A SURVEY: ENERGY EFFICIENCY OF MOBILE CLIENTS IN CLOUD COMPUTING

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Abstract: Mobile Cloud Computing (MCC) is an emerging and popular mobile technology which uses fully available Cloud Computing services and functionalities. This technology provides rich computational services to the users, network operators and Cloud service providers as well. However due to users mobility and high computational operations, consumption of energy is a major issue. Energy efficiency over MCC is needed since 57% of generated energy is used by ICT related devices and other negative impacts over environment. We present the analysis of energy efficiency over MCC approaches. Since, mobile devices have limited computational resources; there is a need for offloading of computations to the Cloud. Offloading is a process of migrating computations to more resourceful systems like Cloud environments for processing and retrieving the results to mobile devices. This paper presents a survey of the research studies on the offloading in MCC.

Keywords: Cloud computing, Mobile cloud computing, Computational offloading

1. Introduction

The mobile devices are facing several challenges over communication networks such as mobility and resources, that is, battery life, storage and bandwidth. Despite the evolution and enhancements that mobile devices have experienced, they are still considered as limited computing devices. Today, users become more demanding and expect to execute computational intensive applications on their smartphone devices. Therefore, Mobile Cloud Computing (MCC) integrates mobile computing and Cloud Computing (CC) in order to extend capabilities of mobile devices using offloading techniques. Computation offloading tackles limitations of Smart Mobile Devices (SMDs) such as limited battery lifetime, limited processing capabilities, and limited storage capacity by offloading the execution and workload to other rich systems with better performance and resources. CC aim at enhancing the computing capabilities of resource-constrained mobile client devices by providing mobile clients access to cloud infrastructures, software, and computing services. For example, Amazon web services are used to protect and save clients' personal data via their Simple Storage Service (S3) In addition, there are several frameworks that allow to process data intensive tasks remotely on cloud servers.

The ability of mobile devices has improved very quickly in terms of computing power, storage,development and so on. This paper will explore the fundamental research and new technique to enhance the performance of mobile cloud computing. These new capabilities will enable mobile user in a seamless way to utilize the cloud to obtain the resources without delay and jitter about saving energy.

2. Cloud Computing Fusion Of Mobile Cloud Computing

This technology is a fast emerging in IT service of user access for the shared pool of distributed resources[5]. Researches have studied many techniques how to consume storage, battery life, and save bandwidth energy. These applications are too intensive to compute and perform on a mobile system [3].offloading is a good solution to the mobile device to cloud side.

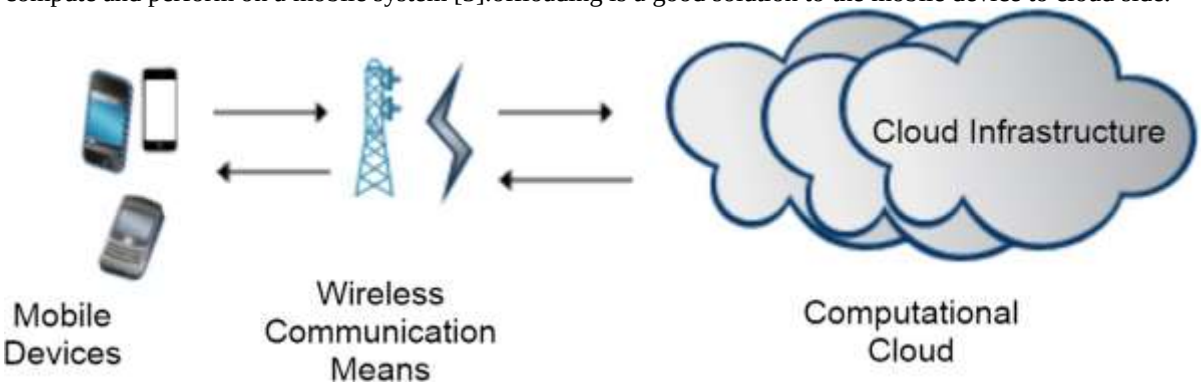

Fig 1.cloud computing fusion of mobile cloud computing

‘‘Mobile Cloud Computing at its simplest form 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 smartphone users but a much broader range of

mobile subscribers.MCC has attracted the attention of business people as a beneficial and useful business solution that minimizes the development and execution costs of mobile applications, allowing mobile users to acquire latest technology conveniently on an on-demand basis .Fig. 1 shows the general view of MCC which is composed of three main parts: the mobile device, wireless communication means, and a cloud infrastructure that contains data centers. These latter provide storage services, processing, and security mechanisms for both the cloud environment and mobile devices.MCC is a technique to connect mobile devices to a cloud, with vast resources in terms of hardware as well as software, for the purpose of computations related to various mobile applications, processing, storage of data etc. The mobile cloud that have unlimited resources virtually run the applications for the smart phones to save the battery, to improve the performance and to improve the overall computational efficiency. *Mobile Cloud Computing* (MCC) integrates *mobile computing* and *Cloud Computing* (CC) in order to extend capabilities of *mobile* devices using *offloading* techniques.

3.Computational Offloading

Offloading in its simple terms can be defined as the mechanism of partitioning an application into offloadable and non offloadable sections considering various parameters and then remotely executing the offlloadble sections. There is no set of guidelines for deciding which section of an application to offload but we can keep in mind the below mentioned points. Offloading can only be triggered considering two things i.e. the benefits the user will get and the availability of resources. The part of application that need to be offloaded from mobile phone to cloud could be done in two fashions that is partial offloading or full offloading In full offloading architecture the full application along with all the data associated to it has been offloaded to the cloud where the entire computation take place and the final results has been sent back to the mobile device as shown in figure-2.

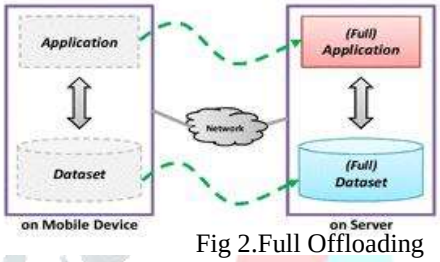

Fig 2.Full Offloading

In the partial offloading architecture only the part of the application that consumes more energy or have complexity in terms of computation has been offloaded to the cloud. In this both mobile phone and the cloud are responsible for the computation and final results comes after merging the individual results of both the computations that is in mobile device and at the cloud as shown in figure-3. The partial offloading computes task locally, which could have been complex due to lack of resources in terms of software, infrastructure etc. Moreover, the runtime complexities could also be avoided if the code is offloaded to the cloud for execution.

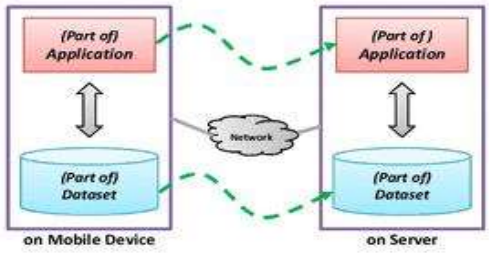

Fig 3. Scenario of Partial Offloading

Good Candidates for Offloading

1. Games like chess and Sudoku Solver which need quick computation and have numerous small datasets.
2. File Search applications which takes more than few minutes to search a particular file.
3. Image Processing tasks and image rendering tasks are quite computational intensive
4. Download Applications can save time and energy when offloaded to cloud.
5. Antivirus Applications can be offloaded to cloud since it involves a complete scan of phone and comparison of several virus signatures.

Bad Candidates for Offloading

1.User interaction related sections as well as interfaces interacting with camera or GPS should not be offloaded because it will increase the communication overhead.
2. Sections which directly access I/O Devices.
3. Some native methods (for eg methods declared static in java)
4. Methods accessing Device specific properties

4. General issues and challenges in computation offloading for MCC

4.1. Platform diversity

One of the challenges in the current computation offloading frameworks is the diversity and heterogeneity of smartphone architectures and operating systems. This diversity is seen in the following example: MAUI is an offloading framework which is applicable for the .Net framework whereas Mirror Server is a framework which is compatible with the Android platform. A consistent access to cloud services is expected wherein SMDs are enabled to access cloud computing services regardless of the installed operating system or the used hardware. A standardized offloading framework for different smartphone platforms is still a challenging issue in the MCC field.

4.2. Security and privacy in mobile cloud applications

Security of data transmission is an important concern in cloud based application processing. Security and privacy are two crucial concepts that need to be maintained during the offloading process. These concepts can be addressed from different angles:

(1) Mobile device,
(2) cloud data centers, and
(3) during data transmission over the network.

Besides all the technologies, there is a great increase in the variety of sophisticated attacks on mobile phones which are the main targets for attackers. Regarding the security in the cloud data centers, threats are basically related to the transmission of data between the different nodes over the network. Thus, high levels of security are expected by both the mobile clients and the cloud providers. In the current frameworks binary transfer of the application code at runtime is continually subjected to security threats. Despite the available solutions, strong measures and a secure environment are required for the three entities of MCC model.

4.3. Fault-tolerance and continuous connectivity

In MCC, mobility is one of the most important attributes of SMDs. This is because freedom of movement and autonomy of communication during the consumption of mobile cloud services, are crucial criteria for users' satisfaction. However, there are some constraints that prevent the achievement of seamless connectivity and uninterrupted access to cloud services while on the move. As mobile users move, data exchange rates and network bandwidth may vary. Moreover, users may lose their connection while sending or receiving data; therefore, offloading approaches should be provided with suitable fault-tolerant strategies in order to resend the lost components, minimize the response time, and reduce the energy consumption of mobile devices. It should be noted that the guarantee of a successful execution of offloaded applications is very crucial for mobile users.

4.4. Automatic mechanism

The available computation offloading frameworks still need to be automated. This will help the offloading process to be performed in a seamless fashion while discovering the surrounded environment. The achievement of such automation is not an easy task as it needs the implementation of a protocol dedicated to finding and discovering services depending on the current context and its constraints.

4.5. Offloading economy/cost

Using cloud infrastructure resources imposes financial charges on the end-users, who are required to pay according to the Service Level Agreement (SLA) agreed on with the cloud vendor serving them. Generally, the operations of content offloading and data transfer between cloud providers incur additional costs on end-users. Therefore, economic factors should be taken into consideration while making the offloading decisions.

4.6. Partition offloading and external data input

At runtime, it is challenging to decide which application components need to be offloaded and to find the suitable server for that. Algorithms answering this problem need resource-intensive effort, which can affect the execution time of the offloaded partitions of the application

Although existing application partitioning algorithms allow an adaptive execution of the application between the mobile devices and the cloud servers, they still do not provide any solution on how to utilize and benefit from the elastic resources in the clouds. This is specifically needed in order to make the applications scalable when a large number of mobile users need to be served and when the application requires input data that are stored in other remote servers.

5. Conclusion

The MCC has been emerged as a most promising solution for increasing the performance and efficiency of mobile devices as the applications has been offloaded to the remote server for the execution, this reduces the complexity and run time if it's done locally. This also proves out to be the solution for limited storage capabilities of the smart devices. The offloading techniques have been analysed in this paper along with its benefits, applications etc. In this paper the survey has been done on the existing models for offloading in MCC for various scenarios. And, finally some of the issues and applications in the field of offloading have been enlisted here.

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