].

D) Community Cloud:-Community clouds are formed to share similar computing resources. Usually such clouds are managed. These clouds cater the demands of a specific community such as medical research, machine designing etc [3].

2. Type of service offered-

Based upon the service offered cloud computing are classified into following ways-

A) IaaS: - IaaS refers to the Cloud service model that provides on-demand infrastructure services like hardware to the customers [4].

B) PaaS: - PaaS model provides a complete platform to the users comprising of hardware and software to test, develop or host their applications. It is a combination of hardware and software.

C) SaaS: - In this model, the Cloud hosts provide software as a service to the user . If any user want to purchase any software then cloud host provide those service . If user wants to purchase a software then this model can provide those service to user on demand and he will be charged according to pay per use model [5].

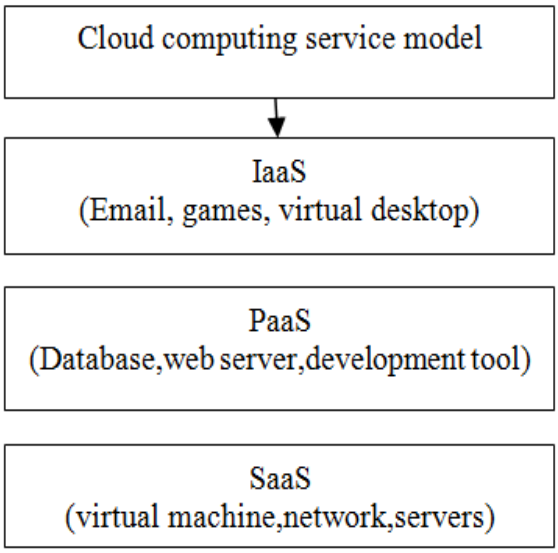


Fig 2. Service Models[4]

Cloud technologies –There are certain technologies that are working behind the cloud computing platforms making cloud computing flexible, reliable and usable. These technologies are listed below-

1. Virtualization- Virtualization introduces a layer between Hardware and operating system [6]. The machine on which the virtual machine is created is called host machine**.** This virtual machine which is managed by a software or firmware, also called hypervisor.

2. Grid computing -It refers to distributed computing in which a group of computers from multiple locations are connected with each other to achieve common goal. These computer resources are heterogeneous and geographically isolated**.**

3. Utility computing - Utility Computing defines a "pay-per-use" model for using computing services [6]. All computing like Cloud computing, grid computing, and managed IT services are based on the concept of utility computing**.**

4. Autonomic computing- The increasing complexity of computing systems has encouraged research on autonomic computing, which seeks to improve systems by decreasing human involvement in their operation. In other words, systems should manage themselves, under high level guidance of humans.The automatic system has four properties is self-healing, self-configured, self-protected and self-managed.

II. MOBILE CLOUD COMPUTING

The term mobile cloud is generally referred to in two perspectives: (a) infrastructure based, and (b) ad-hoc mobile cloud. In infrastructure based mobile cloud, the hardware infrastructure remains same and the services or resources are provided to the mobile users. Alternatively, ad-hoc mobile cloud refers to a group of mobile devices collaborating to form a cloud in order to provide access to local or Internet based cloud services to other mobile devices [7].

Mobile cloud computing is combination of following three technologies like that is the combination of mobile computing, mobile internet and cloud computing. Applications in different areas like business, news, games, entertainment etc are being run on mobile devices now a day.

Every day the new application getting heavier. Mobile cloud computing is to share resources, transport data of computers or other intelligent terminal equipment such as smart phones and providing other services to the mobile user[8].

System architecture of mobile cloud computing-

The client end of mobile cloud computing is rapidly changed, but the basic concept is still cloud computing. The cloud end server offers large amount of storage and service while the wireless user obtain service.

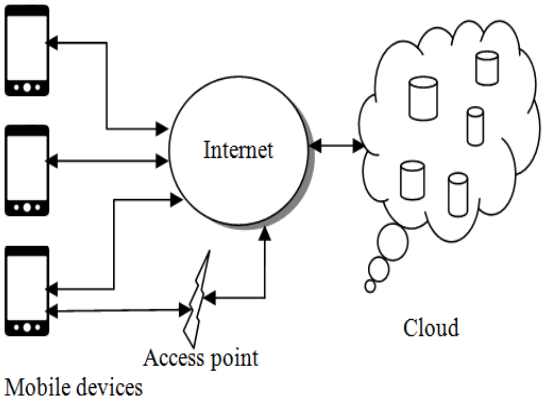


Fig 3. Mobile cloud architecture [9]

In the current mobile cloud architecture, mobile devices user can access cloud services in two ways, i.e., through mobile network (telecom network) or through access points, as shown in Figure .

In the mobile network case, the mobile devices such as smartphones are connected to a mobile network through a Base Station (BS). However, if the smartphones are not equipped with a satellite communication module, then external satellite communication devices are used. The telecom networks are further connected to the Internet and provide Internet connectivity to the users. Therefore, if the users have mobile network connectivity, the users can access cloud based services through the Internet.

In the access point case, the mobile users connect to the access points through Wi-Fi that is further connected to the Internet service provider. It is used to provide Internet connectivity to the users. Therefore, the mobile cloud users can access cloud based services without utilizing telecom services, which may rent for them for data traffic. Moreover, Wi-Fi based connections provide low latency and consume less energy compared to 3G connections. Consequently, mobile cloud users prefer to use Wi-Fi Internet connections whenever accessible [9].

Characteristics of mobile cloud computing-

a) Convenience of sharing data- Mobile cloud computing could store huge amount of data on servers. The cloud storage method increases the capability of sharing data and ensures reliability.

b) Effectiveness of task processing- The mobile devices will be used as an interface for input, output and actual task processing will be done at heavy backend cloud servers

c) Elimination of regionality- Mobile cloud computing eliminate the regionality for accessing the data. The client can access anything at any place and at any time.

d) Hardware of handheld equipment and independence of the system- All the computation are carried on in the cloud-far end servers, therefore, mobile cloud computing does not have requirement for handheld equipment, even unintelligent cell phones can realize mobile cloud computing[7].

Application of mobile cloud computing-

The applications based on mobile cloud computing is used everywhere. Various mobile applications have taken the advantages of MCC. Some typical MCC applications are introduced.

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 store on a server (outside the mobile phone) and all processing is performed on the cloud.

B. Cloud entertainment: Providing facility of "Music/vedio Anywhere" to customers on their mobile device is an example where Mobile cloud computing is used. You tube for mobile is an example.

C. 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.

D. **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 All data storage and processing is happening on the cloud so it provides learners a number of services at low cost, at faster processing speed on on-demand basis [10].

Issues	Cloud computing	Mobile cloud computing
Mobility	X	✓
Bandwidth	X	✓
Security	✓	✓
Location awareness	X	✓
Device energy	X	✓

Cloud and mobile cloud comparison [8]

III. OFFLOADING IN ANDRIOD SMARTPHONE

Smartphones have become more and more intelligent and powerful. Many complex applications, which used to be only on PCs, have been developed and running on smartphones. However, they also greatly increase the workload on smartphones and introduce a lot of data transmissions overheads between smartphones and telecom networks. The heavy workload and traffic affect both smartphone users. For users, heavy workload and traffic drain smartphone battery quickly [11] Smartphones are becoming increasingly popular. They have evolved into small and portable personal computers that allow users to browse the Internet, send e-mails or connect to a remote desktop [12].

In this section we presents offloading .We divide the components of an offloading system in two planes: components on the client – the mobile device – and components in the environment – either a cloud, a cloudlet, a peer device, or a hybrid environment. Many of the current research efforts focus on thoroughly understanding the application to be offloaded [13]. These new applications could be very resource exhaustive and the phones have a limited memory, computational power and battery life. That's why it makes good sense to offload the heavy applications to the Virtual Smartphone running on the cloud, thus saving the actual phone's precious resources.[14].There are two type of offloading-

1. Partial offloading: Conceptually when an application could be offloaded in parts i.e. only the compute intensive part of the application is offloaded then it is known as Partial Offloading.

2. Complete offloading: In this offloading method complete application is offloaded to the cloud to save the battery life of smartphone.

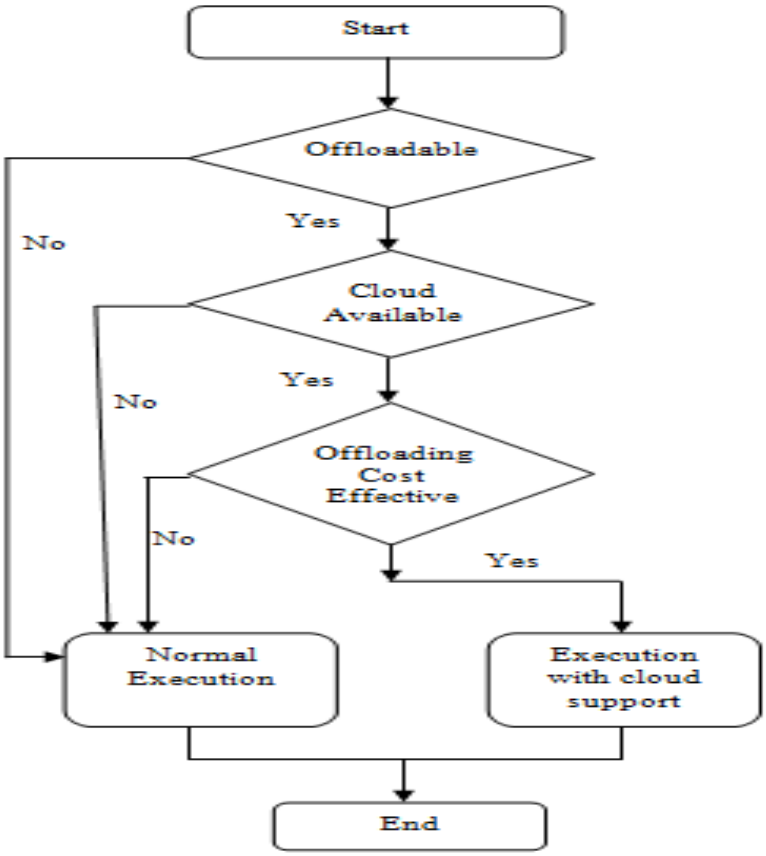


Fig. 4. Process of computation offloading

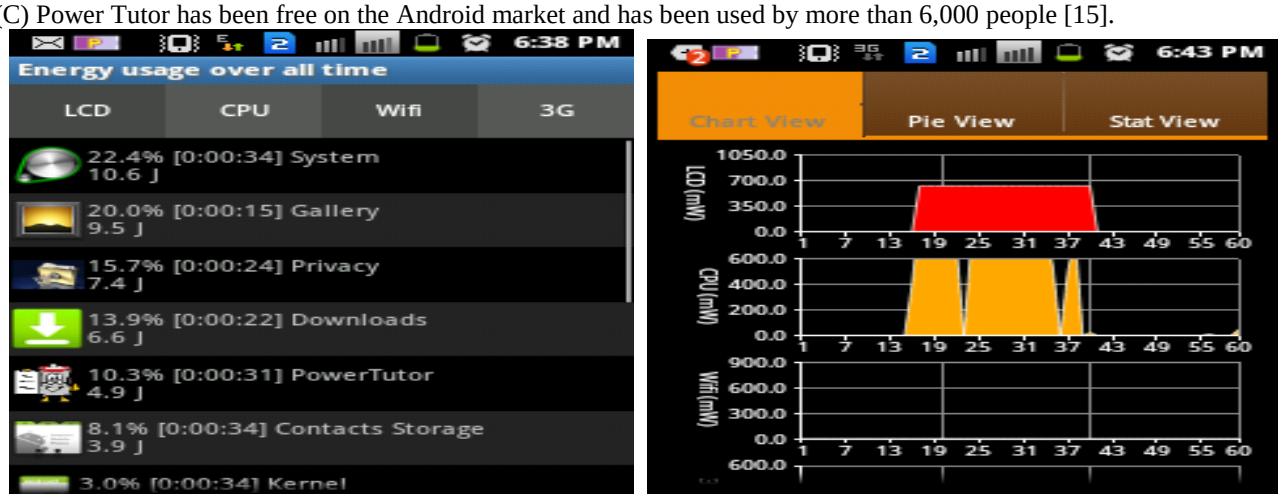
IV. ENERGY CONSUMPTION IN MOBILE DEVICES-

Power consumption increases intensely while we are using different features like surfing internet, watching videos, antivirus scanning etc. With the help of a clone cloud, we can greatly reduce the workload and fundamentally expand the resources of the smartphones [15].

(A) Application developers can use Power Tutor to rapidly, accurately, and conveniently determine the impact of software design changes on power consumption. It provides a time series of power consumption estimates per hardware component, allowing developers to identify power disorganized behaviour, much of which results from unintentional but inappropriate use of smart-phone hardware devices [15].

(B) Smartphone owners can use Power Tutor to determine the power consumption characteristics of all competing applications. Most existing application descriptions and reviews do not mention power consumption.

(C) Power Tutor has been free on the Android market and has been used by more than 6,000 people [15].



(a) Main view (b) Chart view

Fig 5.Accuracy Analysis for the Battery utilization through power tutor application [16].

V. RELATED WORK

1) Augmented Execution- The concept behind this architecture is to seamlessly offload execution from the smartphone to a cloud infrastructure. First of all the clone of the smartphone is created in the Cloud. Then the phone synchronizes with clone automatically. Synchronization can be done in two ways- Periodic or on-demand synchronisation. The smartphone and the clone have a replicator which is responsible for synchronising the clone state with the smartphone (on-demand or periodic). Then Resource intensive processes or portions of processes are performed by the smartphone clone in the Cloud and the results are then merged with the state of the smartphone which resumes execution. This process of splitting the computation between the smartphone and its clone is referred to as "augmentation" [17].

2) Clone Cloud Architecture- The prototype implementation evaluation proves up to 20x speedup and 20x energy reduction. Again in this technique an extra overhead of synchronization comes into play and the phone has to be always kept synchronized with the clone. Furthermore, the details of how a smartphone and its clone are kept synchronised have not been discussed. Therefore, analysis of how a clone would be created and managed needs to be considered if this architecture is to be adopted [18].

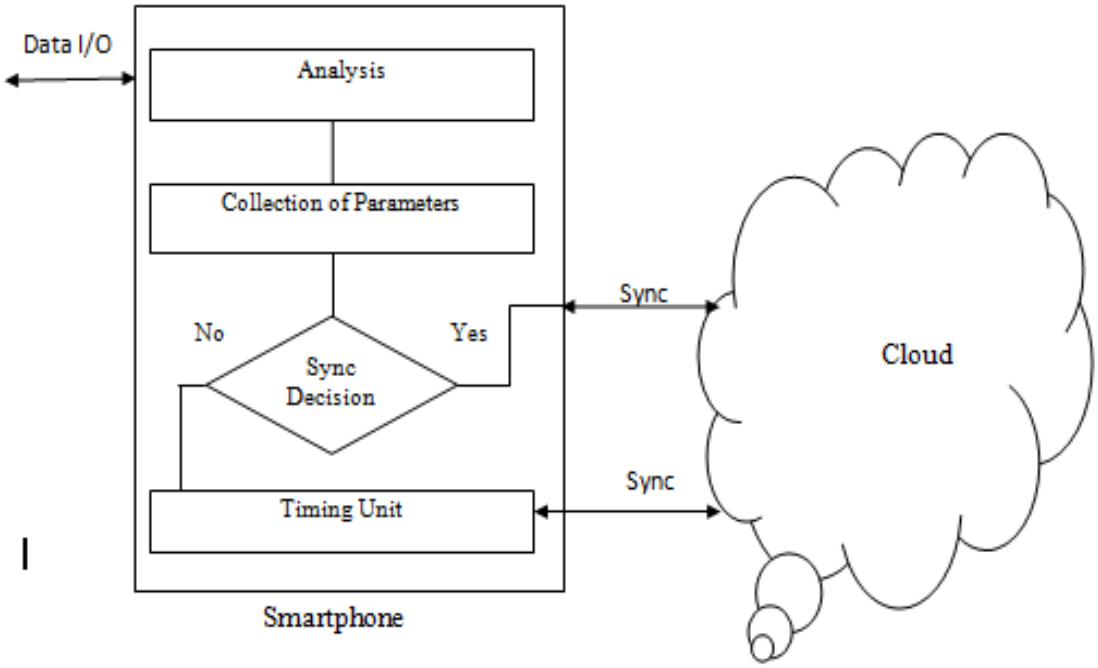
3) Data Synchronization Using Cloud Storage-

This research helps users to access a large volume of storage on cloud. In this project, the user can upload file from mobile or PC to the cloud storage. These files will be automatically synchronized to the user's devices when they are connected to internet. So, user files can be viewed from anywhere by any device. In the existing system, we need to download files manually. This paradigm provides automatic synchronization of data between devices registered to a single user. This architecture is developed for windows platform. This paper shows the development of a Windows Mobile application and Windows Desktop application, so that whenever the user modify or update a file, it will be automatically synchronized to the devices running any of those applications [19].

VI. PROPOSED WORK

As discussed is the previous section it is clear that the synchronization is highly required in case of offloading as the data needs to be consistent in both the Smartphone as well as the Cloud Side failing to which the whole concept of Offloading could fall into jeopardy[20]. Yet keeping the smartphone and the Clone Smartphone on the Cloud side synchronised all the time will lead to loss of energy as sending data over 2G will be very costly in terms of energy. Sudha S et al. proposed architecture to help users to access a large volume of storage on The Cloud. They focused on automatic synchronization of data between different devices such as a Mobile and a PC. But again this research has a drawback that a lot of energy would be wasted while keeping the state of the mobile device and the PC running the same application same as the data needs to be physically transferred to the cloud. It is proposed to make the synchronisation process more aware of the user's requirements and priorities as well as the best synchronisation environment.

The above diagram depicts the working of the proposed Architecture. The user gives an input to the smartphone via any medium, it could be an image from the camera or Bluetooth or any other source. The analysis unit starts its work of deciding whether this type of data needs synchronization or not. If synchronisation is required the parameters are collected and passed on to Synchronization Decision system. Depending upon the parameters provided by the Collection unit the decision is made. If the conditions are favourable the synchronization is made at that time itself otherwise the synchronization is made to wait till the timing unit allows it.



VII. CONCLUSION

The number of mobile users increases with the new technology of smart phones. Mobile cloud computing is an extension of cloud computing. The objective of Mobile Cloud Computing to offer the resources to the users and enhance the performance. In this paper, give an idea about the Mobile Cloud Computing including offloading and energy consumption. Offload method reduce the workload. Still, there are lot of limitation in resources and battery life time issues due to the provisioning of resources of The Cloud

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