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Virtual Machine Allocation Policy in Cloud Computing Environment using CloudSim

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ABSTRACT

Cloud computing has been widely accepted by the researchers for the web applications. During the past years, distributed computing replaced the centralized computing and finally turned towards the cloud computing. One can see lots of applications of cloud computing like online sale and purchase, social networking web pages, country wide virtual classes, digital libraries, sharing of pathological research labs, supercomputing and many more. Creating and allocating VMs to applications use virtualization concept. Resource allocates policies and load balancing polices play an important role in managing and allocating resources as per application request in a cloud computing environment. Cloud analyst is a GUI tool that simulates the cloud-computing environment. In the present work, the cloud servers are arranged through step network and a UML model for a minimization of energy consumption by processor, dynamic random access memory, hard disk, electrical components and mother board is developed. A well Unified Modeling Language is used for design of a class diagram. Response time and internet characteristics have been demonstrated and computed results are depicted in the form of tables and graphs using the cloud analyst simulation tool.

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1. INTRODUCTION

From the current scenario of computer networking, it is observed that the computer networks have become an integral part of everyone. Before 40 years, a project of ARPANET was started for connecting the mainframe computer systems across network covering the long distances. Slowly-slowly computing has been started across network and one of the popular approaches was the centralized computing in which numbers of the desktops are connected to a server and these systems can easily accessed the server which has the numbers of application softwares. Due to the complexity of the research problems, the centralized computing systems have been shifted towards the distributed computing systems, if the server fails then users can work or compute the programs or they can use the application softwares on own machine. Due to further increasing the numbers of applications in the form of audio and video files, distributed computing systems move towards the clustering approach called as the cloud computing. Amazon.com is the first one to introduce this type of computing facilities and used for selling the consumer products like books, e-books, etc. Now this type of approach is adopted by the various kinds of service providers. There are a lots of features are available on this kind of computing and supports the heterogeneous collection of devices which may have hand-held devices like mobile, laptops, palmtops, etc. This kind of computing supports wire based networking as well as wireless network connectivity. In India, one of the important projects was initiated in the year 2009 by Government of India called as a National Knowledge Network (NKN) which was based on this approach with main objective is to connect all the National Laboratories, Higher Learning Institutions, Medical Labs, Countrywide Virtual Class Rooms, Digital Libraries across the Nation, etc. The project is successfully functioning with bandwidth of 10 Gbps which can be further enhanced upto 20 Gbps. The handheld devices can easily access the clouds which are amorphous clustering of the machines that can store and process the audio, video, documents, images, social networks, business applications, etc.

Since numbers of connecting devices are increasing day by day, therefore it is a big challenge to solve the issues of the resource management across the networks and also other important issue is the energy consumption which should be minimized across the networks. For connecting the devices, static and dynamic interconnection techniques are used which are known as the topologies. In the present paper, the aforesaid two problems shall be solved analytically and critical observations shall be reported.

Cloud computing is described as sharing of computing resources across the networks with different configurations of servers, storage media, media files, etc. and applications on demand are delivered to the different organizations. The clouds may be private, public and hybrid and consists of the various layers namely Software as a Service (SaaS) layer, Platform as a Service (PaaS) layer, Infrastructure as a Service (IaaS) layer and data Storage as a Service (dSaaS) layer for implementing the services to the users. There are number of challenges on each of the above layers and some of the challenges are given below:

a. Confidentiality of information should be maintained and information should be shared among the privileged users and not to irrelevant users;
b. If any disaster occurs then cloud provider should recover information through efficient mechanism;
c. The data are segregated in such a manner so that one instance of information should be different from other one;
d. Resource management for execution of applications on demand is a big challenge for getting the results within minimum time.
e. Since all the devices connected across networks especially for cloud server systems, therefore it is big challenge to minimize the energy used which is known as run time energy consumption across networks and based on the workload;
f. Secure virtualization is another kind of problems for monitoring virtual machines (VMs) and it allows easier management of security or complex cluster of servers;
g. When the server is in sleep mode then energy gain is to be studied and it is a big challenge to wake up the sleep mode in the complex clusters of clouds.
h. The cloud providers should record usages of data by users in efficient manner however, users can use the clouds as a service for information sharing, resource sharing, files sharing, audio and video sharing, database storage, collaborative research work, accessing of digital libraries, classrooms, Institutions, hospitals, etc.

2. RELATED WORK

The proposed problems consist of the two parts one is the modeling and other is the computation of extensive results for minimization of energy consumption and resource management. Object-oriented modeling approach was invented by the Greedy Booch[1], various diagrams are proposed by Booch et al.[2] and versions of UML are released by an active Object Management Group(OMG) [3], [4]. The different tools are available for the designs which are based on the concepts given by the Greedy Booch, et al. The names of tools are Rational Rose, Smart Draw, E-Draw, Ms-Visio, etc. In the proposed research work, any one said tool shall be used for modeling of problems.

In 2002, Pllana and Fahringer [5], [6] used the UML for obtaining the performance of the parallel and distributed architecture problems. Saxena and Arora [7] also used the UML for finding the performance of the object-oriented programming languages. Pooley and King [8] have used the object-oriented programming language for solution of engineering problems. Gomma [9] described concurrent, distributed and real time systems by the use of Unified Modeling Language. From the review of literature, it is observed that many of Scientists and Engineers have used the UML in the networking field also. Zhang et al. [10] computed the performance of the network topologies for agent based open connectivity architecture for the decision support system and they used the UML for computing the performance of network topologies. UML is also used for observing network performance by traffic reduction and loads are also shared for the distributed systems [11], [12].

The complexity of the network is based upon the heterogeneous kinds of topological structure of network and heterogeneous devices which are interconnected across distributed networks which can be further enhanced towards the cloud networks. There are numbers of factors which may vary from one device to another device and produces effects on the energy produced by different devices. One of the important parameters is the voltage and voltage scheduling for low energy consumption for the real time applications are explained by Shin et al. [13]. Yang et al. [14] have explained consumption of energy utilized at the run time with scheduling techniques for embedded microprocessor. Modeling is also proposed for saving the dynamic voltage and for this purpose statistical techniques are used by the authors [15]. Concepts of graph theory [16], [17] are used for scheduling of power consumption for the real time applications across the distributed network. Dynamic tasks are also scheduled through algorithms for optimization of usage of voltage [18], [19].

In India or abroad, telecommunication network is vast network and sufficient literature is available on this kind of network but saving the energy is the key issue which has been proposed by the various authors [20-22]. Routing techniques play an important role in the power consumption on the network, Chabarek et al. [23] have explained a network design and routing technique for saving the consumed power by the devices. There are numbers of open challenges for improving the energy efficiency across the network [24]. One of the challenges is to optimize the power across fibre optics networks [25] while another on the wireless network in which numbers of wireless devices are consuming the energy [26]. Energy saving technique for flow based routing is well explained by [27]. Loop free routing technique is used by Lee et al. [28] to update the link state routing technique for saving the energy across networks. Parallelization of tasks may save the consumed energy during the execution of tasks [29].

The concept of game theory is also used for optimizing the energy consumption and minimizing the response time across the computational grid networks [30]. Chiaraviglio et al. [31] have proposed a technique for optimizing the energy cost for the Internet Service Provider (ISP) network. Shortest path technique for the Internet Protocol (IP) traffic is used for optimizing the energy paths [32]. Validation of execution of task on step network has been done by Zaidi and saxena [33].Reliable method to compare the performance of cloud services has been done by Alhamad et al. [34] and different types of metrics are generated and a methodology is proposed to measure the expandability of cloud services and comparison of cloud providers with proposed approach has been done.

Agraj [35] has proposed an algorithm for load balancing of cloud by considering response time of every request and on the basis of response time next allocation is done, this approach reduces the extra computation loss on server. Chitra D. and Rhymend [36] proposed a scheduling and load balancing algorithm for evaluating the capabilities of virtual machines and also interdependency of multiple tasks is analyzed as well as proposed algorithm is compared with existing methods. Tyng-Yeu Jie Li [37] proposed an algorithm based on K-Means for Cloudlets and performance of algorithm shows that this algorithm reduces the network latency as well as number of service instances to tolerate network latency. Dynamic Time Slice Calculation for Round Robin Process Scheduling Using fine tuning time slicing of processes which didn't completed in allotted timeslot was well explained through a new method proposed in [38]. Experiments on cloudsim toolkit has been demonstrated by Gibet and Amrani [39], as well as two new scheduling strategies has been proposed that depicts the strength and weakness of scheduling algorithms.

The present paper is based upon the analytical study on behavior of cloud servers which shall be interconnected across step network designed by author of the project and thereafter a new analytical methodology shall be proposed in the form of Mathematical modeling. The proposed methodology in the entire project work shall be the backbone for future research in the field of cloud computing. Overall computed results for minimization of energy consumption and proper utilization of the resources shall be compared by taking the variations of numbers of nodes and in different cases like sleep node, various types of variables which shall be used to handle the energy consumption, etc and new results shall open the new dimensions for future research in cloud computing. The current paper emphasized on mapping between cloudlet to VM to balance the workload and scheduling of workload on Round robin allocation policy. The present work focuses on task binding to VM for providing high speed or less execution time to the tasks. The user base traffic is routed by datacenter using service proximity policy and it selects closest data center having lowest network delay. Simulation results depict the regions with response to time results. Request servicing time for data centers and cost details represented in Tables.

3. UML MODELING

The systematic accessing of the NKN clouds is also represented in the Figure 1. In this figure user is well connected through the various Virtual Local Area Network (VLAN) system. A UML class model is designed for computation of energy consumption and for accessing the cloud servers and represented in Figure 2. In this case the cloud servers are arranged through step network and in India the project is initiated by the government of India to establish nationwide network called as a National Knowledge Network (NKN). The main purpose is to connect all the higher educational Institutions, pathological labs, research labs, sharing of digital libraries, virtual classes, etc. For representing the static behavior of the problem, UML class for accessing the NKN clouds is shown below in Figure 1 which consists of thirteen major classes. Many users have the computer systems or hand-held devices connected across the distributed networks. The communication networks are well connected through switch by means of topology. This is shown by considering the five classes called as USER, COMPUTER_SYSTEM, COMMUNICATION_NET WORK, SWITCH and TOPOLOGY. Multiple switches are well connected to the router which is controlled by many servers taken as a cloud servers. The servers consumed the static and dynamic energy represented by two classes called as STATE_ENERGY_CONSUMPTION and DYNAMIC_ENERGY _CONSUMPTION. The cloud servers are connected to the step network controlled by STEP_NETWORK class and resources are controlled by RESOURCES class. The NKN clouds are provided by the service provider controlled by the SERVICE_PROVIDER class. In India, the service provider is the National Informatic Centre (NIC), New Delhi.

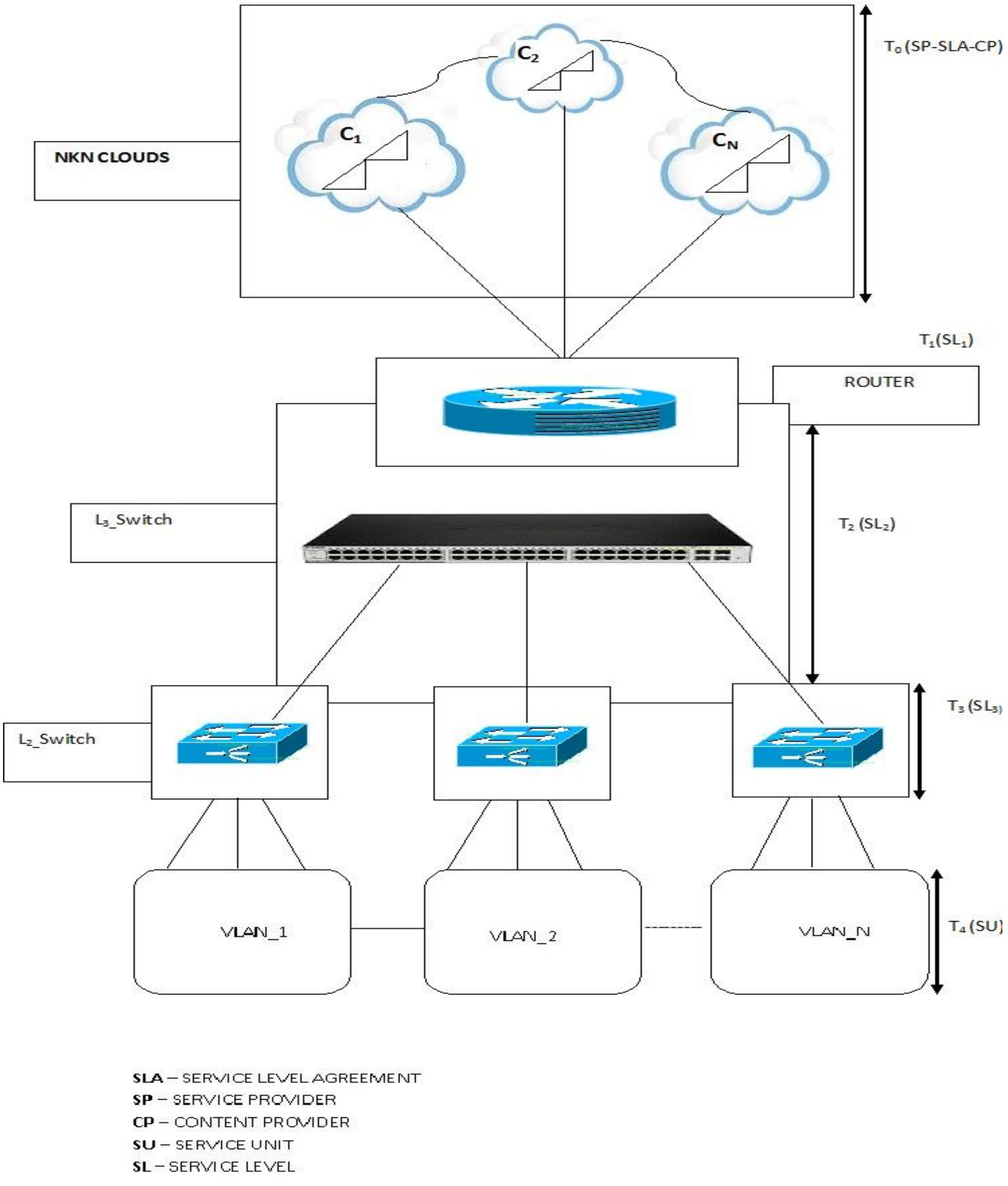


Figure 1. Accessing of cloud servers by users

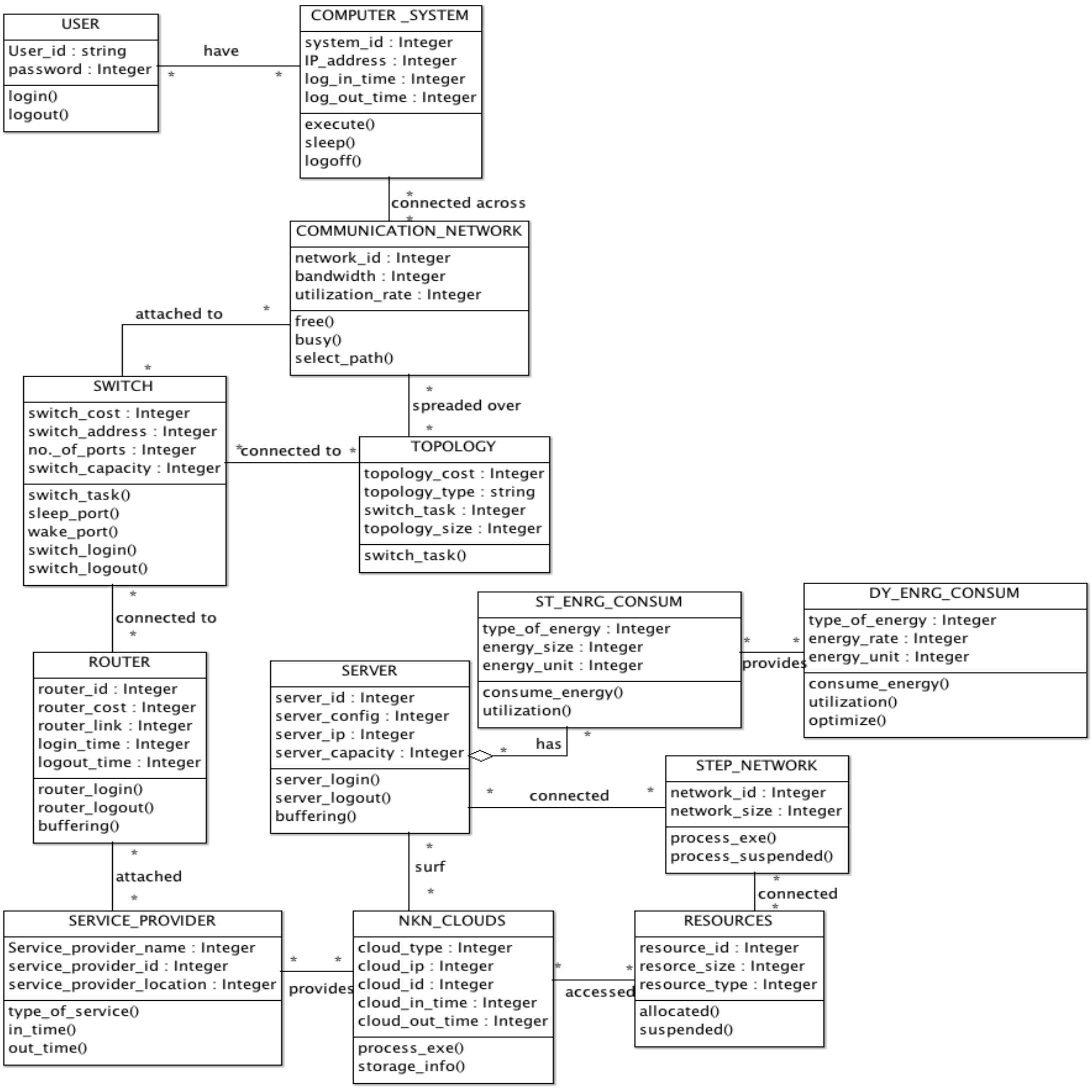


Figure 2. UML class model for energy consumption and accessing NKN of cloud servers

4. METHODOLOGY

The Figure 1 shows a model for creation of the clouds for the various kinds of services attached dynamically through step network. One should measure the energy efficiency of devices regularly e.g. hourly, daily, monthly or continuously. The continuous measurement of energy efficiency of the devices can help to detect the following patterns:

a. Lack of full utilization of energy expressed in kilowatts per user per day (kwh/ur/d) which shows that the full utilization of cloud servers are not done and a lots of space are available for the utilization of the resources.
b. Energy efficiency increased when one is upgrading across the cloud servers and it is computed in terms of kilowatts per tera bytes (kwh/tb).
c. If proper cooling is not available at the work place where the servers are installed then consumption of energy is more and computed in terms of kilowatts per day (kwh/d).

On the basis of above, electricity can be consumed in the following cases:

a. Offices of Organization;
b. Research Laboratories;
c. Audio Visual Entertainment;
d. Data Centres;
e. Digital Libraries;
f. Super Computing.

Now let us consider voltage on the voltage lines $v_k(t)$, where t is the time and these draw the current $i_k(t)$, the power is defined for the lines is

$$p_k(t)=v_k(t)*i_k(t) \quad (1)$$

Now consider M Direct Current (DC) output lines are available with N voltage lines, then total power is delivered between time t_1 to t_2 [34]

$$E_{DC} = \int_{t_1}^{t_2} \sum_{j=0}^{N} \sum_{k=0}^{M_j} p_k(t)dt \quad (2)$$

The above energy is the energy consumed by the system denoted by $E=E_{DC}$ with sum of the energy components consumed by different sub systems which may be of the following types:

a. Energy consumed by the processor (E^p);
b. Energy consumed by dynamic RAM (E^d);
c. Energy consumed by hard disk (E^h);
d. Energy consumed by motherboard (E^m)
e. Energy consumed by electrical components (E^e).

The total energy consumed by the system is

$$E=\int_{t_1}^{t_2} \sum_{j=0}^{N} \sum_{k=0}^{M_j} (E_k^p + E_k^d + E_k^h + E_k^m + E_k^e)dt \quad (3)$$

The interval t_1 and t_2 are explained as per the following:

a. Active Time (t_a) represents when the cloud server is in active mode and processing the information;
b. Sleep Time (t_s) represents when the node is idle i.e. no process is executed on node then called as sleep time;
c. Sharing Time (t_{sh}) represents when node takes the resources or it is shared by other nodes and it includes listen time also.

Energy produced by one server is given by

$$\frac{dE}{dt} = E_F + \frac{dE_C}{dt} \quad (4)$$

Let total nodes used for energy consumption are N_1, N_2, ... N_n where T denotes total numbers of nodes which are heterogeneous nodes.

For first node N_1

$$E_{1,}=E_F+E_v \quad (5)$$

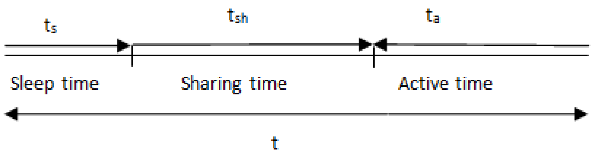
Let all nodes generate fixed amount of fixed energy then

$$\begin{aligned} E &= E_1 + E_2 + \cdots . E_N \\ &= E_F + E_{V1} + E_F + E_{V2} + \ldots\ E_F + E_{VN} \end{aligned} \quad (6)$$

$$E = NE_F + \sum_i^N = 1E_{Vi} \quad (7)$$

Energy depends on the time then taking into variable part of energy consumption

$$\frac{dE}{dt} = \sum_{i=1}^{N} \frac{dE_{Vi}}{dt} \quad (8)$$



Active time of Node $T_3 = (P + m + k)t_3$

Sharing time T_2=ht_2+(1-h) t_2

T_1=T-($(P + m + k)t_3$)+(ht_2+(1-h) t_2)

5. CLOUD ANALYST

Cloud analyst is a simulation tool developed at University of Melbourne for achieving specific goal.It shows graphical representation of output.It is used for simulation of distributed application scattered in various datacenters and user groups.It also support simulation of social network tools.When a user request for a a task, broker entity route the user traffic to the datacenter according to round robin policy.

Main entities in cloud analyst are Internet, region, user base, Internet cloudlets, Cloud App service broker, Data center controller ,VM load balancer and GUI.

6. RESULTS AND DISCUSSIONS

In this experiment, internet application is located on six data centres globally.The cloud enviroment consists of six user bases which are distibuted and six data centres with 5,5,5,5,5 and 5 Virtual Machine (VM's).

Geographical view is shown in Figure 3.

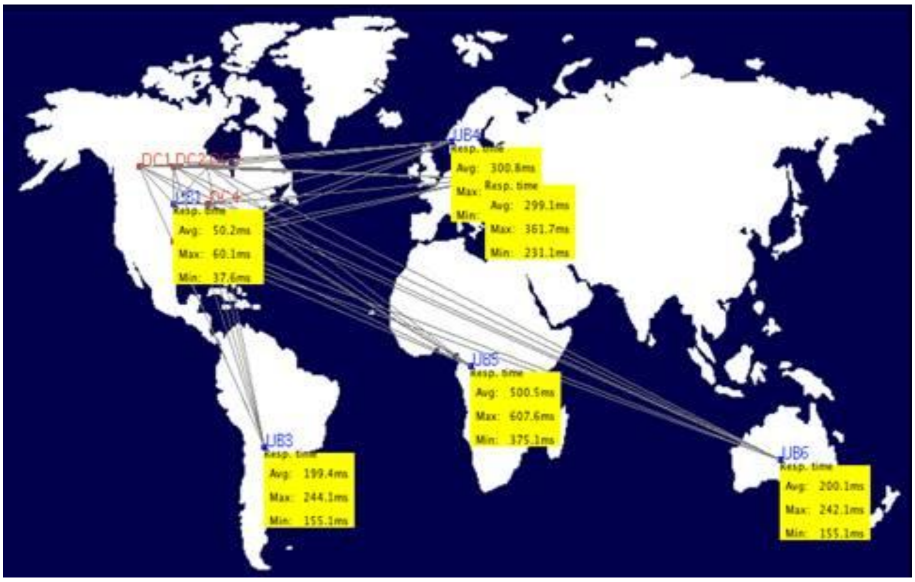


Figure 3. A view of geographical response time

Different regions are categorized from the geographical area and six-user base have been created using the simulation tool. Response time of each user base is recoded in the table 1. The lowest response time is recorded by user base (UB1) which has range from 37.631 to 60.10, hence average is 50.204 milliseconds. The maximum is recorded by the user base (UB5) which has range from 375.141 to 607.643 with average time is 500.533 milliseconds. The overall response time is recorded as on average of 259.82 with 0.31milliseconds processing time. For computing purpose round robin policy has been adopted. The results are also demonstrated through graph represented in Figure 4.

Data centre request service time is also computed in round robin manner for six regions and it is observed that the minimum service request is performed by data center 1(DC1) while maximum is data center 4 (DC4), graphical representation is shown in figure 4, loading on six data centers is also represented in Figure 5.

Since loading is done on each machine hence costing is one of the major factor in computing through round robin manner for six user base (UB), it is represented in figure 6. Simulation result shows that virtual machine cost is $3.01 while data transfer cost is $0.38.

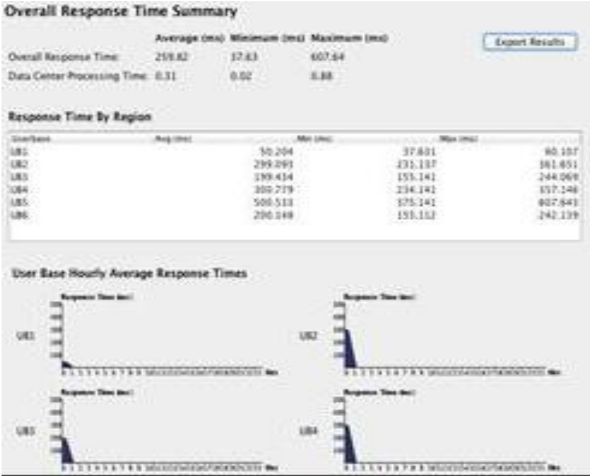


Figure 4. A view of response time for UB

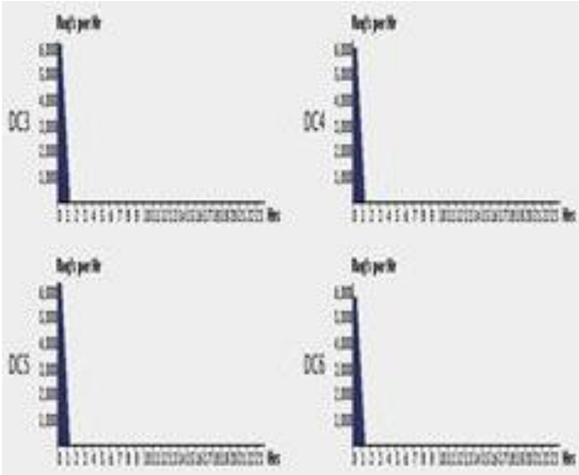


Figure 5. Results of loading on DC

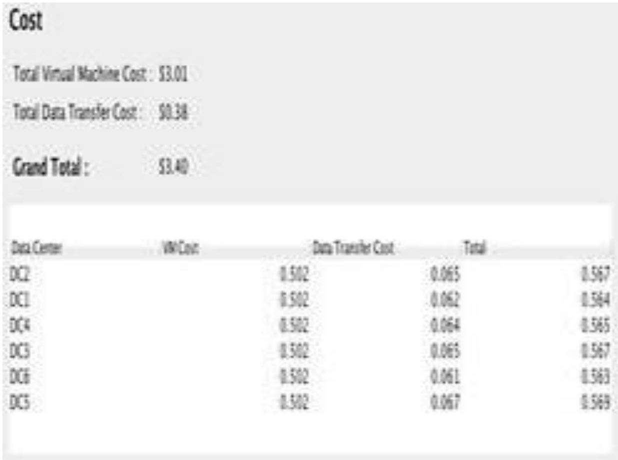


Figure 6. Total cost DC and VM's

Transmission of files in cloud computing environment is shown in figure 8, so bandwidth and delay in network is important factor. Bandwidth matrix is shown in table1 for six regions and delay matrix represented in Table 1 and Table 2. These two represent internet characteristics.

Table 1. Representation of Internet Characteristics

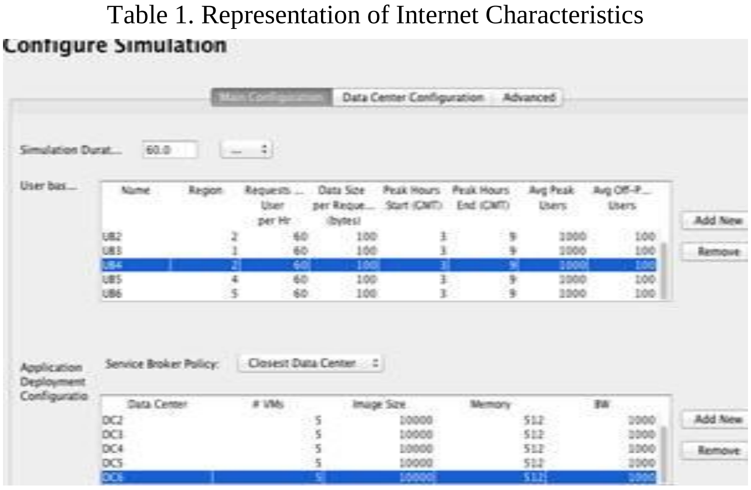


Table 2. Representations of Configured Simulation

Configure Internet Characteristics

Use this screen to configure the Internet characteristics.

Delay Matrix

The transmission delay between regions. Units in milliseconds

Region\Region	0	1	2	3	4	5
0	25	100	150	250	250	100
1	100	25	250	500	350	200
2	150	250	25	150	150	200
3	250	500	150	25	500	500
4	250	350	150	500	25	500
5	100	200	200	500	500	25

Bandwidth Matrix

The available bandwidth between regions for the simulated application. Units in Mbps

Region\Region	0	1	2	3	4	5
0	2,000	1,000	1,000	1,000	1,000	1,000
1	1,000	800	1,000	1,000	1,000	1,000
2	1,000	1,000	2,500	1,000	1,000	1,000
3	1,000	1,000	1,000	1,500	1,000	1,000
4	1,000	1,000	1,000	1,000	500	1,000
5	1,000	1,000	1,000	1,000	1,000	2,000

Complete simulation results are represented in Table 3 as data size per request is 100 bytes which is along with regular size. Memory cost is $0.05 per userbase (UB) with data transfer cost is $0.1 for each userbase(UB).

Table 3. Complete Simulation Result for Datacenter

Configure Simulation

Main Configuration | Data Center Configuration | Advanced

Data Centers:

Name	Region	Arch	OS	VMM	Cost per VM $/Hr	Memory Cost $/s	Storage Cost $/s	Data Transfer Cost $/...	Physical HW Units
DC1	0	x86	Linux	Xen	0.1	0.05	0.1	0.1	2
DC2	0	x86	Linux	Xen	0.1	0.05	0.1	0.1	1
DC3	0	x86	Linux	Xen	0.1	0.05	0.1	0.1	1
DC4	0	x86	Linux	Xen	0.1	0.05	0.1	0.1	1
DC5	0	x86	Linux	Xen	0.1	0.05	0.1	0.1	1

Add New

Remove

5. CONCLUSIONS

The above approach is useful for finding the simulation results for the variable energy consumptions by the devices used in the computer centres of an organization. In this work user bases have been created and tested and response time along with internet characteristics have been defined. Active time of the node has been computed and results are represented with the help of tables and graphs. As user bases have increased, the results are not going to divert, hence these results are optimized results.

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