Mobile Cloud Computing as Competence Intensifier

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Abstract:
Since the arrival of mobile devices, such as Personal Digital Assistants (PDA's), smartphones, tablets etc., and their amalgamation with cloud computing is bringing up and transforming ubiquitous computing into actual existence. This concept of ubiquitous computing straightens out the way to unusual and experimental applications, in which the mobile devices are integrated and provide assistance to the users. This paper discusses about the concept of mobile cloud computing, identify advantages and disadvantages of collaborating mobile applications with cloud and identify benefits of leveraging mobile learning services on cloud. Mobile cloud computing induces innumerable benefits and overcomes the technical limitations of mobile learning.

Introduction:
Now days, mobile phones are increasing day by day and it is becoming part of human life as most effective and convenient communication tool and is not bounded by time and place. Information Technology plays an important role in educational sectors also. Due to the growth of educational institutions all over the world there is a requirement of developing cloud architecture which can help storing and processing large information produced by these institutions. The rapid growth of mobile applications and also emerging of cloud computing results in recommending mobile cloud computing for various services like health sectors (M-Health), commerce (M-Commerce), gaming (M-Gaming) and education sectors (M-Edu) [8]. Mobile Cloud computing can be a solution for storing the educational data into more systematic manner and it can be reached out easily to all kind of people in all regions.

Statistics of Smartphone users in India:
There is a rapid increase in the use of mobile phones among common people worldwide. Even the smartphone penetration rate has increased worldwide and even in India. The statistics [10] shows that worldwide, the number of smartphone users is predicted to spring up from 2.1 billion in 2016 to around 2.9 billion in 2020.
For 2017, the numbers of mobile phone users in India were approximately about 730.7 million. In this same year the numbers of smartphone users in India were about 340 million and are predicted to reach almost 468 million by 2021.
Hence, smartphone users can be provided with the facility of moving anywhere and accessing the data any time.
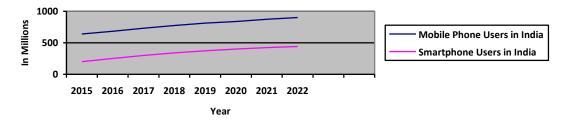

Fig.1 Graphical representation of mobile and smartphone users over the years

Mobile Computing:

Mobile Computing is marked as the use of portable devices to run standalone applications and/or to access remote applications via wireless networks [2]. In other words, it is the technology which enables to transmit data, voice and video signals through a computer or any wireless device without having any wired connection. For this process, it requires mobile communication (mobile network), mobile hardware (mobile devices) and mobile software.

Cloud Computing:-

Cloud Computing was materialized to help users to run their newest software applications without worrying about the device requirements. The most common and standard definition of Cloud Computing is the one from National Institute of Standards and Technology (NIST) [1] which states that "Cloud Computing enables on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service interaction"[2].

The main service models provided by the Cloud Computing paradigm are: Platform as a Service (PaaS), the customer can develop his/her application on the provider supported platform; Infrastructure as a Service (IaaS), the provider hosts the consumer's virtual machines and provides networks and storage; and Software as a Service (SaaS), only hosted applications are provisioned [3].

In addition to these service models, four deployments have been added: Public cloud, Private cloud, Community cloud, Hybrid cloud.

Mobile Cloud Computing:-

The Mobile Cloud Computing (MCC) is defined as *"Mobile Cloud Computing at its simplest, refers to an infrastructure where both the data storage and the 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 mobile computing to not just smart phone users but a much broader range of mobile subscribers"* [4].

Aepona [5] describes Mobile Cloud Computing as a new exemplar for mobile applications whereby the data processing and storage are moved from the mobile device to substantial and unified computing platforms located in clouds. These centralized applications are then accessed over the wireless connection based on a thin native client or web browser on the mobile devices. Briefly, Mobile Cloud Computing provides mobile users with the data processing and storage services in clouds. The mobile devices do not need a powerful configuration (e.g., CPU speed and memory capacity) since all the complicated computing modules can be processed in the clouds.

Mobile devices have to confront with many resource challenges such as less storage space, low battery life, less bandwidth etc. Mobile Cloud Computing allows users and renders advantages by permitting them to avail the facility of infrastructure, platforms and software by cloud providers at affordable cost and in a flexible on-demand fashion. Mobile cloud computing issues data storage and processing services to the mobile users in the cloud, without the need to have a powerful device configuration (e.g. memory capacity, CPU speed etc.), as all resource-profound computing can be executed within the cloud.

Hence, mobile computing can be integrated with cloud computing to raise its strength.

Advantages of Mobile Cloud Computing [6], [7]

1. Some mobile applications need extensive computations and such computations can be offloaded from mobile devices to servers in cloud. This results in low power consumption, enhances CPU performance and extends battery lifetime.

2. Mobile cloud computing enables mobile users to store and access large data on the cloud. Mobile applications now no longer have limitations of storage capacity of the device.

3. It improves reliability and availability as it keeps the data and applications in the cloud and hence reduces the potential risk of losing the data in case of hardware failure.

4. All types of security measures are taken into consideration for keeping the data secured in the cloud. Mobile cloud computing can be outlined to provide with an extensive data security representation for users as well as service providers.

5. The data and services in the cloud are always available even when the users are moving from place to place and can get access to the recently updated documents. The mobile applications can be run without advanced booking of the resources which is called as dynamic on-demand provisioning.

6. The categorization of mobile applications can be scaled to meet the growing user demands due to adaptable resource allocation process. With very small amount of limitations on resource usage, the service providers can add an application and service.

7. In Mobile cloud computing, the network operators and data center owners can easily share the resources and costs to shoulder up variety of applications and numerous users.

8. Multiple services can be integrated very easily through the Internet and cloud to meet today's complex user demands from different providers.

Applications of Mobile Cloud Computing

Mobile cloud computing is the important technology because it integrates both mobile and cloud computing and is modelled to be accessible over the internet. Some of the real world applications [8] are discussed below:

1) Mobile Commerce- Mobile commerce (m-commerce) is a business model for using various mobile devices in commerce such as for e-shopping, e-banking, e-advertising. These applications manage and achieve various jobs which require a type of mobility such as mobile ticketing, transactions through mobile, mobile messaging, content purchase and delivering the content. Mobile commerce, when working in cloud environment helps to resolve the issues related to high complexity, low bandwidth and security. It determines the security measures to be considered to accommodate a high amount of traffic due to concurrent access by the users.

2) Mobile Social Networking- In this application, a group of mobile users are allowed to transfer audio files or video files or any multimedia data for sharing it online users. Along with data transfer it also provides security to protect the data and maintain its integrity.

3) Mobile Healthcare- The main motive of mobile cloud computing in healthcare is to reduce the obstacles we come across in traditional medical care and treatment. It also minimizes the limitations to keep the patient's data and treatment secured and private. It allows to store large amount of data on the cloud and hence makes it easy and feasible for remote diagnosis which helps doctor to continuously monitor the patient's health.

4) Mobile Gaming- Mobile gaming (m-game) minimizes the amount of large computing resources required by offloading the game engine to the server on the cloud and hence saves the energy for various mobile devices and increases the time for playing game on mobile devices. The person having the game only interacts with the screen, whereas need not worry about any resources. M-Gaming attains scalability through scalable computation and by immediately updating the data on the cloud and the screen refresh on the mobile device.

5) Mobile Sensing- This mobile cloud application uses a smartphone equipped with sensor which collects data from other mobile cloud applications. It includes, social networking, healthcare, health monitoring, environment monitoring etc.

6) Mobile Email- This is the most known and common application of mobile cloud computing. When a user is accessing mobile email means he is connected to cloud. All emails are stored on the server which is outside the mobile phone and all the processing is performed on the cloud. Mobile email permits the users to read/ view, send reply email, and manage all the other functions anytime and anywhere.

7) Mobile Learning- Mobile learning (m-learning) is a step towards learning anywhere and anytime and student centered learning. The base of it is mobility and electronic learning or e-learning. It is initiated to resolve the constraints of limited and high cost of educational resources. Conventional m-learning applications have certain limitations about less rate of transmission, high cost devices; limited resources related to education. All these limitations are overcome through cloud based m-learning. It provides the students with huge data and information storage capacity, faster processing speed and processing ability and longer battery life.

Mobile Cloud Computing in Education sector

In the investigation and analysis with respect to education, the past few years have been years of evolution. Most of the independent educational organizations all over the world have started receiving enthusiastically the different types of cloud technologies and imparting them as principal potentiality of their teaching/learning structure. All over the globe the national and international sponsoring agencies developed policies and work procedures to hold projects directing to foster the use of cloud in investigation and analysis related to education. The European Commission and the American National Science Foundation [9] both have accepted the steady growth of cloud technology in the education sector. The advantages [7], [8], [6] of using mobile cloud technology in education sector are:

1) It allows its users to store and share massive amount of data and information on the cloud in the form of audio and video lectures, eBooks, applications, documents, images, photos and many more.
2) It saves all the content and organizes it properly without the risk of being deleted. All the information of the documents will remain safe and protected. It insures reliability and availability of the resource materials saved on the cloud server.
3) Cloud based mobile learning is student centric or learner oriented. The learners can choose the appropriate learning resource and may track their own learning progress and learning outcomes.
4) The learners can study as long as they like and from any location at any time. They can form groups online and collaboratively study and share the resources. For both the lecturers and students this becomes beneficial to carry out group projects and collaborative lesson plans.
5) As the study material is available online at any time, the student is not required to spend time taking printouts or copying the lengthy documents.
6) The lecturers can also post the assignments online and can very easily keep track of assignment submission by the students.

Educational Technology in India
The ICT in Indian education sectors is also seeing a change from past few years. For improving the education services in India, government has taken the serious steps towards the development of basic infrastructure. As such India has the second largest mobile phone user subscription base in the world, with over 900 million mobile phone users. The mobile phone penetration is good in rural region of India also. Taking advantage of this and an attempt to provide quality education to all, the Government of India has taken several initiatives to promote e-learning like [11] Swayam, NPTEL, e-Basta, e-Sikshak etc. These platforms take care of the entire learning community. The Centre has also launched Digital India campaign which provides free Internet connectivity and Wi-Fi facility to the rural area schools.

Conclusion
Implementation of cloud computing in mobile applications has several advantages since it combines the advantages of both mobile computing and cloud computing, thus providing ideal services for mobile users and it has the capacity to change the computing scenario. The cloud-based mobile application market is expanding at an exponential rate and it is a total market changer and a new "industrial revolution". It enables the developers to build highly available, reliable, scalable and secured applications for the users. Mobile Cloud Computing in education is a combination of mobile learning and cloud computing that has great strength to enhance the potential of teaching-learning process and improve the education process model. The implementation of such technologies has improved the quality of teaching learning process in most of the educational institutions where it is practiced. It has huge benefits in education and is going to be a dominant technology in future.

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