CLOUDLET-BASED ARCHITECTURE FOR IMPROVED CLOUD COMPUTING ENVIRONMENT

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ABSTRACT: *Currently, smartphones and their increasing capabilities, made them very important in the human's life. However, these mobile devices face some challenges such as battery life, weight, memory, and heat dissipation, which may result in decreasing the capabilities of these devices. Services of cloud computing would offer great solutions to overcome these drawbacks but also, cloud computing services may suffer from expensive roaming charges and long-latency. Cloudlets would provide some benefits over distance cloud such as faster data transfer, faster processing of the application and reducing the use of resources of the mobile devices. In this paper, we deal with cloud computing basic concepts and the integration of cloudlet in the IT sector. Cloudlets influence on the performance of cloud computing applications has been focused in this paper. Moreover, the use of the cloudlets for enhancing the performance and supporting cloud computing environment has been reflected. In other words, this paper describes a cloudlet-based architecture for supporting cloud computing environments. Cloudlets would help to deploy mobile applications at the network edge; therefore increase the performance of cloud-based applications by reducing network stress and network latency. We propose a cloudlet-based architecture that supports the environments of these applications. The proposed architecture would greatly increase the performance within cloud computing environments. Experimental results are provided, along with an illustrative analysis of text data exchange in the experiment. Results show that the proposed approach is efficient and effectively increase the effectiveness of the performance of applications in cloud computing environments.*

Keywords: *cloudlet; cloud computing environments*

1. INTRODUCTION

Internet users can access their data and applications from anywhere whenever they want using cloud-computing technology. New type of IT infrastructures can be created by integrating different technologies. The modern era of computing has experienced drastic changes in the technological point of view. Mobile computing facilitates sending and receiving data to wireless devices without the need of physical connections. Mini-sized portable computers are being used to run applications using various communication technologies [1].

Basic aspects of cloud computing and cloudlet integration with cloud computing technology is discussed in this paper. Many advantages and benefits of cloudlet are also outlined to demonstrate cloudlet positive effects on cloud computing technology.

1.1 Cloud Computing

As commented by Jin [2], accessing applications online refers to cloud computing. It is a fundamental principle of reusability of the IT capabilities in the market [3]. Cloud Computing has helped in connecting millions of devices with each other in the world. The data and files can be accessed from anywhere in the place with the help of the Internet [4]. These help in providing flexibility to the user's experience using cloud-computing services [5].

As commented by Fernando [6], cloud computing has provided many opportunities for technology in the market. Business organizations are implementing cloud computing in their operation management to analyze the behavior of the operations [7]. Cloud computing has enhanced the efficiency of the servers but not keeping them in the idle state.

1.2 Cloudlet

Cloudlets are the mobile enhanced small-scale devices that help in supporting cloud computing in the market [8, 9]. Smartphones and tablets have gained importance in the modern world. These devices are acting as cloudlets for the users. As mentioned by Carvalho [10], the power of the CPU and RAM are the important factor in supporting cloud-computing services in these cloudlets [11]. Therefore, a cloudlet is a small data center to help users to access their data that is stored in the cloud.

Enhancing response time of cloud-based running applications is an essential goal for using cloudlet [12]. This also helps in increasing the latency of the mobile applications used for cloud computing services [13]. The cloudlets act as a virtual machine in the mobile device that helps in supporting the cloud services online. Cloud computing has able to provide efficient and low spectral efficiency to the users in the market [14]. The transformation of fog computing to mobile edge computing has enhanced the technology of the cloudlets on the market [15]. The cloudlets have helped in advancing the cloud servers anywhere in the world. These have helped cloud users to access cloud services anywhere and anytime. A cloudlet has helped in controlling, updating, and storing data in the cloud servers.

1.3 Advantages of Cloudlet

There are various advantages of the cloudlet discussed as the following:

1.3.1 Accessibility

The cloudlets help in accessing the cloud computing services in mobile devices. This has helped in the frequent use of cloud services by the users. The latency of using cloud services has increased in these days [16]. These have also increased the cloud udders all over the world by providing cloud services. The cloudlets have reached to every mobile phone of the users enabling the use of the cloud services in the world. Therefore, the accessibility of cloud services has smoothened in the market [17].

1.3.2 Security

Cloudlet has increased the security of the data and information stored in the cloud. The mobile device is a secured cloudlet that helps in securing the data and information on the internet [18]. There are various security systems installed in mobile devices that help in maintaining security. The cloudlet helps in enhancing the speed of internet access by the users [19]. The security system of the cloudlet devices is upgraded to modern technology that helps in preventing cyber attacks over the internet.

1.3.3 Environment

The cloudlet has helped in improving the cloud services in different fields. The Cloud foraging includes the dynamically augmenting of the computing resources in the mobile devices to fix the cloud proximity [20]. The Cloud foraging helps the cloud users to offload expensive processing applications including voice recognition and language translation. The cloudlet has channelized the cloud environment in many applications including the virtual machines in the mobile device. The On-Demand virtual machine is a provisioning tool to assemble the service of the VM during runtime [21]. The cloudlet has provided the benefit of the on-demand service of the cloud to the users by initiating the virtual machine concept in the mobile devices. The users can easily involve in the cloud environment to access their data and files.

2. RELATED WORK

Li and Wang [22] introduced cloudlet properties such as reachable time, lifetime and size. They also explored the performance of mobile cloudlet within cloud computing. A data security protocol for cloudlet-base architecture was proposed by Jindal and Dave [23] through an integrated model with a base station. They assumed that the proposed protocol can protect data from unauthorized access and prevent exposure of data to the cloud owner.

3. USE CASE SPECIFICATIONS: QUERY ABOUT TEXT CONTENTS

3.1 Brief Description:

This use case allows clients to inquire about the text files contents in the available cloud servers. The clients can inquire about words and their occurrences in very long text files. The designed system provides a list of all words and their occurrences that being asked by the clients and compares the elapse times needed for providing answers for all clients' questions. The purpose of the system is to compare the performance of processes with and without cloudlet while using cloud-based applications in the cloud computing environment.

Actors*:*

Primary Actors- Clients and system administrator.

Flow events:

3.2 First Flow

3.2.1 First flow starts with cloud server at a specific machine with the port number. The cloud server read a large text file and store each pair words and their occurrences.

3.2.2 Clients send words request to the cloud server, which replies with requested words and their occurrences.

3.2.3 After answering all requests, the system shows how long it takes to provide all the answers.

3.3 Second Flow

3.3.1 The second flow starts with the cloud server at a specific machine with the port number. The cloud server read a large text file and store each pair words and their occurrences.

3.3.2 The cloudlet server between the remote cloud server and the clients starts at a specific machine and specific port by the system administrator. The cloudlet server does not store a hash table; it stores the cache only, which is some temporary data that are asked most frequently by clients during their processes.

3.3.3 Clients send word requests to the cloudlet and it answers back the clients, if not, which means the cloudlet does not have the answer then it sends to ask the cloud server.

3.3.4 The cloud server answer the cloudlet and the cloudlet answer the clients.

3.3.5 The system displays how long the process takes to answer all clients' requests.

4. DESIGN

The purpose of our work is to provide clients the data they need in a faster manner within the cloud environment. The general experiment architecture is shown in figure 1. The cloudlet acts as an intermediary between remote cloud servers and clients as illustrated in figure 2.

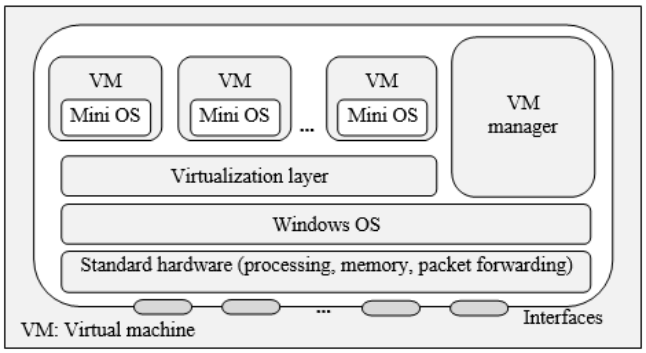

Figure 1: Generalized Experiment Architecture

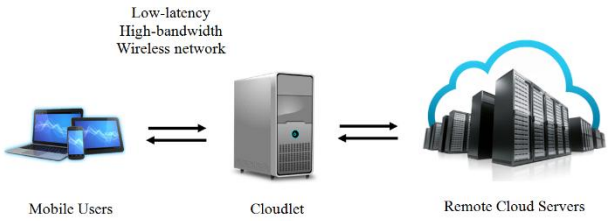

Figure 2: The Proposed Architecture.

5. IMPLEMENTATION DETAILS

Real cloud environments can be simulated using Virtual Machines (VM), as in our implementation, we deployed five VMs, one cloud server, one cloudlet and three clients over a public network where the cloud server was installed in the United States of America, the cloudlet was installed in the United Kingdom and the clients were installed in Germany. VMware Workstation 9.0 was used to deploy the VMs.

TABLE 1: EXPERIMENT HARDWARE

Item	CPU	disk	Speed	RAM
5 - VMs	Intel (R) Xeon (R) CPU E5-2676 v3	30 GB	2.40 GHz	1GB

Figure 3: Geographic Distribution of our experiment.

We attended to examine two scenarios of cloud environment using cloud server and clients and using a cloud server, cloudlet and clients. Thus, the primary objective of our work is to measure the data latency and the efficiency of the performance in these two scenarios. JAVA was used to implement our machines. \

6. EVALUATION

The results were collected from 5 virtual machines, 1 as a remote cloud server, 1 as cloudlet and 3 as clients. We took measurements of 3 clients in two scenarios and we concluded with that the 3 clients get the requested data in the second scenario -where clients ask cloudlet- more faster than getting it in the first scenario.

TABLE 2: SUMMARY OF RESULTS OF THE EXPERIMENT

Items	The time needed when a cloud server and clients scenario was used	Time needed when cloud server, cloudlet and clients scenario was used
Client1 (ip: 54.93.213.110)	1 302 777 milliseconds	1 031 556 milliseconds ≈ - 20%
Client2 (ip: 52.59.207.98)	1 305 123 milliseconds	1 008 946 milliseconds ≈ - 23%
Client3 (ip: 52.59.227.48)	1 290 222 milliseconds	967 666 milliseconds ≈ - 25%

From the experiment above, we can observe improvements in the performance when the cloudlet architecture is used. The results show that the improvements in the performance would be in the range between (20% - 25%) while we are using text files data exchange.

7. CONCLUSIONS

It can be concluded that cloud computing has enchanted the growth of the IT sector in the market. Cloud computing has enhanced the flexibility in accessing the data and information of the clients over the internet. Moreover, the cloudlets used in cloud services have increased the efficiency of cloud services. The cloudlets are the small data center used by the clients at their home or workplace. The cloudlet has influenced the cloud services in many ways including enriching performance of the cloud servers and supporting cloud environment on the mobile devices. The virtual machine technology in mobile devices has strengthened the cloudlets.

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