ORIGINAL CONTRIBUTION

Mobile Cloud Computing (MCC): A Survey of Privacy, Security and their Impact on Social Life of Users

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Abstract— A foremost debated area in the IT world is Mobile Cloud Computing (MCC) which merges cloud computing and mobile computing; MCC is a prospective technology of mobile services that have been inaugurated together with the fast development in mobile applications and cloud computing technology. MCC is in the early phase of development, so it is essential to have in-depth knowledge of the technology to identify future research. Cloud computing has seen exceptional advancement in the past couple of years regarding its turn of application and development. Thus, development and research in cloud computing are scaling in a positive direction because of the increasing demand for cloud computing. On the other hand, no one is concerned about its effect on mental health. People are more concerned about the privacy, access, and security of their data over the cloud. Users are not aware of the data stored in cloud technology. Therefore, end users are always worried about the security and privacy of personal data. When cloud base services are used, users have mental stress because of the unknown place of the data storage. Consistent use of cloud-based services creates a sense of anxiety among users that are more particular about data privacy. The present article gives a transitory explanation of cloud computing and mobile computing. Applications such as M-healthcare, M-commerce, and M-gaming have been discussed to debate potential applications for mobile cloud computing.

Index Terms— Cloud Computing (Cc), Mobile Cloud Computing (MCC), Hybrid cloud, Private cloud, and public cloud
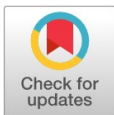
Introduction

The capacity of data to be operated increases expressively due to the progress in computer systems, either due to the increasing volume of the information available or the opportunity to execute extremely complex operations that were not possible in the past. Though, the tasks that are based on the operation of a huge amount of information that is yet performed at a high computational cost that is either the

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enormous processing time or they will need rigorous use of the computer resources (Aliyu, 2020; Hamid, Jam, & Mehmood, 2019; Jam, 2019; Jam et al., 2010)

Storing and computing facilities are delivered through the internet in cloud computing environment by rented data centers, hardware, and software. Ubiquitous data access is made possible due to the storage facility of data on clouds rather than on users' devices (Jam, Mehmood, & Ahmad, 2013; Jam et al., 2014; Jam, Singh, Ng, & Aziz, 2018; Kovachev, 2014) . It mitigates the user's problem of complete software installation and frequent upgrading on their native or confined devices. With software deployed in the cloud, users' applications can be processed on a considerably more prevailing cloud computing platform (Gu, 2018). This research aims to provide a comprehensive survey detailing the privacy and security issues that are caused due to the adoption of MCC. Moreover, to the best of our knowledge, there is a lack of comprehensive surveys of MCC issues concerning societal impacts. This research aims to fill this research gap and link MCC-related privacy and security issues with their social impact.

Cloud computing

Evolving engineering targeted at providing numerous computational and storage facilities over the online network is Cloud computing. The CC framework incorporates medium and software facilities (Wang, 2014). Online access to computer services or resources through enormous groups of distant servers networked together to permit central data storage is called Cloud computing (Mollah, 2017). CC exists when the job and data are retained on the internet relatively than in separate devices, giving the request access. Clouds can be classified as depicted in Figure 1.
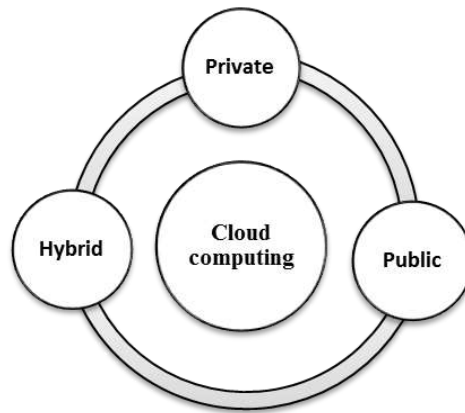

Fig. 1. Classification of cloud

Private cloud

Infrastructure cloud functions exclusively for a sole organization is the Private cloud (Shukur, 2020). It is hosted by the organization itself or may be managed by any other organization. The private added advantages of virtualization with the cloud model are similar to organizations' more conventional model of local access networks (LANs) earlier.
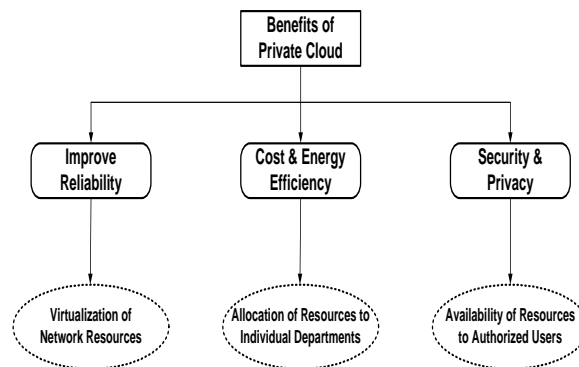

Fig. 2. Benefits of private cloud

Public cloud

The public cloud model is accessible over a public network such as the internet, in which cloud services are delivered in a virtualized environment (Ullah, 2014). Public cloud services may be offered for pay or free, depending upon the usage model. Technologically there may be no difference or a little between private and public cloud architecture. However, the security contemplation may be considerably different for the service (other resources, applications, and storage) readily available by the service provider to the public. At the same time, communication is influenced by the non-trusted network (Boukerche, 2019).
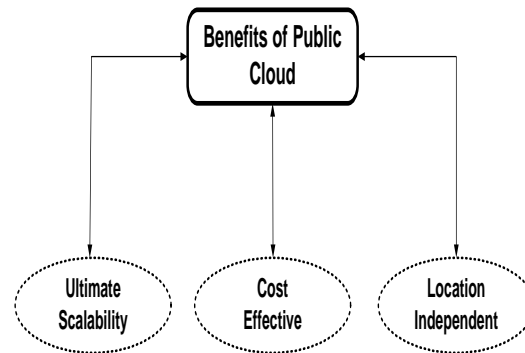

Fig. 3. Benefits of public cloud

Ultimate scalability

Enormous pools of resources are reachable on demand from public clouds, so applications that process on them could respond seamlessly to the variations in activity (Sun, 2020).

Cost effective

The greatest economies of scale could be benefitted from public clouds via a greater level of resources. The management and centralized operation of underlying resources are shared over the consequent cloud services and components, like servers (Tabrizchi, 2020). On the other hand, several bunch market suggestions still are freely approachable by clients, depending on publicity for their earnings.

Location independent

Availability of public cloud services via an internet connection assures that services are accessible anywhere the client is situated. This provides valuable opportunities to the enterprise, e.g., online document cooperation from multiple locations or remote access to the IT substructure (in case of emergencies, etc.) (Rodriguez, 2017).

Hybrid cloud

The hybrid cloud combines the benefits of both private and public clouds. The dispense of applications through both public and private clouds is introduced by Hybrid clouds (Srivastava, 2018). The hybrid cloud has furthermore termed hybrid IT. A hybrid cloud implementation policy should address budgeting, security, change control, fault management, and configuration management to be operative.

MCC

The infrastructure formed by combining cloud computing, mobile computing, and wireless networks to provide mobile users with complex computational resources is known as MCC (Wang, 2014) . In MCC, collectively, the data storage and the data processing take place outside the mobile device (Shamshirband, 2020).

Architecture of the mobile cloud computing (MCC)

The mobile devices are linked with the mobile networks through the base stations, which control and establish the functional interfaces and the connection between the mobile devices and the networks (González-Martínez, 2015) . At the request of Mobile handlers, the information's transferred to the central processors, which are connected with the servers giving facilities to the mobile network. Users'

requests are carried over the internet to the cloud. In the cloud, the cloud controller operates upon the requests to offer the agreement upon cloud services to mobile users (Khan, Shahbaz, & Jam, 2019; Khan et al., 2012 ; Noor, 2018). Based upon the subscriber's data stored in the databases, the Home Agent (HA) is used to provide user services (such as authorization, authentication, and Accounting). After that, the user requests are transported to the cloud. These amenities are based on the use of virtualization, service-oriented architecture, and computing. The specifics of cloud computing would be altered from different perspectives. Saving data on the cloud using cloud technology on the clients to access the data is the main objective of the cloud computing system (Aliyu, 2020). 4, given below, illustrates this concept.
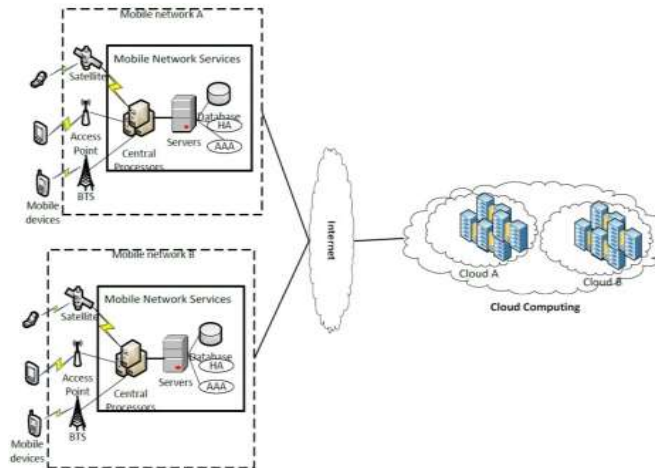

Fig. 4. Architecture of the mobile cloud computing

Benefits of mobile cloud computing

Due to mobility, communication, and portability, cloud computing is a promising solution for MCC (Elgendy, An efficient and secured framework for mobile cloud computing, 2018). The figure below lists the benefits of mobile cloud computing.
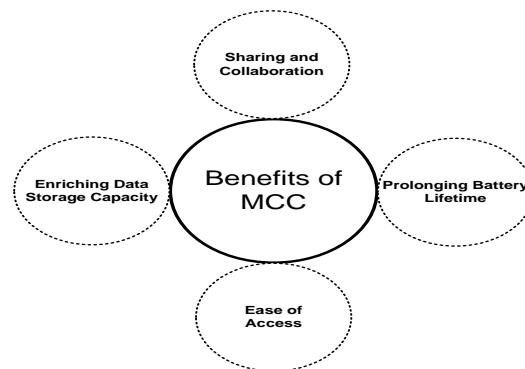

Fig. 5. Benefits of MCC

Sharing & collaboration

A yielding way for the mobile users and the service providers to process their applications without advance reservation of the resources is the Self-service basis though on request dynamic provisioning of the resources on the fine-grained (Shorfuzzaman, 2019).

Scalability

Flexible resource provisioning is the utilization of mobile applications that could be accomplished to meet and measure the impulsive demands of the users (Lo'ai, 2021). Application Services, with or without the little limitation on resource usage, can easily add and expand by the Service providers (Almaiah, 2020).

Multi-tenancy

In order to support the diversity of the applications and a huge number of users, the Service providers (such as owners of the data center and the network operator) can share their costs and resources (Dinh, 2013).

Ease of Integration

In order to meet the user's demands, the numerous amenities from the various service providers could be combined without difficulty over the internet and the cloud (Alzahrani, 2014).

Uses of Mobile Cloud Computing

Overall mobile market Mobile programs achieve an upward share. Numerous mobile programs have benefited from MCC (Pramanik, 2019; Murphy, 2022). In this segment, some characteristics of MCC uses are presented as under in 6.
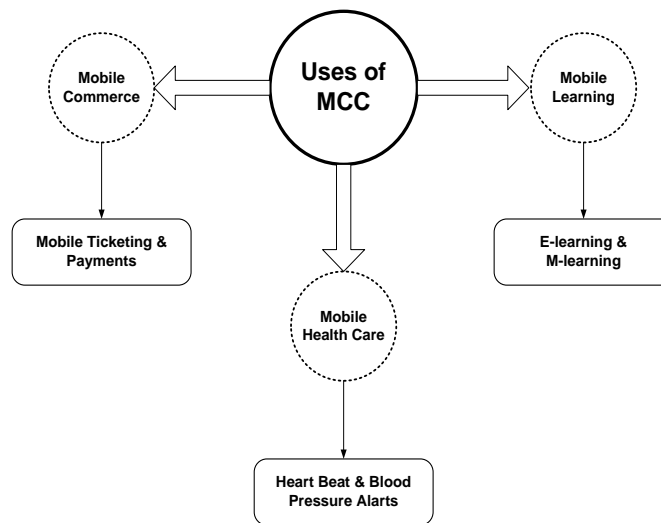

Fig. 6. Uses of MCC

Mobile-commerce

Mobile commerce (m-commerce) using mobile devices are the business paradigm for commerce. Mobility of the task is normally achieved by m-commerce applications (Chouchane, 2022). Classifying m-commerce applications can be done into a few classes: shopping, advertising, and finance. Thus, these possibilities to be an enormous area of publicizing in the future (Almazroa, 2019). Huge complications of mobile device Configurations and security laminate network bandwidth are various issues that the m-commerce applications have to experience. Therefore these issues are discoursed by combining m-commerce applications into a CC environment. (Jin, (2018))Suggests a 3GE-commerce platform based on CC. The benefits of the third generation (3G) network and CC standard are grounded on public key infrastructure (PKI) to enhance the security level and the data processing speed to certify the confidentiality of the user's to retrieve and allocate the data access control. PKI mechanism is totally based on encryption (Kang, 2018; Mohammed-Ali, 2018).

Mobile learning

Electronic learning (e-learning) and mobility are designed based on Mobile learning (m learning). Though, low network transmission rates, high cost of devices, and restricted educational resources are the restrictions for the conventional-learning software (Wu, 2012; Ghazizadeh, 2012).

Mobile healthcare

For better care of patients in healthcare environments, mobile computing devices have been used that help in quicker and easier data access, thus ensuring improved treatment (Aceto, 2020). It is made possible through wireless technology with the help of Mobile healthcare

(m-healthcare) that facilitates victims to be supervised at anytime, anywhere (Shah, 2013; Suganya, 2018). Also, the emergency system alert and health-conscious mobile devices are used to detect pulse rate and blood pressure to save patients from any hazards. Moreover, the patient's current and past medical reports of patient's data can be accessed at the tip of their fingers by using m-healthcare, and other healthcare organizations can use it. Mobile computing devices provide additional facilities more effectively, with a lesser fault ratio, creating more free space, less confusion, and minimizing costs via connecting with automated health systems (Somula, 2018).

Additional uses

Mobile users share their videos and pictures with the people upon widespread community interacting websites such as Twitter and Facebook, which the MCC will assist. Cloud services, for example, route guidance and different applications that give area-based information like discovering the nearby weather, street activity, or nearby restaurants, are also provided to Mobile clients (Maray, 2022).

Challenges and Solutions

Users use their mobile devices to access the data from the cloud conveniently and quickly is the fundamental objective of mobile cloud computing; while improving the user's accessibility, numerous issues still remain in the grasp of MCC (Jebbar, 2013; Amin, (2013,). 7 shows some challenges of MCC.
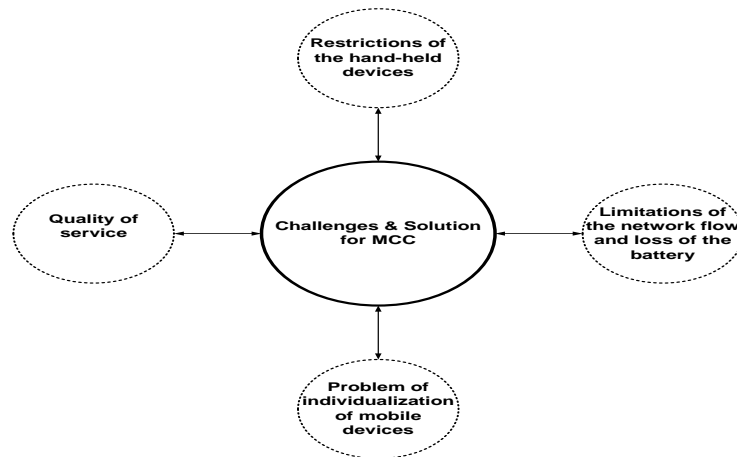

Fig. 7. Challenges &Solutions for MCC

Restrictions of the hand-held devices

A resource constraint is the first thing that must be considered even when conversing about mobile devices using CC (Shakarami, 2020). Even though mobile devices have enhanced in all perspectives, such as the size of the screen, storage, CPU capacity, remote correspondence, and operating system, there are some severe restrictions in computing capacity and vitality sources to build diverse applications. While mobile phones are constantly refining, the enormous inconsistencies still pretense a restraint to MCC (Buyya, 2018).

Limitations of the network flow and loss of the battery

An application that needs a lot of the network stream and battery will be difficult to set up on mobile devices (Amin, 2013; Garcia, 2011). This constraint can be minimized by optimizing the cloud end to reduce the volume of data transactions and data exchange rate between cloud and mobile devices (Popa, 2013; Jiang, 2020).

The problem Of Individualization Of Mobile Devices

In order to build an application that depends on the hand-held device, it is necessary to make the user end of the application software simple to meet the requirements of numerous hand-held operating systems (Guo, 2018). Simple client end means that a huge quantity of data computing can be set in the cloud end, and the client side can be prepared with the standard to run on any mobile device without making the abundant alteration (Toosi, 2014).

Quality of service (QoS)

As the Internet service provider is generally distant from the mobile device, the user's data transmission rate in the MCC atmosphere is ever-varying, and linking is intermittent (Dev, 2014). 'The possible interruption period in a wired network is 50 milliseconds while in wireless networks it may be 200 milliseconds". Dynamic modification of application output, users' freedom of movement, and even climate are responsible for deviation in bandwidth and network connection (Phuoc Hung, 2014). Thus, the delivery postponement in the mobile network is greater than in the wired network. When requesting services and resources, mobile users have to communicate with the servers situated in the cloud (Akherfi, 2018). When the users want to connect with the cloud, mobility causes some problems that the mobile users might face, such as signal reduction, network disconnection, and blocking due to restriction of the wireless bandwidths; this causes delays, so QoS is reduced sensitively (Basha, 2014).

Open issues in MCC

Though valuable exploration and progress in MCC exist in the literature, there are numerous areas in which enhancements must be made to acquire the full remunerations of MCC (Arpaci, 2019).

Data distribution

Mobile devices have prospective issues in cloud retrieving, reliable retrieving, data communication, and so on due to resource limits (Kadibagil, 2014). These issues can be resolved via middleware, and the special application (service) provides a platform for all the MCC systems (Pramanik, 2019; Donald, 2013).

Job partition

Dividing the jobs (applications) from the mobile devices into the various sub-jobs and distributing a few to process in the cloud is a good elucidation for a resource-restricted mobile device (Almusaylim, 2020). Though, we do not have an optimum approach or procedure for splitting these jobs, which one would be processed by the devices and the cloud (Fiandrino, 2019).

Enhanced facility

Provisioning of the PC-liked facilities to the mobile stations is a unique tenacity of MCC (Zeng, 2018). Though, there exist differences in applications between PCs and mobile devices. We could not straightly transfer the services to mobile devices from PCs (Elgendy, An efficient and secured framework for mobile cloud computing, 2018). So, to discover techniques on how to deliver responsive and appropriate communication services for mobile devices, additional research is needed (Ma, 2021).

Future Direction

As mobile cloud computing is the latest technology, so it still has a possibility for future research extensions in the areas such as:
- A single accessible forum for mobile cloud computing using numerous operating systems (e.g., MeeGo, Symbian, Apple, Chrome, Android) needs to be established.
- Security issues are yet alarming; hence there should be a reasonable solution to it
- Mobile cloud Architecture for the diverse wireless network must be investigated.

Conclusion

Data computation has been considered an essential source in various states because of the continuous increase of data calculation in science and commerce; scalability and mobility have inherited MCC as the development and extension of MC and CC. In this paper, we have given an overview of CC's definitions, establishing elements ("that are cloud platform and cloud applications), and finally, we have discussed the challenges of cloud computing in mobile applications and their possible solutions.

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