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Mobile Cloud Computing Issues, Challenges, and Needs

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Abstract: Mobile cloud computing has gained popularity because of its potential to minimize power consumption and enhance user experience by outsourcing resource/computation intensive applications/operations from mobile devices to clouds. Mobile Cloud Computing: Architectures, Algorithms, and Applications is the first complete reference book on mobile cloud computing. Mobile devices suffer from poor battery life and limited resource and storage capacity. To overcome these constraints, mobile cloud computing has introduced offloading, where data storage and computations are performed inside the remote cloud instead of the mobile device. With this emergence, mobile cloud computing has become a vital issue that requires an energy-efficient mobile network and green cloud environment. Resource allocation and security are also important issues discussed in detail in this book. Mobile cloud computing–based health monitoring, gaming, learning, and commerce are feasible due to high-speed 4G/5G mobile networks. The issues of mobile cloud computing are discussed in the 14 chapters with future open research problems

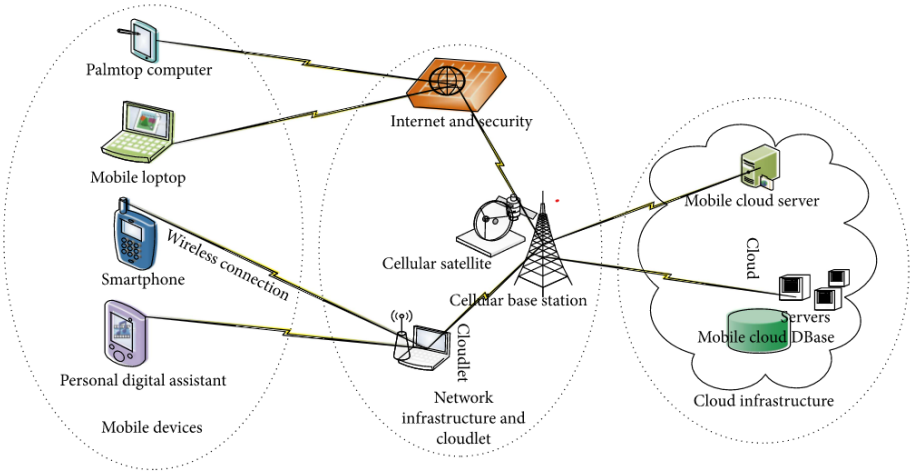
Keywords: Mobile cloud computing, cloud computing, mobile cloud services, mobile cloud applications, and mobile computing

I. INTRODUCTION

[1]Mobile cloud computing (MCC) has witnessed more rapid growth in terms of research due to the reason that mobile phones are becoming a vital need for human life. It is portable and is everywhere, which is very effective and suitable for communication irrespective of time and place The birth of MCC is a significant turnaround for computer science technology and also phone developers. MCC is an important technology which is applicable in different services such as Electronic Mobile Learning (EML), Electronic Mobile Commerce (EMC), Electronic Mobile Banking (EMB), Electronic Mobile Game (EMG), and Electronic Mobile Healthcare (EMH) Meanwhile, Mobile Devices (MDs) are becoming more sophisticated due to the development of large and complex applications. Consequently, MDs are constrained with challenges of battery power, memory space, and computation power; for these reasons, the idea of offloading task to the cloud has been integrated into mobile devices. When offloading a task to cloud, so many issues are resolved, such as security, quality of service, and mobile application development.

[2] Figure01-MCC System view

[Article-Mobile Cloud Computing: Taxonomy and Challenges- Ahmed Aliyu, Published - 01 Jul 2020, "What is cloud computing"]



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II. BACKGROUND OF MOBILE CLOUD COMPUTING

2.1. Mobile computing

[3]Mobile computing depends on the ability to use computer resources through mobile devices. Moreover, mobile computing enables the execution of tasks that have been traditionally done by normal desktops. In general, mobile computing is supported by three basic concepts: hardware, software, and communication. Hardware constitutes devices (e.g., tablet PCs and smart phones) that can be utilized by users. Software includes applications designed and developed to execute tasks in a mobile environment and communication which includes networks and protocols that can support the communication aspects of mobile computers such as Wireless Local Area Networks (WLAN), Long-Term Evolution 4G LTE and satellite networks. The mobile computing environment supports the following. First, there is mobility which allows mobile nodes or fixed nodes to connect with other devices' nodes in the mobile computing environment through Mobile Support Station (MSS) (e.g., servers and access points). Second, diversity of network access types refers to mobile nodes which can communicate using various types of access networks, for example Long-Term Evolution 4G LTE or Wireless Wide Area Network (WWAN) each with different communication bandwidths and overhead between the mobile nodes and the MSS. Third, frequent network disconnection means mobile nodes are not able to keep the connection consistent because of limited mobile nodes' resources such as battery energy and communication bandwidth. Fourth, regarding the issue of poor reliability and security, mobile node signals suffer from interference and eavesdropping in mobile networks which make security increasingly more important in mobile computing

2.2. Cloud computing

[4]Cloud computing is a technological approach that aims to increase capacity and capabilities of Information Technology (IT) networks by centralizing how data is stored and processed It allows consumers to access applications without first installing them and increases access to personal information over the Internet Furthermore, cloud computing has led to reduced costs of building IT infrastructures, and in acquiring new resources. Cloud computing service computers benefit from the multitenant architecture by maintaining one application). Cloud services are defined by five essential characteristics which include:

• **On-demand self-service:** A cloud computing service user leverages computing capabilities such as virtual machine time for processing and storage tasks whenever necessary without seeking the attention of each cloud provider. • Broad network access: Cloud computing service users can access datacenters resources online using devices such as workstations, laptops, smartphones, or tablets.

• **Resource pooling**: Multiple cloud computing service users share the cloud service provider's resources (i.e., cloud computing resources includes processing power, storage, network bandwidth, and memory) in a multi-tenancy manner, where each user can run and stop these resources as needed.

• **Rapid elasticity**: Resources are elastically supplied or released automatically or manually depending on the consumer's needs. From a consumer perspective, the cloud resources capabilities are often unlimited and can be used anytime.

• **Measured services**: Cloud service providers may charge consumers based on a pay as you go pricing model. The cloud computing service usage is monitored and reported in real-time which ensures transparency between the cloud service provider and cloud computing service users.

III. MOBILE CLOUD COMPUTING ARCHITECTURES

[5]SMCC is a new field of mobile cloud computing (MCC). It is used in some applications such as rescue services, healthcare, and so on. Mobile devices are being equipped with various sensors to sense data from the environment or the human body and send the aggregated data to the cloud through the Internet. By introducing a mobile phone between a sensor and the cloud server, data communication overhead can be reduced with the help of intelligent data filtering

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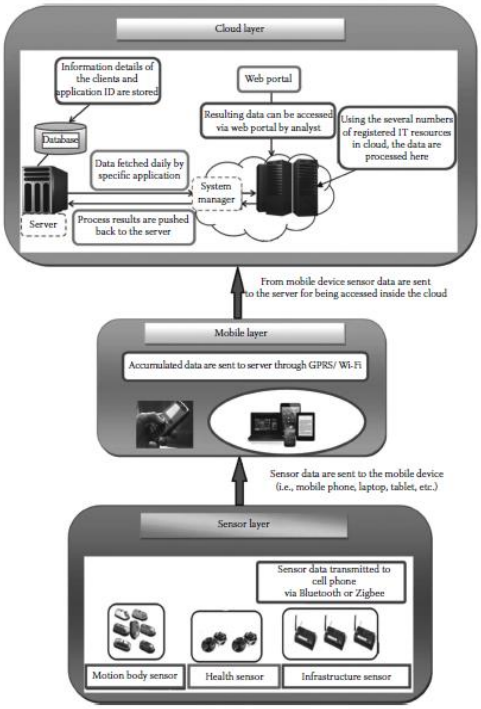
and fusing techniques. It has been shown that data transmission in a sensor mobile cloud requires less energy than that in a sensor cloud. Therefore, MCC plays an important role in wireless sensor networks.

3.1 Architecture of Sensor Mobile Cloud Computing

The sensor mobile cloud architecture is developed to improve the capability of a sensor mobile network. Here, capability means data processing, memory management, data communication, and energy efficiency. Since the capability increases from the sensor to the mobile and from the mobile to the cloud, integration of the sensor, the mobile, and cloud, which is SMCC, increases the capability tremendously

[6]Figure02- Sensor mobile cloud computing architecture [Figure02- Sensor mobile cloud computing architecture, Debashis De MOBILE CLOUD COMPUTING Architectures, Algorithms and Applications. Publication- a chapman and hall book, West Bengal University of Technology Kolkata, India**]**



1. Physical sensors: Sensors are placed arbitrarily in various locations (e.g., on the human body) for monitoring. Different sensors are used in different applications. A portable electrocardiography (ECG) system uses smart phones attached to the
heart and transmits heart rhythm data to the health provider. An asthma sensor has been developed to track the environmental conditions that can cause possible problems to asthma patients.

2. Mobile phone: From Figure02, it is clear that the sensor's data are sent to the mobile
phone via Bluetooth or Zigbee networks. A mobile phone collects the sensor data, processes the data, and transfers it to the cloud for further processing. Low computational devices such as mobile phones can be used to filter the sensor data.

3.2 Architecture of Sensor Mobile Cloud Computing

[7] Mobile phones are now ubiquitous in most people's daily activities and this has motivated companies to develop applications that can be easily accessed through mobile phones. The Internet, GPS and games applications are behind the worldwide popularity of mobile devices. However, limited resources (e.g., CPU, memory, and data storage) of mobile devices pose some design challenges to mobile application developers. To overcome these challenges, cloud computing is being used. Today's lifestyle often requires one to stay in touch through mobile communication

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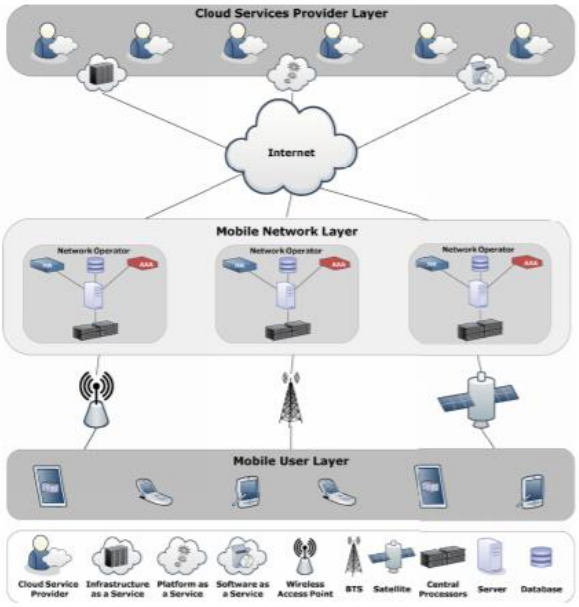
technologies. Sending and receiving data are becoming easier to do. Mobile cloud computing combines the concepts of cloud computing and mobile computing. The concept of Mobile Sensor Cloud Computing (MSCC) can be defined as a network of sensing mobile devices which communicates and sent data to cloud server with help of hub/controller. The sensed data collected by a cloud server, stored in the database and returned to the requester. There are primarily two mobile phone sensing paradigms [39]: In participatory sensing, portable clients effectively take part in sensing exercises by manually deciding how, when, what, and where to sense. In opportunistic sensing,

[8] Figure03-mobile cloud computing architecture

[mobile cloud computing architecture, Debashis De MOBILE CLOUD COMPUTING Architectures, Algorithms and Applications. Publication- a chapman and hall book, West Bengal University of Technology Kolkata, India.**]**



1. Mobile User Layer : This layer consists of many mobile cloud service users who access cloud services using their mobile devices (e.g., smartphones and tablets). These mobile devices connect to the Mobile Network Layer using Wireless Access Points (WAPs), Base Transceiver Station (BTS), or satellite.

2. Mobile Network Layer :This layer consists of multiple mobile network operators which handle mobile users' requests and information is delivered through base stations. Mobile user requests and information transfers are handled by mobile network services such as Authentication, Authorization, and Accounting (AAA) which are provided by the Home Agent (HA). At this point, the mobile network operators help to identify the subscribers' data that is stored in their databases through their HA. After successful authentication and authorization, the operator delivers the mobile users' requests to a cloud through the Internet. The mobile user is then able to access the corresponding services as provided by the controllers in the cloud.

3. Cloud Services Provider Layer : This layer consists of multiple cloud computing service providers which provide all types of cloud computing services including IaaS, PaaS, and SaaS. These cloud computing services are elastic and can be increased or reduced based on what cloud computing service users demand. Cloud computing provides services to users including those with mobiles can access cloud services via the Internet.

IV. MOBILE CLOUD COMPUTING RESEARCH

[9] 4.1 Engineering for MCC

The research work on engineering for MCC must focus on how to use well-defined and cost-effective modeling, design, validating, and measurement methodologies andtechniques and tools to support the development of mobile

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clouds and service applications. Here, special attentions should be givento design and testing for mobile cloud scalability, multi-tenanted mobile SaaS, energy-efficiency mobile computing, cloud mobility and mobile security.

4.2 Mobile networking for MCC

Mobile networking in mobile clouds encompasses diverse wireless networks and Internet. Innovative network protocols and communication technologies
should be the major research focuses in the networking community to address desirable needs in energy- efficient communications, elastic scalability in network infrastructures, and intelligent connectivity among networks, devices, and computers.

4.3 Mobile cloud infrastructure

The research work on this subject focuses on how to build cost-effective and energy efficient mobile
cloud infrastructures to support three groups of underlying resources: a) computing resources, b) network resources, and ¢) storage resources. The typical topics include resource provision,
virtualization, management, and monitoring, as well as load balancing and usage billing.

4.4 Mobile platform and enabled technologies

Providing efficient and easy to use mobile platforms on mobile devices has been focused subject in both academic and industry. As mobile apps become more sophisticated, they can be preferable over their desktop counterparts: fully functional, but faster and easier to use. 'Two major computer makers (Apple and HP) recognize what this 'means: the potential for huge disruption through a subtle merger of traditional desktop computing and mobile platforms. In addition, earlier some research work projects have been done to develop virtual mobile platforms on clouds to cope with the diverse needs from mobile users with low-end mobile devices.

4.5 Mobile cyber security in MCC

The research on this address security issues and needs at different levels in MCC, including mobile cloud infrastructures, networks, platforms, and service applications. Typical attentions could be given to mobile data and information security, end-to-end mobile transactions, secured mobile cloud connectivity.

4.6 Mobile SaaS

Acording to a recent report from Forrester forecasts, mobile SaaS market will reach over $92 billion by 2016. 'Some existing mobile SaaS examples include Apple's Mobile Me, Funambol, and Microsoft's LiveMesh. For large-scale mobile SaaS applications, we expect to see interesting research topics on mobile SaaS reference infrastructures and architectures, mobile SaaS platforms**.**

[10] Table01- Personal Clouds for Mobile Users

Personal Cloud	Supporting Features	URL address
Lenovo Cloud By Lenovo	Personal mobile data storage and application	http://www. lenovo.com/products/us/Ienovocloud/#lenovocloudstorag
Acer By AcerCloud	Music, photos, videos and document for pc and machines for mobile devices.	http://www.computerworld.com/s/article/9223247/
iCloud By Apple Inc.	Personal storage mobile users, including key values personal data and personal core data.	http:// www icloud com/
Polkast Cloud By Polkast	Docs and photos, as well as videos an Plus music with stream support connectivity between computers	http://support polkast.com/entries/20080987-what-is-polkast

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[11] V. Mobile cloud service models

The concept of mobile cloud computing is categorized in different service models. Some of the prominent models of mobile cloud services are as follows:

5.1 Mobile Cloud Infrastructure as a Service (MIaaS)

This service model provides cloud environment and storage facility for the mobile user. It is like the infrastructure as service model of cloud which provides all the infrastructure for cloud. The example of MIaaS is Apple iCloud: it is Apple's own cloud-based storage system and initially it gives 5GB free storage. The other examples are Amazon Cloud, Dropbox, Google Drive, Microsoft OneDrive etc.

5.2 Mobile Network as a Service (MNaaS)

This service model offers network infrastructure to users for creating network. In other words, we can say that mobile network as a series is used to create virtual network and for connecting mobiles with servers. The example of MNaaS is OpenStsck: it is used to create virtual networks. The other examples are CoreCluster, OpenVZ, SmartOS etc.

2.3 Mobile Data as a Service(MDaaS)

This service model provides database service so that mobile cloud users can perform data management and other operations to their data. Example: CloudDBCloud based database made for mobile cloud computing. Oracle's mobile cloud data as a service

2.4 Mobile Multimedia as a Service(MMaaS)

This service model offers a platform to access or run the multimedia in cloud environment, like playing high-memory capacity required games, playing highdefinition videos etc.

2.5 Mobile App as a Service(MAppaaS)

This service model provides a platform to users for executing app, and the using app also manages the apps using wireless network. Examples: Apple app store, Google play store etc.

2.6 Mobile Community as a Service(MCaaS)
This service model offers the facility to mobile users to create community network or social network and to manage all such networks and get the services needed for them .

[12] VI. Challenges in Mobile Cloud Computing
Mobile cloud computing is a service of cloud computing used in smart phones or in tablets. Mobile computing and cloud computing combine together to form mobile cloud computing and give services of cloud to mobile computing users like on-demand self-service, resource pooling measured services, elasticity, broad network access. Mobile cloud computing uses wireless communication technology to communicate between mobile and cloud. Owing to the combination of mobile computing and cloud computing and use of wireless communication, we face many challenges in mobile cloud computing, such as limited resources for mobile devices, stability challenge occurring due to limitation of wireless network, cost of network access going high various times in
mobile cloud computing.

VI. SECURITY ISSUES IN MOBILE CLOUD COMPUTING

6.1 Data Security issues

In mobile cloud computing mobile user's data is available and stored in cloud and the processing of that data is also done in IaaS of cloud. Many attacks are executed on data of mobile cloud computing like, data loss, data breach, data recovery from damage, data locality, data correctness etc. In data loss, user's data is mussed while performing any

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computational task; for example, while transmitting data through public network. In data breaches, an authorized user's data is accessed by an unauthorized person by injecting into cloud or by getting it using any unwanted activity. In data recovery from damage issues, a user should get a valid data of his own while recovering due to damage of system or mobile device. Cloud stores the data in any data centre; so the location of that data not known to anyone. So the challenge is that the user should know where his important data is stored.

6.2 Virtualization Security issues

Cloud services are provided to mobile users using virtualization. A virtual machine of mobile is re-installed in cloud, which is called as mobile clone, and this cloud-based virtual machine does all the processing. The main advantage of using virtual machine is that it creates instances of various machines and this is achieved through hypervisor. But the challenges to virtual machine used in cloud computing are unauthorized access to the main machine through virtual machine, root attack, VM to VM attack, communication in virtualization and confidentiality of data while being processed through hypervisor.

6.3 Offloading Security issues

Offloading means transformation of task to external platform. Mobile cloud computing requires wireless network for offloading in cloud, but precisely because of this, unauthorized access of data is possible during offloading. The main issue in offloading is availability which happens because of jamming of the mobile device while the offloading is taking place. Also, while offloading of data if it contains any malicious content, then it affects the confidentiality and privacy of the mobile user.

6.4 Mobile Cloud Applications Security Challenges

Various mobile cloud applications are affected by various malware, worms, Trojan-horse, botnet etc., which in turn affect the confidentiality and integrity aspects. These malwares are run in mobile devices and bind themselves in the application and mutate, which cause very serious issues to mobile cloud computing

5.5 Mobile device Security issues

This is the most ubiquitous issue in mobile cloud computing occurring due to theft or loss of mobile device. Here, the main loss is of user's data. If the attacker gets access into any mobile device then unauthorized access to data and application occurs. The device can also be used to do some unwanted tasks like bonnet: to carry out DoS or DDoS attack through mobile device [20]. A new attack related to power consumption is carried out on mobile devices when the device is connected to the wireless network; then its power consumption increases to discharge device battery fast Mostly a mobile device stores user's personal information into internal storage; but when the user uses mobile cloud computing then all data is synchronized to cloud and there the security of user's personal data becomes insecure. In mobile computing, malware and viruses constitute the very old methods of attacks but they are effective and work in mobile devices because mobile operating system is neither secure nor strong.

VII. CONCLUSION

We have extensively reviewed related work and presented the most recent research development in MCC. MCC is an important technology, which is applicable in different service areas including learning, multimedia, banking, healthcare, commerce, and so on. MCC improves the performance of the mobile computing devices by handling the tasks, which are large and complex for MDs capabilities. We also include some issue and challenges of MCC and Architecture regarding it. Hence, MCC is a promising paradigm, which is viable and technologically feasible in the pervasive computing research domain.

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