Mobile and Android Cloud Computing: A Survey

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ABSTRACT

Mobile Cloud Computing (MCC) is the combination of cloudcomputing, mobile computing and wireless networks to bring rich computational resources to mobile users, network operators, as well as cloud computing providers. The ultimate goal of MCC is to enable execution of richmobile applications on a plethora of mobile devices, with a rich user experience. Android platform occupies a predominant proportion of mobile market but lacks an approach that can provide accurate, efficient and agile security assessment for android applications present in the application market. In this paper, we provide an extensive survey of the recent research work, while highlighting the issues with the help of a taxonomy. This will help general readers have an overview of MCC including definition, architecture, and applications. We conclude the paper with critical analysis of the challenges and our proposed solution with future work.

Key Words: Mobile Cloud Computing, Mobile Computing, Offloading, Mobile Services

1. INTRODUCTION

In recent years, applications targeted at smart mobile devices have started becoming plentiful with applications in various categories like entertainment, heath, games, business, social networking, cloud storage, travel and news.
Recently mobile cloud computing is becoming very crucial part of life. According to a survey statistics of Statista[1], more than 2.7 billion users will use the mobile devices to access cloud computing services.

Smartphones and Android devices have significant constraints imposed upon them because of importance and desirability of smaller sizes, lower weights, longer battery life and other features. Cloud Computing allows devices to avoid these constraints by carrying more intensive tasks performed on powerful systems in cloud and results sent to the device. [2].

2. WHAT IS CLOUD COMPUTING

Cloud computing, also known as 'on-demand computing', is a kind of Internet-based computing, where shared resources, data and information are provided to computers and other devices on-demand. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources. [3]

Cloud Computing Services

The cloud computing model is based on three services delivery models.

1) Software as a service (SaaS)Cloud-based applications—or software as a service (SaaS)—run on distant computers "in the cloud" that are owned and operated by others and that connect to users' computers via the Internet and, usually, a web browser.

2) Platform as a service (PaaS)It provides a cloud-based environment with everything required to support the complete lifecycle of building and delivering web-based (cloud) applications—without the cost and complexity of buying and managing the underlying hardware, software, provisioning and hosting.

3) Infrastructure as a service (IaaS)Infrastructure as a service provides companies with computing resources including servers, networking, storage, and data centre space on a pay-per-use basis.

4)Database as a Service (DBaaS) is a cloud-based approach to the storage and management of

structured data. DBaaSdelivers database functionality similar to what is found in relational database management systems (RDBMSes) such as SQL Server, MySQL and Oracle.

B. Cloud Deployment Models

The cloud has three different deployment models and each model has its own benefits and trade-offs.

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.

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.

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.[3]

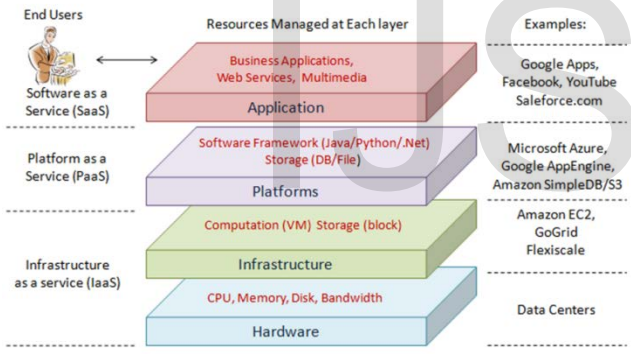


Fig1 Cloud Computing

1 WHAT IS MOBILE CLOUD COMPUTING?

'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'[4]

2 WHAT IS ANDROID CLOUD COMPUTING?

Android Cloud Computation is combination of android and cloud computing. The data or computation is being transferred to the cloud storage via smartphone network. If any computation task arrives which android is not capable of executing due to lack of battery power and resources in mobile phones hence it is transferred to resourceful cloud which does the execution.

3 ARCHITECTURE OF MOBILE CLOUD COMPUTING

There must be architecture of MCC based on the reliability, effectiveness, validity and security to support the mobile users. The architecture of mobile cloud computing is shown in the fig. 2, which is divided into four layers named as control layer, management layer, virtual layer and physical layer. Different layers perform different functions for mobile computing.

Control layer also known as access layer controls the services interface to the clients, reasonable service access and service registration. Management layer manage the services in the cloud computing system architecture. Virtual layer includes the virtual system, virtual environment, virtualization of resources like network, storage and computing. Physical layer provides the detail of physical devices like mobile phones, tablets, smart phones, desktop etc. As shown in the fig 2, the mobile devices are connected to the wireless network based stations. User request is sent through the wireless network to access the cloud server by **AAA mechanism** (Authentication, Accounting and Authorization mechanism). This request is processed by central processors having a direct contact with the servers. By taking the input from the stored information in the database, AAA services are provided by the mobile network operator to the users. The user can get the access of different services like databases, virtualization, applications, computing resources and storage services in the cloud.[5]

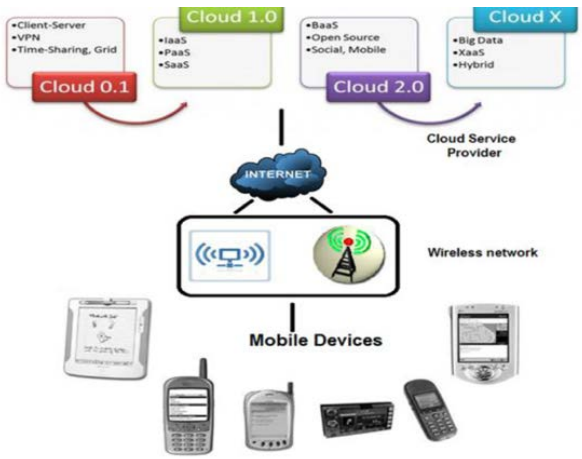


Fig 2 Architecture Of MCC

4 COMPUTATION OFFLOADING DECISION MAKING

A mobile cloud application goes through the following steps before offloading computations to the cloud.[15]

The workflow starts with the execution of an application followed by checking the user's offloading permission. If offloading is enabled, then application checks connectivity to the cloud resources and notes the available/assigned resources.

The next step involves deciding whether offloading is favorable, depending on the users' desired objective. If it is favorable, then the computation offloading is performed. Otherwise, the application performs all computations locally.

The decision of computation offloading is an extremelycomplex process and is affected by different entities, for instance user, connection, smartphone, application model, application (nature) and cloud service. Figure 3 presents different entities that can affect the computation offloading decision in multiple ways.

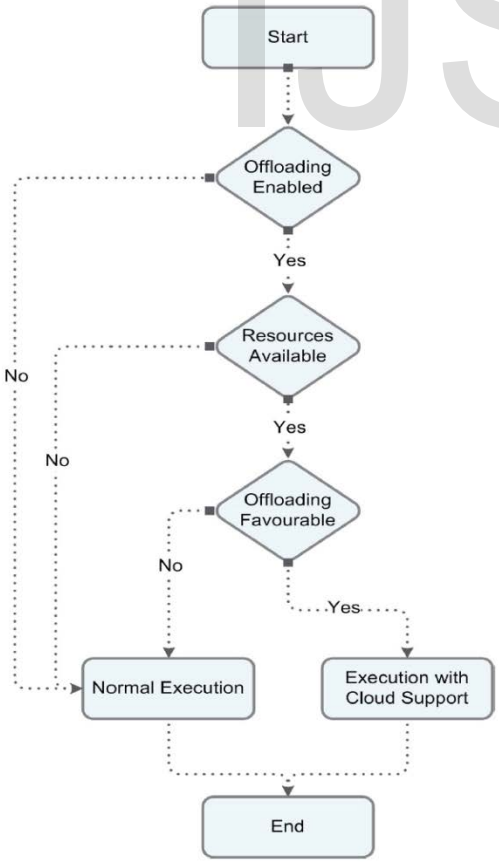


Fig3 Method Of Computation Offloading

5 ARCHITECTURE OF ANDROID CLOUD COMPUTING

Android is a Linux kernel based operating system and was designed for the touch screen tablets and smart phones that

accept the touch inputs. Based on this Linux operating system, there are three application models as below:

A.Clone Cloud Model: Partitioning mechanism of CloneCloud is a combination of static analyzer and dynamic profiler, which aims to decide which parts of the application will execute on the mobile device and which will migrate to the cloud. At selected points, threads are automatically migrate from mobile device to the clone and other threads are keep executing on the device as shown in Fig. 4. Remote threads complete their execution in cloud and reintegrate back to the device with computed results.

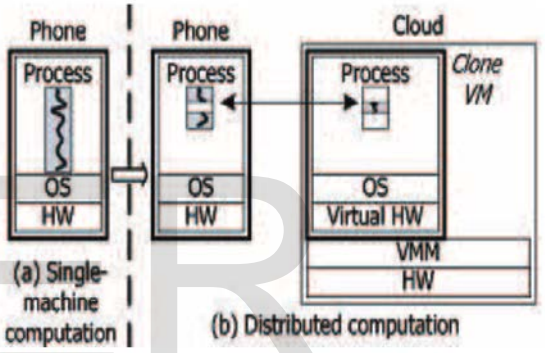


Fig 4 CloneCloud Model

B.ThinkAir: A framework that makes it simple for developers to migrate their smartphone applications to the cloud. ThinkAir exploits the concept of smartphone virtualization in the cloud and provides method-level computation offloading. Advancing on previous work, it focuses on the elasticity and scalability of the cloud and enhances the power of mobile cloud computing by parallelizing method execution using multiple virtual machine (VM) images.[6]

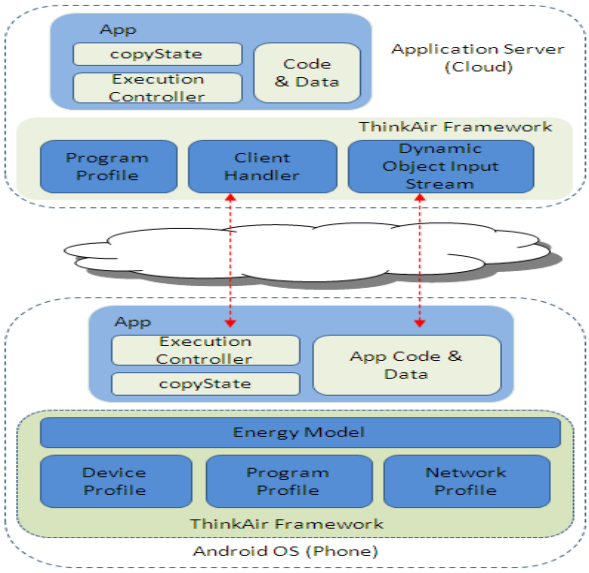


Fig5 ThinkAir Model

C.Cuckoo Model: Cuckoo model is developed by Kemp et al. in 2012, is based on the property of partial offloading of applications to nearby cloud or infrastructure and is designed with the intention to make the programming easy for the developers. The main advantage of using Cuckoo is that it supports partial offloading of the applications and uses well known tools for development. In Cuckoo based applications Java Virtual Machine (JVM) can be used to offload their data and computation that is residing on the nearby cloud or infrastructure.[5]

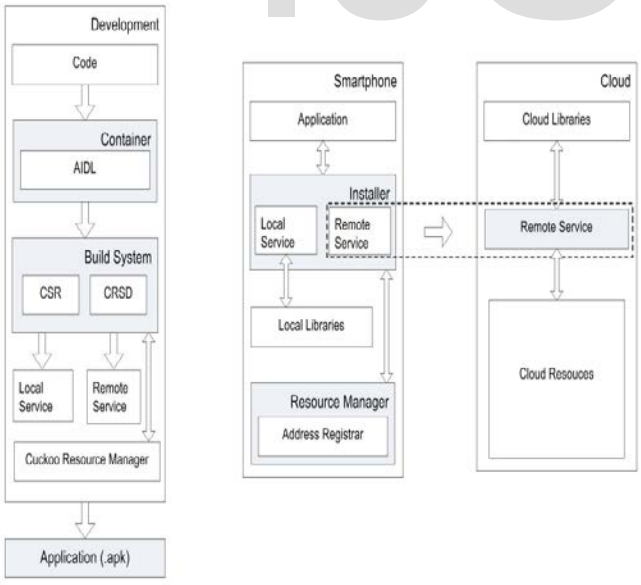


Fig 6 Cuckoo Model

that is responsible for monitoring the performance of an application.

6 ADVANTAGES: MCC & ACC

In the following, we describe how the cloud can be used to overcome obstacles in MC,thereby pointing out advantages of MCC.

A. Extending battery lifetime

Battery is one of the main concerns for mobile devices. Computation offloading technique is proposed with the objective to migrate the large computations and complex processing fromresource-limited devices (i.e., mobile devices) to resourceful machines (i.e., servers in clouds). This avoids taking a long application execution time on mobile devices which results in large amount of power consumption. For example, using memory arithmetic unit and interface (MAUI) to migrate mobile gamecomponents [9] to servers in the cloud can save 27% of energy consumption for computer games and 45% for the chess game.

B. Improving data storage capacity and processing power

MCC is developed to enable mobile users to store/access the large data on the cloud through wireless networks. First example is the Amazon Simple Storage Service (Amazon S3) which supports file storage service. Cloud computing can efficiently support various tasks for data warehousing, managing and synchronizing multiple documents online. Mobile applications also are not constrained by storage capacity on the devices because their data now is stored on the cloud.

C. Improving reliability

Storing data or running applications on clouds is an effective way to improve the reliability since the data and application are stored and backed up on a number of computers. This reduces the chance of data and application lost on the mobile devices. In addition, MCC can be designed as a comprehensive data security model for both service providers and users.

MCC also inherits some advantages of clouds for mobile services as follows:

a) *Scalability*: The deployment of mobile applications can be performed and scaled to meet the unpredictable user demands due to flexible resource provisioning. Service providers can easily add and expand an application and service without or with little constraint on the resource usage.

b)Dynamic provisioning: Dynamic ondemand provisioning of resources on a finegrained, self-service basis is a flexible way for service providers and mobile users to run their applications without advanced reservation of resources.

c) *Multi-tenancy*: Service providers (e.g., network operator and data centre owner) can share the resources and costs to support a variety of applications and large number of users.

d) *Ease of Integration*: Multiple services from different service providers can be integrated easily through the cloud and the Internet to meet the user's demands.[7]

Why cloud computing for Android devices?

Cloud computing has taken the IT world by storm. There are various layers to the Android programming model that easily fit in with the creation of secure applications specially made for the cloud environment. The open source Android operating system allows complex cloud computing applications to run wherever the user is.Android developers can write applications to take advantage of the cloud and can leverage the faster time to market, the agility, cost benefits, etc. Most of the time, as users, we merely consider games and other apps that simplify daily life as the inspiration for Android apps. But make no mistake; enterprise apps are a good bet too. According to top research analysts, mobile-centric applications and interfaces are among the top 10 strategic technology trends in 2012 and 2013.

In the traditional environment, the complete infrastructure needs to be maintained at the back end. Hence, the focus is more on maintaining the environment and not on making applications that are robust and innovative. In the cloud environment, infrastructure is managed by service providers in public clouds.Hardware maintenance is the responsibility of the service provider and, in addition to this, service providers also maintain the software stack.[2]

7 ISSUES & CHALLENGES: MCC & ACC

Because of the integration of two different fields, that is, CC and mobile networks, MCC has to face many technical challenges. This section lists several research issues in MCC.

Operational Issues

A. *Method of offloading*

The main operation in any mobile cloud would be the offloading of jobs that take place from the resource constrained mobile device to the cloud. Because of issues such as the physical distance separating the mobile device and the cloud and the heterogeneity of the underlying systems, different research has tackled this in a variety of ways.

B.Connection Protocols

The current mobile cloud computing research uses a varietyof connection protocols for communication including Wi-Fi, Bluetooth, and 3G, though the majority has employed Wi-Fi for many reasons.

End User Issues

End users issues relate to issues that directly involve users such as incentives for participating, interoperability and cost. When using a mobile cloud, one of the key challenges experienced by the end users is the transaction infrastructure.

A.Utilization of resources through collaboration

In cases of mobile devices themselves acting as resource providers as discussed in Section 3.2 and in works such as Hyrax [14], the participating devices need to have incentives as to 'loaning' their resources. Furthermore, there need to be mechanisms to prevent 'free riding'.

B.Presentation and usability issues

User interface issues in mobile computing. Mobile devices span a large number of heterogeneous platforms. To design and develop separate user interfaces (UIs) for each and every type of device would be highly inconvenient and unrealistic for the UI developers.

Service Level Issues

Service and application level issues relate to the factors concerned with performance measurements of the system, and the Quality-of-Service of the system.

A.Availability

Service availability becomes more important issue in MCC than that in the cloud computing with wired networks. Mobile users may not be able to connect to the cloud to obtain service due to traffic congestion running out of battery power, network and hardware failures,out-of-signal and other common factors.

B.Performance

To improve the user experience that can be hindered because of disconnection, caching and prefetching has been proposed in research. This approach enables the user to continue his/her work for a period of time while in offline mode. Furthermore, caching and prefetching also gives an increased response time.

Privacy, security and trust

Whether offloading intensive computations, or data storage, using the cloud for mobile devices does pose questions of security and trust issues. Cloud services are stated to be vulnerable and users may lose their data if the services go out of business, or simply if the services fail due to technological problems. Mobile cloud computing inherits the security threats of conventional cloud computing in cases when the definition of mobile cloud means to connect mobile devices to a remote cloud.

Techniques of anonymous routing such as onion routing can also be used to provide privacy for mobile nodes in a decentralized mobile cloud.

A.Personal data storage on mobile cloud

One of the key concerns for people about using a mobile cloud is that their personal data on mobile device could be stored on, or accessed by the cloud. A mobile device contains contact lists, text messages, personal photos and videos, calendars, location information, and these data can reveal many things about someone's personal life. SQLite is popularly used by mobile platforms (e.g.: Android and iPhone) and web browsers (e.g.: Mozilla Firefox). Others include database systems such as MiniSQL, BerkelyDB, and Sybase.

Data management Issues

Data representation in mobile devices vary, and in a heterogeneous mobile cloud, this would lead to problems with portability and interoperability. Computations in a mobile cloud would be spread across a distributed file system, where multiple devices may need to access and modify files.

CHALLENGES: MCC & ACC

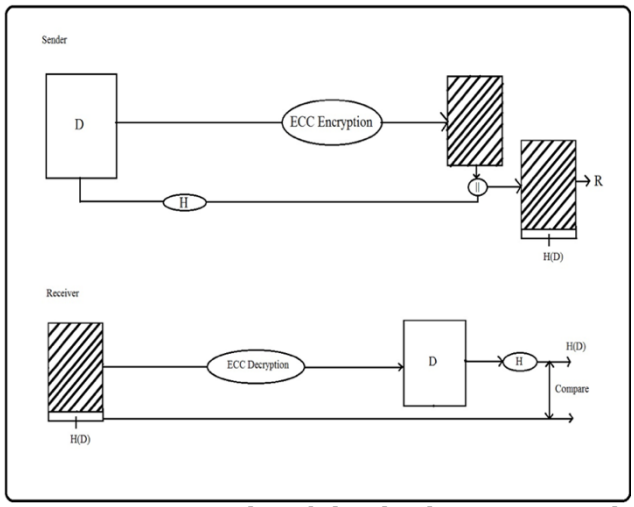
The major challenge of mobile cloud computing comes from the characters of mobile devices and wireless networks, as well as their own restriction and limitation, and such challenge makes application designing, programming and deploying on mobile and distributed devices more complicated than on the fixed cloud device.

A. Limitations Of Mobile Devices:Though smartphones have been improved obviously in various aspects such as capability of CPU and memory, storage, size of screen, wireless communication, sensing technology, and operation systems, still have serious limitations such as limited computing capability and energy resource, to deploy complicated applications.

***B. Quality Of Communication*:**In contrast with wired network uses physical connection to ensure bandwidth consistency, the data transfer rate in mobile cloud computing environment is constantly changing and the connection is discontinuous due to the existing clearance in network overlay.Some other issues such as dynamic changing of application throughput, mobility of users, and even weather will lead to changes in bandwidth and network overlay. Therefore, the handover delay in mobile network is higher than in wired network.

C. Cost Model:The cost model takes inputs from both device and cloud, and runs optimization algorithms to decide execution configuration of applications.The partitioning problem seeks to find an optimal solution in the graph satisfying an objective function and device's constraints. The objective function tries to minimize the interactions between the phone and the server, while taking into account the overhead of acquiring and installing the necessary bundles.The model could predict costs of different partitioning configurations before running the application and deciding on the best one.[7]

PROPOSED SECURITY MEASURES, CONCLUSION AND FUTURE WORK



For an operational mobile cloud, our proposed technique could provide an additional security measure by using some typical cryptographic techniques like Elliptic Curve Cryptography[9] and Message authentication code(MAC)[10]. Applying ECC encryption and SHA I on the information to be secured can help achieving a system which could decrypt without using a TTP(Trusted Third Party) and use MAC for checking the authenticity of the received information on the receiver's side.[4]

This system would use less resources and help extending battery life and achieve a secure channel for data transmission.

Mobilecloudcomputing aimsto empowerthemobileuser by providingaseamlessandrich functionality, regardlessofthe resourcelimitationsofmobiledevices. We havegivenan extensivesurveyof currentmobilecloud computingresearchin thispaper.

In the recent future, mobile cloud is expected to successfully integrate with Internet of Things and provide extensive grid of applications and benefits to the end user by getting all the information about health of individuals using different sensor networks and remote daily life appliances and would certainly pave the way to a new era.

CONCLUSION

With the high increasing of data computation requirement in commerce and science, the capacity of data processing has been considered as a strategic resource in many countries. Mobile cloud computing (MCC), as a development and extension of mobile computing (MC) and cloud computing (CC), has inherited the high mobility and scalability, and become a hot research topic in recent years. We conclude that there are three main optimization approaches in MCC, which are focusing on the limitations of mobile devices, quality of communication, and division of applications services. Firstly, using virtualization and image technology can address it effectively, and migrate task from terminal to cloud is also a good way to achieve better results. Secondly, as we know the quality of communication in wired network is better than in wireless network, so reducing the proportion of data delivery in wireless environment is an effective way to improve the quality. In addition, upgrading bandwidth is envisaged to be a simple way to increase performance but it incurs additional cost to users. Deploying an effective elastic application division mechanism is deemed to be the best solution to guarantee the application service in MCC.

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