Abstract: As mobile applications as well as cloud computing grow immensely mobile cloud computing (MCC) is introduced as evergreen technology in recent world. MCC integrates cloud computing and the mobile environment as well as overcomes the various issues on the mobile computing side which area related to performance which includes battery life, storage, environment in mobile computing. In this paper we can have an overview of the MCC including the definition, comparison of cloud and mobile cloud, its architecture, and brief applications. Various issues regarding the mobile cloud computing side are tackled and their proposed solutions are explained.

Keywords - Mobile cloud computing (MCC), issues, offloading, applications.

1. INTRODUCTION
Mobile devices are becoming essential part of communications in today’s world of communication. Mobile users are greatly experienced of the services of mobile applications (e.g., Google apps, etc), which run on devices or remote servers with the powerful proceedings of MC as a powerful trend in the development of IT [1] technology as well as commerce and industry fields.

LITERATURE REVIEW
Several mobile cloud applications are discussed in the paper. None of the existing approaches meets completely the requirements of mobile Clouds. Online and offline applications are two extremes of mobile applications. Former lacks from available device computing resources suffering from the interactivity issues. Later type uses mobile devices capabilities but cloud integration is poor. Either whole application or parts of applications are offloaded. Offloading can happen to remote data centers or cloud cluster. Effective programming abstraction will be required. Mobile cloud computing will be a source of challenges in recent years. But a lot of power is required to run the application. Peripheral needs a lot of heat. With VMWare and Citrix, XEN virtualization allows the instances to run on multiple OS.

I. A MOBILE CLOUD COMPUTING VS CLOUD COMPUTING
Cloud computing

In science, cloud computing is a synonym for distributed computing over a network and means the ability to run a program on many connected computers at the same time [9]. Popular examples are Amazon’s Elastic cloud; Microsoft’s Azure platform; Google’s App Engine and Salesforce.com are some public clouds that are available today. Cloud computing is known to be a promising solution for mobile computing due to many reasons (e.g., mobility, communication, and portability [2]). Cloud computing is defined as aggregation of computing and software as a service. Virtualization of the different resources is a key requirement for a cloud provider as it is needed for creating illusion and scalability of different resources.

Mobile Cloud Computing

There can be several existing definitions of the’ mobile cloud:
1. The term mobile cloud computing means running the applications like Gmail for Mobile on the remote resource rich server and the mobile device are thin client that connect over to the remote server. For example: Face book’s location based services, Twitter in mobile, weather widgets for mobile etc.
2. In other approach the mobile devices are cloud providers. Hence collective resources of local proximity can be run easily.
3. The cloudlet is another approach to mobile cloud computing. Here the computations are locally offloaded to cloudlet. Example in coffee shop

<table>
<thead>
<tr>
<th>Properties</th>
<th>EC2</th>
<th>GAE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administration</td>
<td>We need to track traffic and put off</td>
<td>Virtually nil</td>
</tr>
<tr>
<td></td>
<td>administration required</td>
<td>administration required</td>
</tr>
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B. Mobile Cloud Computing (MCC) Architecture

General architecture of MCC can be shown in Fig.1. Connections (air links) and the base stations (e.g., base transceiver station (BTS), access point, or satellite) that establishes functional interfaces between the networks and mobile devices are connected to mobile device through mobile networks. Mobile user’s information (e.g., ID and location) and requests are transmitted to the servers which are connected to the central processors for providing mobile network services. After that network operator provides various other services to the mobile users as the authentication, authorization, and accounting based on subscribers data stored in databases and the home agent (HA). The subscriber request are serviced in the cloud where the cloud controllers processes the requests to provide the mobile users with the respective cloud services.

Cloud computing can be considered as promising solutions for the mobile computing due to mobility, portability as well as communication [14]. Solutions to overcome the above problems of mobile computing.

1) Extending battery lifetime: Battery is considered as major concern for mobile devices.

Offloading Computations migrate the large data from resource limited devices (mobile device) to the resourceful devices (e.g.: cloud). Hence taking a long application execution time on cloud can be avoided. [7]
2) Improve data storage and computation power: Other constraint for mobile devices is storage capacity. MCC helps to store and access large file on to the mobile devices. Amazon S3 [10] is an example that enables to store and access large files. Users may access all images from any devices User can save the storage space to considerable amount since they can upload the contents to cloud directly. Flickr[11] and Shozu are famous content sharing applications on cloud. Facebook is also the content sharing famous application and used to share images on cloud.

3. SOME APPLICATIONS
Mobile commerce is the helping solution to business.MCC helps the learners to access the applications remotely. The coordination between healthcare providers and the healthcare centers as well as the receivers with high availability and stability can be achieved. [17] .MCC helps to play the games in the mobile devices by offloading the part of game moves from mobile devices to the cloud.

4. MCC – ITS ISSUES AND APPROACHES
The available solutions to address issue of offloading are reviewed.
   a) Offloading computations:
   But still there is lack of the resources. One of the solutions for overcoming this issue is MCC [4].In order to improve performance and increase battery lifetime, offloading part of computations is the proposed solution.

<table>
<thead>
<tr>
<th>Static environment offloading</th>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>When the size of code compilation is large</td>
<td>offloading consumes less energy as compared to local processing.</td>
<td>When the size of code compilation is small</td>
</tr>
<tr>
<td>Most of the current execution happens either on the device or on backend.</td>
<td>Mobile clients face variations as well as rapid changes in the network conditions and local resource availability. To enable the applications continue to operate in dynamic environments, applications of the mobile cloud must adjust dynamically to the changing environment. Computations must be adaptive to changing response from clients.</td>
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</table>

Outsourcing Primary functionality: Computation hungry applications for example video processing, graphics, etc are split so the user-interface and other low processing applications are kept at the smart phone, while high computation applications are offloaded to the cloud.

Background: In this augmentation functionality does not deal with user interaction as was the case in previous one. This functionality occurs in the background for example Virus scanning file systems, file system indexing for the searching facility, common application like photos analyzing systems, news paper crawling systems, etc. Also the offloaded functions can act as virtual clients i.e. when the mobile is turned off the client can run on the background. When the smart phone is on, they can be resynchronized. [5]

Mainline augmentation: This augmentation is in between the primary and background where the user runs an application in the totally wrapped fashion by altering execution method but not semantics. Few examples are fault-tolerance (e.g. protect an application from bugs), leak of private-data detection, (e.g. employing multi-variant execution analysis), debugging (e.g., keep track of allocated memory dynamically to catch the memory leaks in the heap). [5]

Augmentation of Hardware: This category augments the replicas on the more powerful virtual machines

Multiplicity: Helps in parallel execution

ARCHITECTURE OF CLONE CLOUD SYSTEM
Augmented execution is performed in four steps: 1) Initially, a clone of the smart phone is created within the cloud (laptop, desktop, or server nodes); 2) The state of the primary (phone) and the clone is periodically or on-demand synchronized; 3) Application augmentations (whole applications or augmented pieces of applications) are executed in the clone, automatically or upon request; and 4) Results from clone execution are re-integrated
back into the smart phone state.[5]

Figure 4 shows the system architecture. It is achieved by combining whole-system replication through incremental check pointing, semi-automatic partitioning and invocation of augmented execution, and coordination of computation between the primary (phone) and the clone. The system components are running inside the operating system (OS). The Replicator is in charge of synchronizing the changes in phone software and state to the clone. The controller running in the Smartphone invokes an augmented execution and merges its results back to the smart phone. It interacts with the Replicator to synchronize states while coordinating the augmentation. The Augmenter running in the clone manages the local execution, and returns a result to the primary. Once a computation block for remote execution is specified, the following steps are performed for the primary functionality outsourcing augmentation category. We omit the steps for other augmentations due to space constraints. First, the smart phone application process enters a sleep state. The process transfers its state to the clone VM. The VM allocates a new process state and overlays what it received from the phone with hardware description translation. The clone executes from the beginning of the computation block until it reaches the end of the computation block. The clone transfers its process state back to the phone. The phone receives the process state and reintegrates it, and wakes up the sleeping process to continue its execution [5].

### CLONE CLOUD PROS-CONS

A major **advantage** of the CloneCloud is enhanced smart phones performance and reduced battery consumption as smartphones do not use its CPU as frequently. The **disadvantages** of CloneCloud are handover delay, bandwidth limitation.

### Cloudlet

Similar approach of using virtual machine (VM) technologies executing the computation intensive software from mobile device is presented by Satyanarayanan [7]. A cloudlet is a trusted, resource rich computer or a cluster of computers well connected to the Internet and available for use by nearby mobile devices. Rather relying on a distant cloud, the cloudlets eliminate the long latency introduced by wide-area networks for accessing the cloud resources. This approach relies on technique called dynamic VM synthesis (Fig 7). A mobile device delivers small VMs overlay to the cloudlet infrastructure that already owns the base VM from which this overlay was derived. The infrastructure applies the overlay to the base to derive the VM which starts executing in the precise state in which it was suspended [4].

#### ELASTIC PARTITIONED

Applications running in the heterogeneous environments of the mobile clouds require partitioning of applications dynamically and remote execution of some components. Performance of applications can improve by delegating a part of execution to the remote execution en resource rich server.

### MAUI

![MAUI architecture](adapted from [8])
This system enables fine-grained offload to the cloud infrastructure from mobile. Hence the battery life of device can be maximized with code offload. While programming the developers decide which methods for remote execution can be offloaded. The bandwidth, latency, and network connectivity measurements can be used for problem optimization as input parameters which are solved periodically in order to decide which methods and when they must be offloaded. In MAUI a fine-grained offloading mechanism on single level methods is allowed, here the complete software module are offloaded.

ARCHITECTURE OF MAUI SYSTEM

Figure 8 provides a high-level overview of the MAUI architecture. On the smart phone, the MAUI runtime consists of three components: 1) an interface to the decision engine (to save energy, the solver actually runs on the MAUI server); 2) a proxy, which handles control and data transfer for offloaded methods; and 3) a profiler, which instruments the program and collects measurements of the program’s energy and data transfer requirements. On the server side, MAUI provides four components: the profiler and the server side proxy who perform similar roles to their client-side counterparts; the decision engine which periodically solves the linear program; and the MAUI coordinator, which handles authentication and resource allocation for incoming requests to instantiate a partitioned application. [8]

HYRAX INFRASTRUCTURE

Due to resource constraints in the mobile a way to solve the problem must be found out. Hyrax—a system developed creates a mobile cloud computing platform and Android-based mobile phones nodes are deployed. A modified Hadoop framework is transplanted into Android. Hence smart phones work like PC. The Hyrax infrastructure is shown in Fig. 9.

OSGi framework

The Java applications are decomposed in software modules. R-OSGi—a modified version of the original OSGi is used because the original OSGi uses same Java virtual machine to run services. [18]

B) Data storage improvement: MCC is developed to enable mobile users to store/access the large data on the cloud through wireless networks. Amazon S3 supports the file storage. If mobile solution includes a manageable number of static images, you can package them as part of your native Android and iOS applications. [13]

5. CONCLUSION

With the data computation highly increasing in science and commerce, the data processing capacity is a resource which is strategic. Mobile cloud computing (MCC) is an extension and development of cloud Computing (CC) and mobile computing (MC), inherited the high scalability and mobility, and has become a research topic. We come to conclusion that three approaches of optimization in MCC that focuses on the division of applications services and mobile devices limitations. Using Virtualization technology we can address mobile device limitations effectively, and then immigration of the Tasks from the terminal to cloud are to achieve better results.
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