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MOBILE CLOUD COMPUTING: PROBLEMS AND SOLUTION WAY

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Abstract- Cloud computing systems are a new computing technology that provides solutions to problems requiring large computing and memory resources by using resources distributed over the network. The rapid development of cloud technologies in recent years has encouraged its professional use by individual mobile users, private organizations and public institutions. The rapid increase in the number of mobile users in clouds causes overloading of communication channels, which leads to great delays in the delivery of processed data to the user and difficulties in the efficient use of Internet services. The article analyzes the problems arising in the use of cloud-based mobile cloud computing and their solutions. Besides, this article studies the problems related to different parts of mobile cloud computing. It identifies the criteria hindering the effective use of cloudlet-based mobile cloud computing (MCC) services in wireless urban networks. A strategy for solving these problems is developed. To implement the proposed strategy, it is recommended to use cloudlets with a hierarchical structure in mobile cloud computing systems.

Keywords: Mobile Devices, Mobile Cloud Computing, Cloudlet, Computing and Storage Resources, Cloud Services, Communication Channel.

1. INTRODUCTION

Nowadays, with the help of cloud computing (CC) technology, researchers implement intensive studies to competently apply resources of distributed computing systems. Through mobile cloud computing created with the help of CC technologies, mobile devices are widely used to handle the tasks which entail huge computing and memory resources. The deficiency of mobile computing and memory resources are solved by mobile cloud computing systems [1]. Connecting mobile devices with cloud servers eliminates the limitations of their technical specifications (battery life, limited computing and storage resources, etc.). High computing and storage sensitive applications are easily run-on cloud servers. Then the outcomes are directed to mobile devices. At the same time, since the cloud servers have great technical capabilities, the tasks are implemented fast. This allows long-term use of battery of mobile devices. Although the cloud servers provide high computing performance in centralized cloud computing utilized by users, they are not capable to provide fast data deliver to users due to network delays. With the rising quantity of users benefiting from mobile cloud computing the connection channels are overloaded. This produces excessive delays in the sending of handled data to users. It further obscures the preparation and exploitation of applications for mobile devices. In CC environment, it is important to eliminate the deficiency of the technical capabilities of mobile devices, to improve the wireless communication quality, to effectively utilize the apps, and to explore and resolve the problems related to the network security.

2. EXPLORATION AND ANALYSIS OF PROBLEMS IN MOBILE CLOUD COMPUTING

Mobile computing environment aims to ensure applications and services for mobile users with the help of cloud service providers. Thus, to provide the users with access the applications installed on cloud servers in mobile cloud computing, we have to study the following shortcomings occurred in different network points: mobile devices, network, mobile applications and security issues [2-3]. When using mobile devices, two main problems often occur: limited battery and resource shortage in mobile phones.

2.1. Limited Battery of Mobile Devices

Mobile phone energy often depends on the restricted power of the battery; thus, it is necessary to extend the lifespan of their battery. As the number of applications implemented in the cloud grows, the energy consumption on mobile devices becomes less. However, in general, transferring the execution of all applications to cloud completely is impossible. For instance, there are main features as using applications, data entry and processing results display on the screen, which the device has to execute itself. Only foremost application functions can be executed on cloud. The mobile devices consume the power on presenting various types of material on its display screen, solving some part of the task and connecting to the Internet [4]. Cloud technologies are used to extend battery life (energy saving). When using computing and storage sensitive apps on a smartphone, its processor and memory resources are entirely elaborated in the task's solution. This causes fast battery discharge. The cloud servers execute the tasks, whereas the mobile phone becomes a terminal. Ultimately, this guarantees an extended battery.

Simultaneously, when mobile phones are linked to the network via Wi-Fi, the energy consumption can be lessened by 23% as opposed to other connectivity technologies.

2.2. Resource Shortage of Mobile Phones

The review of mobile phones in cloud environment shows that the resource limitation should be considered. Whereas many options of smart phones, i.e., processor and memory resources, dimensions of screen, wireless communication, sensor technology and operating systems have been greatly upgraded. However, some shortcomings associated to the energy consumption and the use of compound apps. Resource shortage of mobile devices is referred to the restricted computing and memory resources. Technical competences of smartphones running Android and Windows Mobile operating systems are far less than the technical opportunities of the personal computer: 3 times for computing power, 8 times for memory, and 10 times for network capabilities [5]. In general, we should mention that this shortage has led to the emergence of mobile cloud computing. To handle this mobile phone shortage, these resources are directed to cloud infrastructure, so that the users can use them whenever they need.

Network problems arising in the use of mobile cloud computing may include [6]:

1. Wireless network problems
2. Providing data accessibility
3. Delays in communication channels
4. Lack of fast mobile internet accessibility everywhere
5. Smooth connectivity problems

1. Wireless network problems: When creating mobile clouds based on wireless networks, certain difficulties and limitations are encountered. Unlike wired networks that use physical connectivity tools and provides fixed coverage, the data transfer environment in mobile computing environment is regularly varying. As the wireless communication channels are used, abundant delays occur, subsequently, network bandwidth decreases. Correspondingly, frequent disruptions (depending on weather, relief, etc.) on wireless networks occur [7]. Given that, cloud servers should be positioned near the base stations near users to tackle these shortcomings.

2. Providing Data Accessibility: Customer data is often stored in different locations or on separate servers in different clouds. In this case, ensuring continuous data accessibility becomes relatively difficult. Moreover, one of the most important requirements for the delivery of cloud services in mobile devices is to provide network accessibility. Mobile users may access the network using a variety of technologies as WiMAX, WLAN, 3G / 4G, GPRS and so forth. Each of these technologies has its own connection schemes, policies, suggestions and restrictions. Since there are different access schemes, the availability of an interrupted connection schemes in the network (to avoid the problems such as disconnection and recovery) is important when moving from one access point to another. The process of continuous communication should be organized. When moving from one network access point to another access point, the problem solution should be completed on a mobile device. Because, when one network access point is logged out and another is logged in, obviously, the quality of service and connection changes.

3. Eliminating Network Resource Delays: Services delivered over the Internet require a robust infrastructure with high bandwidth. Regardless of the architecture used in the creation of mobile cloud computing, the infrastructure developed must be reliable. Produced network must have high bandwidth to be capable of eliminating delays. The factors affecting the delivery of the applications may include: [8-9]:

- Data processing time in data processing center
- Data processing time on mobile device
- Network delays
- Transmission time in communication channel

A number of measures can be taken to eliminate network delays. The latency problem in network can be minimized if the applications are located on the nearest servers, because the delays are mostly dependent on the distance. Thus, service providers can effectively update their coverage by re- establishing the path of the Internet traffic, logically based on the location and caching capabilities.

4. The lack of fast mobile Internet accessibility everywhere: new technologies, such as HTML5, have been created to provide fast mobile internet. This technology provides the network with local cache devices. At present, researchers are working on improving the mobile web sites to provide fast accessibility. New technologies, such as the OMA Smartcard Web server and TokTok, provide more convenient mobile web accessibility. OMA Smartcard Web server is a SIM card being directly connected to the carrier and provides mobile phones with applications. TokTok technology provides voice access to web services as Gmail and Google Calendar. Many providers offer 4G/Long Term Evolution (LTE) services to solve the connectivity problem of mobile devices. These services provide users with many advantages such as data storage capabilities, high-bandwidth communication channel, and selection of low latency paths.

5. Smooth Connectivity Problems: Mobile operators are trying to set up Wi-Fi in the streets to provide data communication using a mobile network. Thus, the problem of mobile traffic overload is eliminated to some extent. In this case, uninterrupted connection between the access networks must be ensured. However, when moving from one network access point to another or from Wi-Fi network to 3G mobile network, the communication may be interrupted or malfunctions or errors may occur. The problem of communication failure can be described as a "broken pipe" problem. Solution of this problem is the use of a zero-window rejection (channel re-clearing and recovery) notification channel. The problem of communication recovery is defined through a connection error and may be resolved by installing TCP port during recovery.

Thus, to address the above-mentioned problems, the strategies are offered as follows [10]:

- Using mobile cloud computing systems with hierarchical architecture;
- Creating a cloudlet-based network infrastructure;
- Predicting the deployment of cloudlets at required locations on the network;
- Deploying applications to neighboring cloudlets to minimize delays;
- Using a minimal communication channel between a user and cloudlet;
- Deploying applications with high usage frequency in cloudlet network in advance;
- Clustering applications based on the intensity of their use in cloudlets;
- and so forth.

Mobile computing cloud with hierarchical structured cloudlets is widely used to implement the above-mentioned strategy (Figure 1).

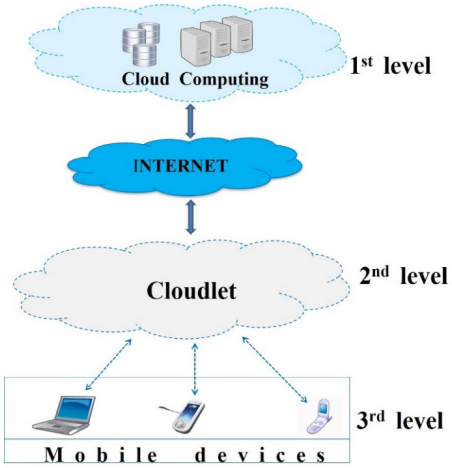

Figure 1. Architecture of cloudlet-based mobile computing clouds with a hierarchical structure

Hierarchically structured architecture positions the cloud servers on the 1st level, builds an edge network on the 2nd level near the base stations. It positions the mobile phones on the 3rd level. Fast service access, supporting mobility, and reducing roaming expenses are the advantages of using cloudlets. The communication interruptions caused by network can be eliminated if locating the cloudlets close to user applications and thus, providing the user with direct access to the data.

Mobile computing cloud with hierarchical structured cloudlets is widely used to implement the above-mentioned strategy. Some of the above-mentioned problems can be solved through the efficient use of cloudlet-based network resources. Determining the computing capabilities and memory resources of cloudlets and deploying the apps on the edge as the user demands still remain problematic. When the computing and memory resources of the cloudlet located close to the access point is unable to process multiple mobile user requests, the mobile user needs to choose another nearby cloudlet to use its resources. On the other hand, the choice of the cloudlet with the higher technical capabilities than the required one for the fast solution of the user problem, and the optimal distribution of users' queries in the cloudlet are topical issues. Computers used in the cloudlet network have different technical parameters (computing power, storage, frequency, etc.). Alternatively, the time for delivering the issue to the user after being resolved is subject on the computing capabilities of the virtual machine built on the edge and the number of nodes located between a user and a cloudlet. As the number of nodes between a cloudlet and a user lessens, the delays become fewer. It can support delivering the results and data to the user earlier. Moreover, any user's request should be directed to the cloudlets with high technical capabilities (to reduce the problem solution time). Therefore, before selecting the cloudlet, the network must first be examined and the circumstances acknowledged. Consequently, following the examinations, the data on downloads and technical opportunities on the edge becomes available. Then, it becomes possible to determine on which cloudlet the task can be implemented faster. The cloudlet with high technical capabilities (computing performance, memory and frequency) will solve the issue more quickly. However, then, the value of the problem solution solved on this cloudlet will be greater than on other cloudlets. Therefore, if the selected cloudlet provides the problem solution within the certain time specified by the user, then the cloudlet with low solution value should be selected. That is, it is not efficient to solve the issue faster and spend more money.

Thus, key performance indicators that hinder the effective use of data processing in mobile cloud computing include data processing time, network suspensions and data delivery time at Data Center and smartphones. Solution of these problems depends on the geographical distance between cloud servers and users, the power of virtual computing machines and the network loading. Therefore, mobile cloud technology servers should be deployed close to users. The best solution is to deploy the cloudlets close to each base station. However, this mobile cloud computing is more expensive, and moreover, the system is not used effectively. For this reason, locations of cloudlets (close to universities, trade centers, places of rest, so forth.) should be monitored and analyzed. To provide consistent functioning of communication channels, the communication channels between the users and the cloudlet have to be minimized. Algorithms should be developed to properly select the cloudlets that ensure solution of the task with the time specified by the user. Methods and algorithms should be developed for correct selection of virtual machines which may reduce the expenditures of the problem solution in cloudlets.

Moreover, it should be determined which applications are used more often by the users in the developed zones. Identifying the applications with high intensiveness, their clustering in cloudlets should be reviewed. Then, the technical opportunities of the edge system to be created in that region should be determined. After analyzing the locations with a large number of human masses and large data amounts used, locations of cloudlets in those regions are determined. Thus, following research will develop a methodology and algorithm to address the aforementioned problems.

3. CONCLUSIONS

This article analyzed the network problems arisen in the use of mobile computing clouds created on the basis of cloud technologies and the ways to solve them. Moreover, it highlighted the shortcomings occurring in various parts of mobile cloud computing. It proposed to use cloudlets to extend the battery life of mobile devices and overcome resource scarcity. The main criteria affecting the effective use of data processing in mobile cloud computing systems were indicated. The selection of a cloudlet with higher technical capabilities was noted in order to solve the user task more quickly. Finally, it was recommended to place cloud servers in cloudlets that are geographically closer to users. The article proposed a strategy for solving the mentioned problems. The use of cloudlet-based hierarchically structured mobile cloud computing systems was proposed for efficient problem solving.

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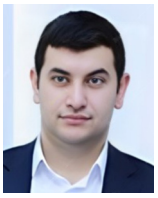

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