ADVANTAGES OF MOBILE CLOUD COMPUTING

Mr. C.Arun[1], Dr. K.Prabu[2]

[1]Research Scholar, PG & Research Department of Computer Science, Sudharsan College of Arts & Science, Pudukkottai

[2]Assistant Professor, PG & Research Department of Computer Science, Sudharsan College of Arts & Science, Pudukkottai

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Abstract - *With modern smart phones and powerful mobile devices, Mobile apps provide many advantages to the community but it has also grown the demand for online availability and accessibility. Cloud computing is provided to be widely adopted for several applications in mobile devices. However, there are many advantages and disadvantages of using mobile applications and cloud computing. Mobile Cloud Computing has originated from mobile computing and cloud computing, but there are significant differences between mobile cloud computing and cloud computing, and between mobile cloud computing and mobile computing. This paper presents an overview of MCC, cloud computing, mobile computing, discuss about the applications of mcc and advantages of MCC.*

***Key Words*:** Mobile, Mobile Apps, Mobile Computing, Cloud Computing and Mobile Cloud Computing.

1. INTRODUCTION TO MOBILE COMPUTING

Mobile communication is the process of executing computations on a mobile device and transmission of data to and from one or more devices [1]. It is the technique of getting connected and making use of centrally located information and application software with the deployment of small, portable wireless communication and computing devices [1–3]. Mobile communication facilitates the execution of a number of applications on a single device. In this ultramodern world, everything is exceedingly reliant on technology. With the increase in the number of mobile users day by day, the need to provide better quality of service at very low power and cost also increases.

2. GENERATIONS OF MOBILE COMMUNICATION

Budding technologies such as fourth generation (4G) and fifth generation (5G) attract a huge portion of engineering and commerce. However, second-generation (2G) and third generation (3G) networks remain highly important and support nearly 80% of the mobile phone industry [1]. With the passage of time and improvements in technologies, mobile communication and computing have evolved from first generation (1G) to fifth generation(5G). The first generation of mobile communication was capable of providing only voice services. In addition to this capability, the second generation of mobile communication was capable of providing data services as well. The third generation provided multimedia services in addition to the services provided by the second generation. The fourth generation of mobile communications supported 3D audio and video in addition to the features supported by the third generation. The fifth generation of mobile communication swill support complete multimedia using cloud-based off loading. In this section, we present an analysis of the evolving generations of mobile communications and computing.

3. CHALLENGES OF MOBILE COMMUNICATION

Mobile communication is gaining utmost importance with the increasing usage of portable computers and the need to access the Internet irrespective of the location of the user [1].The effectiveness of upcoming technologies lies in their capability to offer more and more innovative applications and contribute to their growth. Mobile devices are expected to meet the goals of effectiveness and convenience. Although mobile devices have attained heights of success, they still have some drawbacks. The drawbacks or challenges faced by mobile communication are divided into the following [4]:

1. Mobility

a. Changing network address

b. Locality migration

c. Location management

d. Mobile network traffic forecasting

e. Mobile call admission control and handover management

2. Resource limitation

a. Data storage

b. Power consumption

3. Wireless communication

a. Network disconnection

b. Network bandwidth

c. Network optimization for confined areas with high user concentration

d. Variable network conditions

e. Security issues

4. Mobile channel models

5. Disaster management

6. Mobile data mining

7. Quality of service

Mobile communication is one of the primary areas of science and technology that has been focusing on the way information exchanges between individuals and organizations via mobile devices. The evolution of mobile communication replaced the usage of telegrams and letters with mobile phones and emails. Mobile communication has recently become the spine of civilization. The technology of mobile communications has improved the art of living and made lives easier. But it comes with certain challenges.

4. CLOUD COMPUTING

Cloud computing is an evolution in the field of computer science and technology. In the twenty-first century, computer users access Internet services via lightweight portable devices because powerful desktop machines are going through a phase of drought. Cloud computing is emerged as a solution to this problem. Cloud is a distributed computing paradigm. It is a collection of interconnected and virtualized computers, which are provisioned and presented dynamically as unified computing resources offered on a pay-per-use basis [5]. Cloud computing is defined as applications that are delivered as Internet services: the hardware and system software in the data centers are used to provide these services[6]. Cloud computing is an advanced technology that focuses on the way of designing computing systems, developing applications, and leveraging existing services for building software [7]. It is based on dynamic provisioning [7]. In cloud computing, resources are offered in an on-demand and pay-per-use basis from the cloud computing vendors [7].

5. CHARACTERISTICS OF CLOUD COMPUTING

The characteristics of cloud computing are indispensable for the clear understanding of the concept of cloud computing.

Broad network access: Capabilities are accessed over the network using standard methodologies that promote the use by heterogeneous thin or fat client platforms such as laptops, PDAs, and mobile phones.

On-demand self-service: A user can provision computing capabilities such as server time and network storage automatically whenever needed without human intervention with service provider.

Resource pooling: The service provider's computing resources such as storage, memory, network bandwidth, processing, and virtual machines are pooled to serve multiple users based on a multi-tenant model. Different physical and virtual resources are rapidly assigned and reassigned according to user demand. In this case, the subscriber has no knowledge or control over the accurate location of the provided resources though the location at a higher level of abstraction can be specified; this is an example of location independence.

Rapid scalability and elasticity: Capabilities are rapidly, elastically, and sometimes automatically provisioned to quickly scale out and released to quickly scale in. Consumers can purchase the capabilities at any time in any amount, which are available for provisioning and often appear to be unlimited.

Measured service: Leveraging a metering capability at some level of abstraction suitable to the service type, cloud systems automatically manage and optimize resources. Resource usage can be observed, controlled, and reported by offering transparency with respect to both users and service providers.

6. CLOUD COMPUTING DEPLOYMENT MODELS

A cloud environment (IaaS, PaaS, and SaaS) can be deployed using the following three main models [8], public cloud, private cloud, and hybrid cloud.

6.1 Public Cloud

A public cloud is shared and used by customers via the Internet; for example, AmazonWeb Services is the leading public cloud provider. The benefits of public cloud are as follows[8]:

• Very low-cost because all the virtual resources, whether hardware, data, or applications, are enclosed by the cloud service providers.

• Storage efficiency and computational services.

• Easy to connect to the cloud servers and to partake of information. Assures suitable use of resources because customers only pay for the services they need.

• Widely spread availability irrespective of geological area.

• Public cloud empowers workers and enables them to be productive even outside the office. The SaaS model makes sure that while delivering the flexibility of output software on the cloud, corporations save on IT expenditures.

The disadvantages include the following:

• Variety of applications, such as Microsoft–Amazon incompatibility

• Security issue

6.2 Private Cloud

A private cloud is a network of all services or a data center that stores hosted services for a restricted number of people [8]. When public cloud resources are used by a service provider to create a private cloud, it is called a virtual private cloud. Whether it is a private or public cloud, the objective of cloud computing is to provide scalable and easy-to-access computing resources and IT services.

6.3 Hybrid Cloud

Sometimes, it may happen that private clouds run out of capacity. To overcome this problem, hybrid cloud is introduced. It is an integration of two or more clouds that remain distinctive entities but are bound together.

7. MOTIVATION TO MOBILE CLOUD COMPUTING

Mobile cloud computing is defined as a rich mobile computing technology that controls integrated elastic resources of different clouds and network technologies toward unlimited functionality, mobility, and storage in order to serve a large number of mobile equipment anywhere and at anytime through the Ethernet channel or Internet in spite of heterogeneous environments and platforms on the basis of the pay-as-you-use principle [9]. MCC is an infrastructure where the data storage and the data processing are performed outside the mobile device but inside the cloud. In MCC, the computing power and data storage are moved away from mobile devices and performed in the cloud, bringing mobile cloud applications and mobile computing not only to Smartphone users but also to a wider range of mobile subscribers [10]. So, MCC is an infrastructure that combines the mobile computing and cloud computing domains where both data storage and data processing happen outside the mobile device. It is not always that offloading will be to a remote cloud, but it can be to a local cloudlet or to the collective resources of mobile devices in the local vicinity. The motivation behind MCC is simply to remove the existing drawbacks of mobile computing. There are several limitations of mobile computing discussed, which are as follows [11]:

1. Limited battery life of mobile devices: Because of the mobility of the device, it is impossible to find an external power source every time. Mobile devices have to rely on the internal battery, which has a charge life of only a few hours, in most cases. If computation is continuous or various applications are running continuously, battery will drain soon.

2. Limited storage capacity of mobile devices: Each mobile device has a limited amount of internal memory. A well-configured smart phone has only 8 GB of internal memory, and a laptop has 500 GB of storage. Though they can be expanded using external memory, in case of organizational data backup, they are insufficient.

3. Limited processing power of mobile devices: Smartphones have ARM processors, which are capable of running only small and a limited number of applications. Though laptops have i3, i5, and i7 type 3G high processing units, often they are not affordable due to their high cost. Processors are an irreplaceable part of a mobile device, so if anyone wants to upgrade it, it may not be possible.

4. Low bandwidth: In mobile computing, EDGE, GPRS, and GSM technologies have very low bandwidth. Though 3G and 4G technologies such as HSPA, WCDMA, LTE, and so on, are

popular, they are available only in a limited number of cities/towns, at too high a cost.

All these problems can be solved only by a cloud platform with MC. Cloud is a very large, virtualized, shared resource or infrastructure that has the capability of computing, analyzing, and warehousing a large amount of data. Cloud serves its clients on an "on demand,""pay as you use" basis, in much the same way as using electricity from a service provider. Because of the elastic nature of cloud, a client can get the desired amount of service as his or her requirements change, and with a high-speed Internet connection, the user canget seamless service from cloud providers. Hence, MCC has become much more feasible than Mobile Computing.

8. MOBILE AD HOC CLOUD OR MOBILE CLOUD

Mobile ad hoc cloud is a group of mobile devices in the vicinity willing to share their resources with each other by taking some incentives. MAC is a new type of MCC. It is usually deployed over mobile

ad hoc networks [12], which allows the execution of compute-intensive applications by leveraging the resources of other mobile devices. As an alternative solution, MAC is an emerging paradigm that mitigates several bottlenecks of server-based cloudlet such as longer delay and low throughput. Moreover, MAC offers a viable solution for a mobile device to execute an application when there is no or weak wireless Internet connection to the remote cloud or the nearby server-based cloudlet is not available. In MAC, mobile devices are expected to manage the cloud, authenticate the users, monitor the resources, and schedule the tasks besides executing the application. Such additional functionalities consume mobile device energy and processor cycles. Finally, local stationary devices such as personal computers and set-top boxes can also become members of MAC.

9. IMPORTANCE OF MOBILE CLOUDAPPLICATIONS

Mobile cloud computing is a very important mobile technology since it combines the advantages of the integration of both cloud and mobile computing to provide the best services for mobile users. There are many applications supported by mobile cloud computing including mobile commerce, mobile banking, mobile learning, and mobile healthcare and other areas. Various mobile applications have taken the advantages of mobile cloud computing such as:

9.1 Mobile Commerce

Mobile commerce or M-Commerce is a business model for using mobile devices in commerce. The M-Commerce applications generally applied for some tasks that require a kind of mobility e.g., mobile ticketing, mobile payments, mobile transactions and mobile messaging. Using M-Commerce applications have open many challenges such as, high complexity of mobile device configurations, low network

bandwidth, security and information flow control. Thus M-Commerce applications integrated into cloud computing environment to address these issues.

9.2 Mobile Learning

Mobile learning or in short M-learning is designed as a combination of electronic learning (e-learning) and mobility. In fact, that the traditional M-learning applications have many limitations such as high cost of devices, network prices, and limited educational resources. Cloud based M-learning utilizes the cloud with the powerful processing ability and large storage capacity, where the applications provide learners with richer services in terms processing speed, capacity of data (information)size and longer battery life.

9.3 Mobile Healthcare

Mobile cloud computing is used in medical applications to reduce the limitations of traditional medical treatment e.g., medical errors, computation speed, small physical storage, security and privacy. Mobile health care (M-Healthcare) supports mobile users with convenient helps in easily accessing the required resources e.g., patient health records or medical staff profile). M-Healthcare offers many on-demand services on cloud to the hospitals and healthcare organizations rather than owning standalone applications on their local servers.

9.4 Mobile Banking

Mobile banking (M-Banking) refers to any operation that related to banking services such as balance check, account transactions, payments and receiving banking SMS via a mobile device. M-Banking today is most often performed via SMS or the mobile Internet but can also use special programs, called clients, downloaded to the mobile device. Cloud based M-Banking apps addresses many M-Banking apps issues such as processing speed and storage capacity.

9.5 Mobile Gaming

Mobile game or (M-Gaming) is a potential market generating revenues for service providers. M-gaming can completely offload game engine requiring large computing resource e.g., graphic rendering to the server in the cloud, and gamers only interact with the screen interface on their devices demonstrates that offloading (multimedia code) can save energy for mobile devices, thereby increasing game playing time on mobile devices.

9.6 Mobile Government

Mobile government (M-Government), is the extension of e-Government to mobile platforms to utilize the government services and applications using mobile devices integrated with wireless Internet infrastructure. M-Government Involves the deployment of government's services and administration on mobile devices to make the government services available anytime, and anywhere.

10. ADVANTAGE

There are many advantages come with mobile cloud computing to both end users and businesses of different sizes. The obvious and big advantage is that users are no more having to care about the infrastructure or have to know about the development and maintains of the infrastructure. The following are some of the most important advantages of cloud computing:

10.1 Storage

The cloud can accommodate and store much more data compared to a personal computer. Using the cloud, basically allow access toun limited storage capability and scalability. Thus, no more infrastructure investments or time spent adding new servers. The cloud minimize worries about running out of storage space and at the same time cloud spares businesses the demand to upgrade their computer hardware, further reducing the overall IT cost.

10.2 Flexibility

Infrastructure can be scaled to maximize investments. Cloud computing allows dynamic scalability as demands fluctuate. The cloud is not dependent on local hardware or software, thus the user gains a new level of flexibility in terms of accessing the solution.

10.3 Cost Efficiency

The cloud cost is based on the subscription model, in some case sit can be pay as you go services, thus whichever works best with organization business model. Regardless the infrastructure cost, cloud minimizes cost of other services e.g., updating and managing applications and decreases on-site energy costs.

10.4 Mobility and Availability

The cloud mobility supports access anywhere using a Web connection. The cloud is anywhere, whether with it's owned development platform or not. Cloud provides services that are available wherever the end user might be located. In which it supports easy access to information and accommodates the needs of users in different time zones and geographic locations. Cloud support easily than ever to access, view and modify shared documents and files.

10.5 Backup and Disaster Recovery

Most types of cloud computing providers across service types and platforms offer comprehensive, reliable and flexible backup and recovery solutions. Using the cloud, the process of backing up and recovering data is simplified in which its now reside on the cloud not on a physical device

itself. The cloud itself is used solely in some cases as a backup repository of the data stored in local computers.

10.6 Resiliency and Redundancy

A cloud computing deployment is usually built on a very strong architecture thus providing resiliency and redundancy to its users. The cloud provides automatic failover between hardware infrastructures out of the box, while disaster backup recovery services are also often included.

10.7 Scalability and Performance

Scalability is a built-in feature for cloud deployments. The cloud instances are deployed automatically on demand and as a result, users are paid only for the required applications and data storage. The cloud is scaled to meet the required changes in IT system demands. In terms of performance, the cloud utilizes distributed system architectures that offer excellent computations speed.

10.8 Quick deployment and ease integration

A cloud can be deployed and run in a very short period. On the same aspect, introducing a new user in the cloud happens instantaneously and quickly, eliminating waiting periods. Moreover in the cloud applications integration occurs automatically in the cloud installations user and business are supported to choose the required services and applications that best suit their preferences, while spends minimum effort in integrating and customizing those applications.

10.9 Cloud is environmentally friendly

The cloud saves energy due to the fact that it takes fewer resources to compute comparing with the typical IT infrastructure. e.g., in case those servers are not used, normally the whole infrastructure scales down, freeing up resources and consuming less power. At any time, only the necessary and required resources are consumed by the system.

11. CONCLUSIONS

The emergence of cloud computing and mobile technology has brought a new dimension to network as a service called mobile cloud computing. Mobile cloud computing is one of the mobile technology trends in the future since it combines the advantages of both mobile technology and cloud computing, thereby providing optimal services for mobile users. The paper has provided a brief overview of cloud computing, its services and models. The paper described the concept of mobile cloud computing and discussed the importance of mobile cloud computing. It has discussed the advantages of mcc.

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