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A Survey on Mobile Cloud Computing

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Abstract: Mobile Cloud Computing, is the new future of both mobile and cloud computing which has become one of the industries' most popular and dynamic research area. As Mobile Cloud Computing is still at the early stage of development, it is important to grasp a thorough understanding of the technology in order to point out the direction of future research. This paper presents a detailed study on the background of Mobile Cloud Computing, characteristics, architecture, challenges and solutions and open research topics. A brief account on the background of Mobile Cloud Computing is presented ranging from mobile computing to cloud computing, followed by a discussion on characteristics, the features and infrastructure of mobile cloud computing is analysed. In the rest of the paper, the challenges of mobile cloud computing are analysed, summary of different research projects relevant to this area is given, and promising future research directions are explained in detail.

Keywords: Mobile computing, Cloud Computing, Mobile Cloud Computing.

1. INTRODUCTION

The mobile applications use different techniques and methods in which they are built ,powered and hosted using cloud computing technology and this is defined as Mobile cloud computing.

Mobile cloud helps the developers to build applications designed specifically for the mobile users without being confined to the mobile operating system, memory capacity and computing of mobile phone. Mobile browser is a medium through which mobile cloud computing applications can be generally accessed. Here, installing of any client application is not required in user's phone as mobile cloud computing generally uses remote web servers.

1.1. Basics of Cloud Computing

Cloud computing [1] is a model that enables convenient, on-demand network access to shared and configurable computing resources such as storage, servers, networks, applications, and services etc that can be quickly released and provisioned with minimal interaction between service provider and the user as well as requires less management effort. This cloud model enhances availability and is composed of three essential features (On-demand self-service, Broad network access, Rapid elasticity,); three service models such as Cloud Platform as a Service (PaaS), Cloud Infrastructure as a Service (IaaS), Cloud Software as a Service (SaaS) and four positioning models (Hybrid cloud, Public cloud, Community cloud, Private cloud). Main key technologies include: (1) powerful, inexpensive server computers, (2) fast wide-area networks and (3) high-performance virtualization for commodity hardware.

1.2. Mobile Computing

Mobile Computing[2] is a technology that allows data, voice and video transmission via a computer or any other wireless enabled device without connecting a permanent physical link. There are two main types involved:

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A. Mobile hardware.

B. Mobile communication

1.3. What is Mobile Cloud?

The people are totally dependent on mobile these days. The traffic is shifting towards smart mobile devices to get things done these days, the more they depend on cloud storage and services to enhance functionality beyond what the smart mobile device itself is capable of. That's why the new dynamic field mobile cloud computing has been introduced.

The IEEE Computer Society has listed mobile cloud as one of its Top Technology Trends in 2014. In the language of IEEE, "Mobile devices are constrained by their processing power, battery life and memory. But combined with cloud computing, data processing and storage can take place even outside the mobile devices."

The main important issue of mobile phones is Memory availability. Smart phones typically have local storage of only 8 or 16GB , but generally tablets used to have 32GB or more than that but still maximum it can have 128GB. HP's Ultrabook and notebook PCs have abandoned traditional hard drives in pursuit of solid state drives (SSD), which comes with usually only 128GB or 256GB. Though there larger SSD's are available, they're generally expensive for common users.

On the other hand, cloud has virtually limitless storage. Whether Box or Dropbox, or SkyDrive, or Google Drive has been used, gigabytes or even terabytes of data can be added that are accessible from mobile devices with WLAN connection availability enabled.

There are two salient benefits of cloud storage on a smart phone.

1. More amount of data can be accessed in the case in which mobile devices are generally incapable of storing.
2. If the mobile device got stolen or lost, the data would be safe and within reach.

The mutual relationship between mobile and cloud is not just about storage capacity. A mobile device has its benefits, but it has it's limitations when it comes to heavy amount of data load. When it comes to local storage of data, mobile devices generally works well and also mobile devices work just fine in case of native applications. But with the help of cloud features it gains the heavy data lifting capability.

The coming together of mobile and cloud into a single, consolidated, mutual platform has been defined by IDC[3] as the "Third Platform". The mobile cloud will provide enhanced access and data synchronization, better reliability ,scalability , collaboration of business applications from virtually at any point of time.

The mobile and cloud have their own unique features and will continue to develop separately, but mobile cloud will change the way of the use of mobile devices and give it a new dynamic era.

1.3. Moving from Mobile Computing to Mobile Cloud Computing

Mobile Cloud Computing is a service that allows users who have limited resources to adjust data processing along with storage capability. It performs transparent partitioning and offloading of the computationally intensive jobs on conventional cloud resources by providing a wide range of wireless access . The Intel company, Aepona defines Mobile Cloud Computing as a new criterion for mobile applications where the processing of data and storage are shifted from the mobile devices to new wide and powerful computing platforms which are in clouds. Powerful configuration of mobile devices are not required in this case such as speed capacity of CPU or high processing power because with the help of the cloud technology, different complex computing modules can be analysed. Many limitations of mobile devices are available

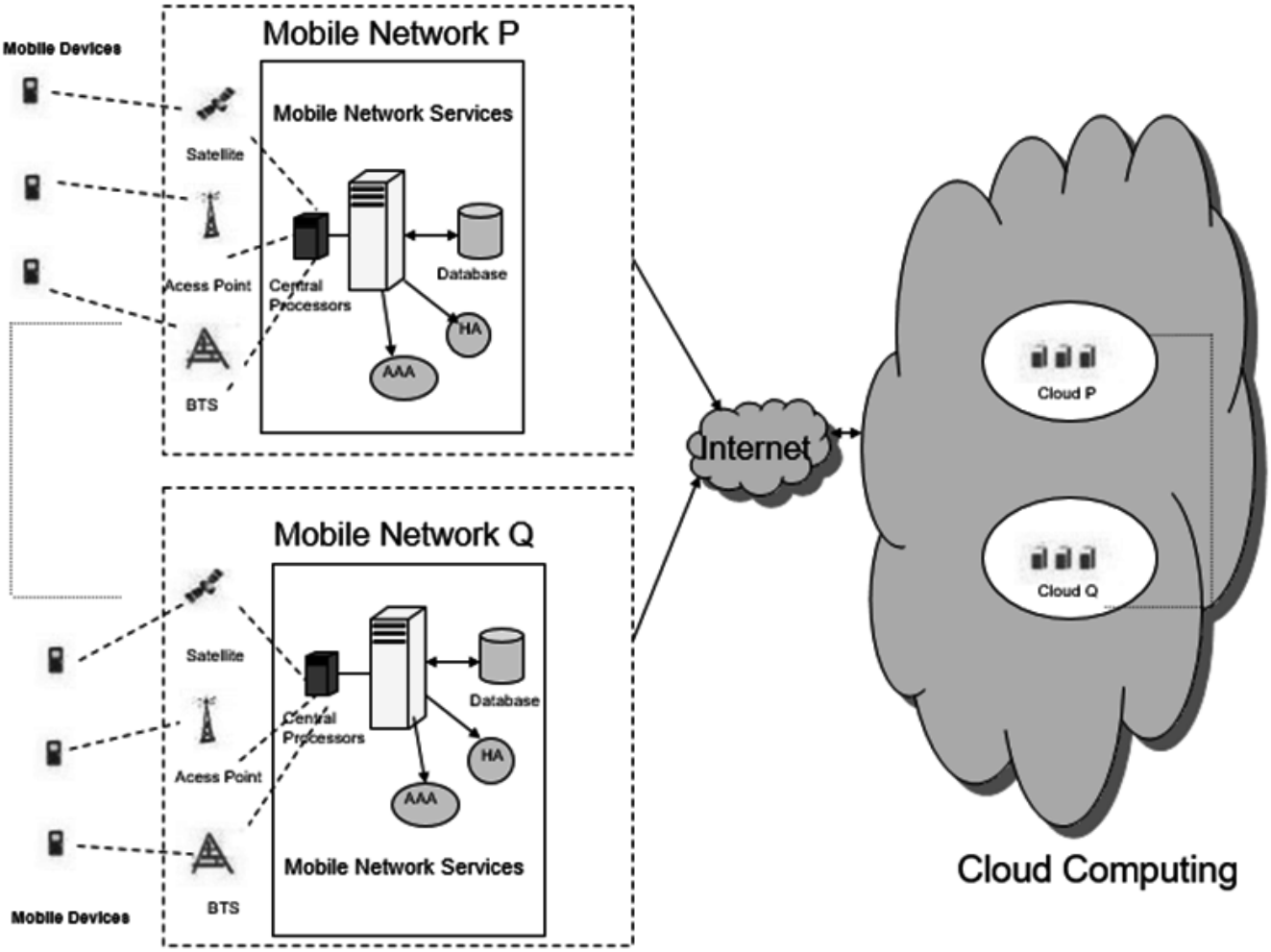
such as limitation in processing power, low storage availability, less amount of security, unpredictable disturbance in Internet connectivity, and less battery back up facility. In order to avoid these limitations of mobile devices , power consuming jobs and jobs with high storage requirements should be shifted to cloud.

2. MOBILE CLOUD COMPUTING ARCHITECTURE

Mobile Cloud Computing architecture [7] involves four types of cloud resources:

- Proximate mobile computing entities (Tablets, Smart phones, any kind of hand-held devices, computing devices which are wearable like Google Glasses and basically part of cloud-related or cloud –based resources comes under proximate mobile cloud computing entities).
- Proximate immobile computing entities [4] (architectural element what comes from the convergence of mobile and cloud computing like "Cloudlet" or "Surrogates" comes under this category).
- Distant immobile cloud type (Huge cloud systems such as Amazon EC2 comes under this category which generally located inside the premise of vendor which is generally very far from mobile clients. These kind offers infinite, elastic computing resources with huge computing power, latency in very high wide area network).
- Hybrid cloud entities (Hybrid is basically combination of other models which comes with unique and combined features).

The following diagram shows the framework for mobile cloud computing architecture:



2.1. Issues of Mobile Cloud Computing

Despite having significant development in the field of mobile cloud computing, many issues still remain unattended such as:

A. *Recurrent and Efficient Transmission:* There should be a flawless and quick data transmission from cloud to the mobile devices and vice versa.

B. *Architectural neutrality:* In order to support and maintain heterogeneous environment the architecture of mobile cloud computing should be neutral in nature.

C. *Real time migration of Virtual Machine:* In order to avoid the challenges of migrating an resource-intensive application to cloud, an error free, real time Virtual Machine is highly needed [4]. That makes it an important issue for mobile cloud computing.

D. *Congestion in Mobile Communication Platform:* Due to high demand for mobile cloud services in the industry, enabling a flawless communication between cloud and mobile devices has become a hard task to perform efficiently. But it needs to be done correctly for a successful mobile communication.

E. *Preservation of Security and Privacy:* As personal information of users is at stake, preserving security and privacy is the most important issue to be taken care of in mobile cloud computing platform or any application based on mobile cloud computing.

3. CHALLENGES AND SOLUTIONS [5]

The main objective of mobile cloud computing is providing a simplified and efficient method for users to access the cloud and receive data from it. Such efficient methods help users to get data effectively from mobile devices. The major challenge of mobile cloud computing is maintaining the differences in the characteristics of mobile devices and wireless networks, with their own particular constraints and this type of challenges render designing of application, programming and the deployment on distributed devices more complex than on the fixed cloud devices. In mobile cloud computing environment, the shortcomings of mobile devices, wireless communication quality, application types, and portability from cloud computing to mobile are all crucial factors that affect assessment from cloud computing.

A. *Shortcomings of mobile devices:* The resource constraints must be considered while discussing mobile devices in cloud. Although smartphones have been improved in various respects such as the capability of CPU and memory, size of screen, storage, sensing technology, wireless communication and operation systems, still have limitations such as energy resource and limited computing capability for deployment of complicated applications. By comparison of PCs and Laptops in a given condition, smartphones like iPhone 4S and Windows Mobile serials decrease 3 times in processing capacity, 5 to 10 times in storage capacity, 8 times in memory and 10 times in network bandwidth. Normally, smartphones have to be charged everyday as everyday applications require a lot of power. As shown by past development trends, the increased mobile computing and rapid development of screen technology ability will lead to more complex applications deployed in smart phones.

   If the technology of battery cannot be improved in a short time, then saving battery power in smart phone is an issue we face today. The processing capacity, storing capabilities, battery power and communication system of those smart phones will be enhanced continuously with the development of mobile computing. However, such huge variations will persist as one of the biggest challenges in mobile cloud computing.

B. *Communication Quality*: Wired networks generally provide physical connection to maintain the consistency of bandwidth, the data transfer rate in mobile cloud computing is constantly changing

and the connection is in a good quality due to the presence of clear network. Also, end users are not present nearby of large data centres or internet service providers, and especially for mobile users it's a normal scenario. Delay in wireless networks can be 200 ms but the amount of delay for same distance in case of general wired networks will be reduced into 50ms. Also there are other problems available for wireless network such as throughput of applications, user's mobility and also bad weather or changes in weather can create problem for this network and can affect the network and the bandwidth usage. So, mobile network has higher handover delay compared to wired network. The main issue of mobile cloud computing environment is limited amount of resources and inability of deploying particular kind of mobile applications such as data or compute intensive applications which may require huge energy resources. So, the applications of the mobile devices have to be divided to achieve the power of performing the core computing tasks which cloud computing can. The main important performance issues of mobile cloud computing here, are mainly processing of data in mobile devices and data centre, delivery time of data and network handover delay. In order to achieve a perfect quality cloud service few things should be taken care of such as division of application between cloud and mobile device should be optimal, for high speed transmission of data high bandwidth must be there ,presence of self adaptive mechanism of mobile cloud computing, cloud application performance related to users and overhead present in cloud servers and mobile devices. The following strategies are used to solve the challenges:

1. Bandwidth enhancement in wireless connection and regional data centres should be used to find out perfect set of web content for mobile network.
2. Utilize the processing node of the application in the cloud edge to minimize the delivery time of data transmission.
3. Virtualization and image technologies can be used to copy mobile devices to cloud in order to process Energy concentrated computing and Data concentrated computing or Data intensive computing like task of scanning virus in mobile devices.
4. Do the dynamic optimization of the pushing in the cloud and make the difference with the mobile device terminals.

4. OPEN RESEARCH ISSUES

Although some projects of mobile cloud computing already have been disposed around the world, there is still lot of spaces available for development so that it can be implemented in the field of business and other areas, and also it is believed that there are many research outlook available which need further attention and dedicated work.

A. *Data Transfer*: Because of the present features of resource management, mobile devices face various challenges while they access cloud or transfer data. Also consistency in accessing the cloud is another challenge. To avoid these challenges specialized application or services like middle-ware is required which can make provision for all kind of mobile cloud computing devices or systems.

B. *Division of task*: Researchers use divide and conquer strategy while choosing which application or which part of any application should run in cloud and which part should be in mobile devices. For that, they need to develop the main task or application in an efficient way so that the operation works successfully, but so far there is no optimal algorithm present which can divide these tasks. Though this division of task is an effective method but in order to get successful implementation researchers need an algorithm which can decide that which task will run in cloud and which one will be in mobile devices.

C. *Providing better feature*: The main purpose of mobile cloud computing is to provide PC-type features to mobile devices. However, in a current scenario it is not possible to implant all the PC's services into mobile devices. Therefore, further research should be encouraged so that researchers can come up with a successful method to provide user friendly interactive and suitable features of mobile devices.

D. *Issues on Context-awareness:* In Contemporary computers, socially-aware and context-aware computing are inseparable properties. Designing environment-aware , resource efficient applications in converged ,heterogeneous networks is a basic need and target of mobile cloud computing [6].

5. CONCLUSION

In many countries, data processing capacity is considered as a strategic resource as the data computation is increasing very swiftly these days. Mobile cloud computing ,which consists of both kinds of features of mobile and cloud computing has better scalability and efficient mobility property and these days it has opened several interesting research areas. We conclude three main important optimization approaches of Mobile cloud computing, mainly based on the limitations of mobile devices and the current available communication quality, and variety of services provided. Firstly, usage of virtualization technique and image technology can find out it effectively and shift task from mobile environment to cloud is another better way to achieve effective result. Secondly, as the quality of communication provided in wired network is quite better than in wireless network; so reduction in the amount of data transmission in wireless connection can be an efficient way to enhance the quality of the service provided. Also, improving bandwidth of the connection is though an easy way to enhance the performance but it can make the service more costly for normal users. Developing an efficient division mechanism for application can be the best solution which can make the application service significantly better in mobile cloud computing. Although it will be complex and complicated in nature but it can produce propitious results and enormous possibilities in this field.

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