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Mobile Cloud Computing Research: Issues and Challenges

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Abstract: ***MCC, or mobile cloud computing, is a new field. Mobile cloud computing is becoming a crucial component for mobile devices due to reliability and portability as data processing and storage take place outside of the mobile due to the widespread use of mobile devices and the variety of apps. It helps mobile devices conserve battery life and processing power, which is important for high - power mobile devices. Mobile cloud computing offers consumers to make calculations and use cloud services on their mobile devices. It is essential to gain a full understanding of current models and emerging trends because mobile Cloud computing is still in its infancy. The purpose of this survey is to identify and describe the main risks and obstacles associated with mobile cloud computing while also showcasing emerging trends in this area.***

Keywords: Mobile Cloud Computing, Cloud Computing, virtualization, personal cloud

1. Introduction

Over the past several years, cloud computing (CC) has grown in importance as a research field because it has made it possible to run software on internet - enabled devices. Users of cloud computing can access applications from all over the world at their convenience. The cloud is made up of datacenters that are run and managed by service providers. Companies like Amazon, Microsoft, and Google moved their data centers and cloud services to various places around the globe. As mobile device usage grows daily along with a rise in computing power, there are now several problems with mobile devices, such as battery management, memory needs, and restricted computing power. MCC has acquired these characteristics from cloud computing, where resources are virtualized and distributed among servers and a data center.

Because cloud infrastructures and platforms today offer essentially large - scale computing capacity with elastic scalability and increased resource sharing and utilization, they significantly benefit mobile users. This could help mobile computing overcome many of its current restrictions. Mobile cloud computing offers the following distinctive benefits by implementing the benefits from mobile computing in ubiquitous, convenient mobile access, and location - based application services.

1) *Efficiency in compute and storage:* The mobile device can reduce the amount of processing power and data storage it needs by offloading taxing workloads and big amounts of data to the cloud.
2) *More potent mobile apps*: Because the mobile device now has access to a potent cloud on the back end, we have the opportunity to develop more potent mobile apps than was previously feasible.
3) *Energy efficiency:* By offloading a large portion of the resource - intensive work of mobile applications to the cloud, mobile clients may concentrate more on lowering energy consumption without compromising performance.
4) *Thin Mobile Clients:* By placing less demands on the mobile client's resources, we may create less - powerful mobile devices that, when used with a cloud platform, perform better overall. By "dumbing down" the mobile clients to solely handle user interaction and offloading all application work and data to the cloud, we are able to take advantage of this.

The article discusses MCC - related cloud computing, cloud infrastructure, and current research topics. Cloud, mobile, computing device, wireless channels, and resource providers make up the MCC. The purpose of MCC is to make it simple for consumers to reliably access everything on their mobile devices. Mobile cloud computing, in its simplest form, refers to a system where computing data is stored and processed externally while resources are accessible via mobile. There are numerous uses for cloud computing, some of which are discussed in this paper.

The contrasts between cloud and mobile cloud architectures are discussed in this research, along with the variables influencing MCC on the cloud. The following part discuss about the architecture; section III Detail Desorption of Mobile Cloud Computing along with their issues and challenges. This research paper is ended at the end with a critical review and suggestions for future work.

2. Mobile Cloud Computing Architecture

In MCC, network latency, problems with communication services, latency in bandwidth, and battery life of mobile devices are key problems that need to be resolved. The cloud offers a service delivery approach that includes software as a service, platform as a service, and infrastructure as a service. Figure 1 depicts the MCC architecture. Mobile devices can access cloud services under this architecture in two different ways.

- Use their mobile network to directly access cloud services.
- Utilize the access points in the cloud as displayed below.

They connect to base stations either through a satellite connection or the mobile network. Telecom networks link to the internet and give consumers access to connection so they can utilize mobile devices to access cloud services.

Mobile customers, mobile operators, Internet service providers (ISP), cloud providers, etc. make up the main architecture. Smartphones equipped with Wi - Fi can connect to network providers using base stations or satellite channels. Requests made via mobile devices are fulfilled by network providers and central servers. Processing occurs at the top level of the architecture, typically in the cloud. Network provider works as a middle ware and provide services to mobile users from the cloud providers.

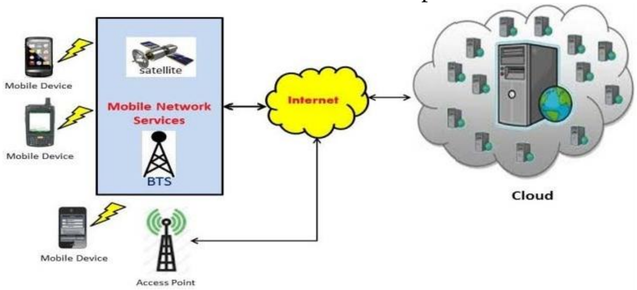

Figure 1: Mobile Cloud Computing Basic Architecture

Numerous MCC applications use the cloud directly with the aid of the internet. Figure 2 provides a more condensed representation of the architecture

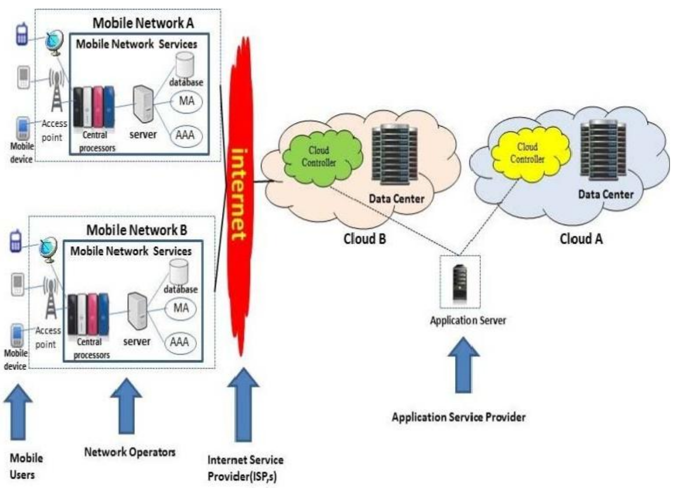

Figure2: Detail View of Architecture

To enhance the performance and battery life of mobile devices, mobile cloud computing uses the method of computation offloading. Some calculation tasks are moved from the mobile device to a distant cloud server in this process.

Numerous functions, including data processing, machine learning, and complicated calculations, can be delegated by the mobile device to the cloud server. By doing so, the mobile device can save battery life and use its resources to handle user interface interactions

Overall, mobile cloud computing's compute offloading offers a potent tool for enhancing the functionality, cost - effectiveness, and energy - efficiency of mobile apps.

In general, the process for offloading computation in mobile cloud computing entails identifying resource - intensive tasks, choosing an appropriate offloading technique, selecting an appropriate cloud server, choosing a suitable cloud server, transferring data to the cloud server, performing the task on the cloud server, and integrating the results back into the application. Figure 3 explain computation offloading in MCC in detail

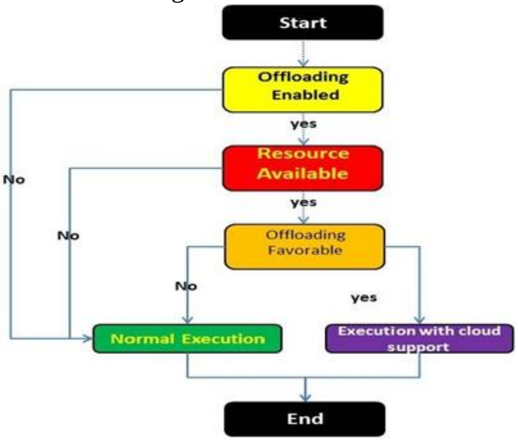

Figure 3: Computation Off loading of Mobile Cloud Computing

To enhance the user experience for mobile users, mobile cloud computing easily switches between resources on mobile devices and in the cloud environment. Mobile applications use the internet to communicate data requests to the cloud. The queries are processed by remote servers, who subsequently deliver the necessary response, which is then shown to mobile users

There are four basic categories of cloud - based resources used in mobile cloud computing architecture.

a) Distant immobile clouds

The virtual servers that cloud computing service providers oversee are referred to as remote immovable clouds. This includes things like Amazon Elastic Compute Cloud (Amazon EC2) instances. The application code is created by developers, who then deploy it to these virtual servers. The servers then handle and address the requests for mobile data.

b) Proximate immobile computing entities

Backend server machines that are closer to your mobile consumers in terms of geography are referred to as proximate immobile computing entities. They accelerate MCC and get over network lag's problems. For instance, you can set up your Amazon EC2 instances to be located in an AWS Region nearer to your end consumers.

c) Proximate mobile computing entities

Some mobile cloud applications can exploit the extra computing power of nearby mobile devices to boost performance. Proximate mobile computing devices are used to describe such mobile devices, smartphones, and wearables.

d) Hybrid solutions

The three types of resources mentioned above are combined in hybrid MCC solutions to support your business applications more effectively.

3. Mobile Cloud Computing Detail Description

What is mobile cloud computing?
Several definitions of MCC are available For Example MCC is defined as *"a rich mobile computing technology that leverages unified elastic resource of varied clouds and network technology toward unrestricted functionality, storage, and mobility. It serves a multitude of mobile devices anywhere anytime through the channel of Ethernet or Internet regardless of heterogeneous environments and platforms based on the pay - as - you - use principle. "*

The MCC forum defines MCC as follows:
"Mobile cloud computing at its simplest, refers to an infrastructure where both the data storage and 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 MC to not just smartphone users but a much broader range of mobile subscribers. "

Additionally, MCC frequently uses three foundations: networking, cloud computing, and mobile computing. The below Figure 4 explain the MCC

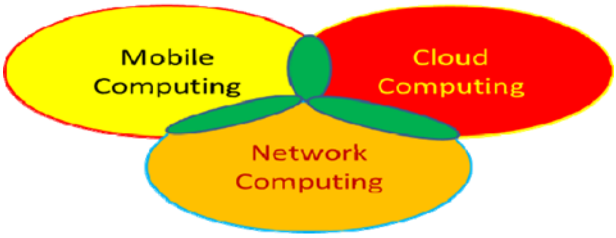

Figure 4: Combine Architecture Model

A. Primary Feature of Mobile Cloud Computing

The primary feature of Mobile Cloud Computing are as follows:

1) *Auto Resource provisional Management:* Mobile clouds allow for the automatic provisioning and de - provisioning of mobile device, network, and cloud computing resources.
2) *Virtualization:* Mobile clouds can support three different types of virtualizations: network virtualization, cloud virtualization for different computing resources, and mobile devices and resources.
3) *Scalability:* In mobile cloud computing, scalability refers to three different aspects: a) network scalability; b) cloud scalability; and c) mobile scalability in terms of mobile users and devices.
4) *Mobile cyber security and privacy:* This means that the body of security capabilities, technologies, processes, and practices designed to guard against attacks, damage, and unauthorized access to data on mobile devices, heterogeneous networks (including wireless networks and the Internet), cloud servers, and mobile application service programs.
5) *Mobile utility billing and energy efficient:* This refers to the mobile - based utility models that are offered, namely the volume - based, subscription - based, and meter - based service billing models.
6) *Mobile cloud service connectivity:* Mobile clouds provide well - defined connectivity APIs and protocols to make it simple and secure to connect to various networks, standards, and third - party software and systems.
7) *Mobility, flexibility, and accessibility:* Mobile clouds give users of mobile devices access to mobile cloud applications and services at any time and from any location with ease.
8) *Multi - tenancy:* This function enables a single mobile cloud software instance to support numerous mobile tenants across a wireless Internet connection or other heterogeneous networks.

B. *Generations of Mobile Cloud Computing*

1) First Generation (2009 - 2012)

When mobile devices started to gain popularity in the late 2000s, the first wave of mobile cloud computing appeared. Mobile cloud computing at the time was mostly concerned with offering storage options and remote access to data. The majority of applications were created specifically for mobile devices, and data synchronization and backup were supported via cloud services. The traditional cloud computing technologies of Infrastructure - as - a - Service (IaaS), Platform - as - a - Service (PaaS), and Software - as - a - Service (SaaS) were predominantly used by the first - generation MCC.

2) Second generation (2012 - 2015):

During the second generation of mobile cloud computing, new cloud computing technologies as well as major improvements to mobile device capabilities were made. Cloud computing innovations like mobile backend as a service gained popularity at this time, enabling developers to build cloud - based APIs and incorporate them into their mobile applications. Building and deploying mobile applications that used cloud services for push notifications, user authentication, and data storage became simpler as a result. The development of containerization technologies during the second generation of MCC also facilitated the deployment and administration of mobile applications in the cloud.

3) Third generation (2015–2018):

Fog computing and edge computing were both used in the third generation of mobile cloud computing. The idea of processing data more locally rather than transferring it to a centralized cloud server is known as edge computing. Contrarily, fog computing describes the usage of a distributed computing infrastructure to bring the cloud closer to the network's edge. This made it perfect for use cases like real - time data analysis, machine learning, and Internet of Things (IoT) applications since it allowed for faster data processing and lower latency.

4) Fourth generation (2018–2021):

The use of artificial intelligence (AI) and machine learning (ML) technologies has significantly increased in the fourth generation of mobile cloud computing. This has been made possible by the introduction of cloud - based machine learning systems like Google Cloud ML Engine and Amazon Sage Maker as well as the accessibility of powerful mobile devices. Serverless computing, which enables developers to execute their apps without managing servers or infrastructure, has grown in popularity with fourth - generation MCC. This makes it simpler to develop and launch applications that can scale up and down according to demand.

C. *Issues and Challenges of Mobile Cloud Computing*

MCC faces may issues ad Challenges some are listed below:

1) *Security:* In mobile cloud computing, security is a major concern. MCC requires sending sensitive data across the internet, which increases the likelihood that it will be intercepted, hacked, or stolen. To reduce this danger, it is necessary to secure the security of both the cloud infrastructure and the mobile device.
2) *Latency*: The time elapsed between a user's request and the cloud's answer is known as latency. When using a mobile device to access cloud resources, this delay may be noticeable, especially if the connection is sluggish or unreliable. The user experience may suffer as a result of the delay, rendering real - time apps useless.
3) *Network connectivity:* MCC performance can be considerably impacted by the reliability and quality of network connectivity. Poor user experience might result from a shaky or unpredictable network connection, which can lead to delays and interruptions.
4) *Device heterogeneity:* Because mobile devices come in a variety of styles, dimensions, and features, it might be difficult to create applications that function on all of them. The flawless operation of a program across a range of hardware, operating systems, and screen sizes is the responsibility of the developer.
5) *Battery life*: The battery life of mobile devices is constrained, and cloud computing services can significantly drain batteries. This may result in a shorter battery life and a less satisfying user experience.

4. Conclusion

This report provides a survey on MCC and discusses its trends and problems. As the use of smartphones rises, mobile applications are becoming more and more sophisticated. Users now prefer to utilize their mobile devices for all functions due to the growth in mobile usage. New prospects are opening up in this industry thanks to cloud computing, which is a popular research topic. The number of computations is rising daily in industries including business, science, and technology. MCC has been concentrating on improving mobile limits and making it more powerful using virtualization approaches in recent years. As was mentioned above, various MCC models have been given; nonetheless, they all have the absence of application privacy as a common deficiency. To prevent malicious assault and ensure against unauthorized access, a security system is necessary. The MCC privacy architecture can be used to address this issue. With the help of this mechanism, a virtual private network can be set up to track user activity and the authentication process. To address these problems and make mobile cloud computing a successful and dependable technology in the future, a standard for data management policies should be developed. This study sets some future paths in this field and serves as a road map for new researchers.

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