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Performance Analysis of Space Shared Scheduling and Time Shared Scheduling in Cloud Sim

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Abstract: Cloud Computing is one of the recent domains of Computer Science in which Researchers across the world are working in order to get deep insight of this domain and to develop new algorithms in various aspects to this domain to make it more easily accessible to the Users. It provides a simple, heterogeneous and architecture neutral platform where the Users can access the Services and Resources as per their requirements with ease. It is totally an Internet based system and works on the principle of Pay per Use.

In order to understand the behavior of such systems, one should require installing and configuring the system with Resources and Services. Sometimes, it is very costly, as all Researchers do not have funding from agencies for handling such expenses. In such cases, where it is not possible to have physical Infrastructure available, Simulators will do the needful. Simulators are those systems which allow us to logically implement and configure real world systems and then we can test our algorithms on it to get a conclusion about its behavior. If an algorithm works good on Simulators, then in most of the cases, algorithms works well in real environments also.

One of such Simulator that can be used to test algorithms for Cloud based Systems is Cloud Sim. It allow researchers to design the logical infrastructure involving Data Centers, Hosts, Virtual Machines, Cloudlets and other entities of the Cloud environment. This paper provides you a deep insight about how we can configure a Cloud system scenario and then implement and test the algorithm to check whether it is functioning properly or not. It is a very good way to understand the behavior and the working of Cloud Computing systems.

Keywords: Cloud Computing, Cloud Simulator, Cloud System Architecture, Cloud Models, Scheduling in Cloud Computing, VM Scheduling, Cloudlet Scheduling

I. INTRODUCTION TO CLOUD COMPUTING

Cloud Computing is one of the recent advancements in the domain of Computer Science which is implemented on the basis of sharing Resources over the Network. Cloud Computing offers everything as a Service ^{[5] [6] [7]}. Today, Cloud Services are rapidly gaining popularity for Service Industry.

According to NIST definition of Cloud Computing, “Cloud Computing is a model for enabling ubiquitous, convenient and on demand Network access to a shared pool of configurable computing Resources, such as Networks, Servers, Storage, Applications and services, that can be rapidly provisioned and released with minimal management effort or service provider interaction” ^[3].

It can be considered as an extension to Distributed Computing. It is an Internet based model for providing Services and Resources to its Users through the underlying Network architecture. There is no need to deploy new Network infrastructure for utilizing Cloud Services. It is based on the Pay per Use model; the User will have to pay only for the Resources and Services utilized, that too on the basis of time duration for which the Services and Resources are utilized. It provides a highly scalable, architecture neutral and heterogeneous environment for its Users ^[4].

II. CHARACTERISTICS OF CLOUD COMPUTING

NIST specified 5 essential characteristics of Cloud Computing, as:

On Demand Self Service: The User can access the Services and Resources provided by the Cloud as and when required. There is no time boundation; only requirement is the availability of Internet ^[3].

Broad Network Access: The underlying network architectures are sufficient enough to enable Users to access the Cloud Systems. There is no need to deploy new infrastructures for this ^[3].

Resource Pooling: All Services and Resources can be provided to the Users by the Cloud in the form of a centralized Repository or Pool. The User can access the desired Services or Resources but the User is unaware about their Location (Location Independence). Lack of Service Provider Interaction and Multi Tenant Model are salient features of Cloud Computing ^[3].

Rapid Elasticity: Resources and Services can be added or removed from the System as and when required. Similarly, number of Users can be increased or reduced. These issues will not degrade the performance of the Cloud Systems. Cloud Systems will work effectively and efficiently, even in heavy Loads with minimal Resources ^[3].

Measured Service: The most striking feature of Cloud Systems is that it provides the Services on Pay per Use basis, i.e., the Customer will have to pay the Amount only for the Services that it had utilized ^[3].

III. CLOUD DELIVERY MODELS

According to NIST, Cloud infrastructures are classified into 2 broad categories, as Service Models and Deployment Models.

Service Models (SPI)

SaaS: “Software as a Service” or the SaaS Model deals with providing various Software / Applications to the Users of the Cloud Systems. These Applications are already deployed on the Cloud Systems ^[3].

PaaS: “Platform as a Service” or the PaaS Model provides the facility to the Cloud Users to access the Cloud Infrastructure for Deployment of the Software / Applications developed by them. By this, Users can get the Domain where they can register their Applications, which can be used by others in future ^[3]. These Services can be accessed by using the Internet through the Web Browsers.

IaaS: “Infrastructure as a Service” or the IaaS Model allows the Users to use the Cloud System Resources like Servers to carry out the desired operation. The Cloud Infrastructure is accessible to the User and the User can use it to store its Data / Information ^[3].

Deployment Models

Private Cloud: The Cloud Infrastructure can be used solely by an Individual or a Single Organization ^[3]. It can be handled by the Person / Member of the Organization to which it belongs.

Community Cloud: The Cloud Infrastructure can be shared by a specific group of People or by a specific group of Organizations ^[3]. It can be managed by these Organizations or by any Third Party.

Public Cloud: The Cloud Infrastructure and its Services are made available to a large group of People or a number of different Organizations ^[3]. It can be managed by the Cloud Service Providers.

Hybrid Cloud: This type of Cloud Infrastructure is a composition of two or more different Cloud Models (Private, Community or Public Clouds) ^[3].

IV. VIRTUALIZATION

Virtualization plays an important role in Cloud Computing environments. Virtualization enables the utilization of the Resources in a much optimized manner. In normal systems, User requests are processed by the physical Machines, but in Cloud environments, User Requests are processed by Virtual Machines (VM).

A VM is a logical instance of a physical Machine that operates in similar manner as physical Machine. There are scenarios in which a number of VM’s are executing on a single physical Machine. Virtualization mainly aims to improving scalability, availability, throughput and optimal utilization of Resources ^[6].

V. INTRODUCTION TO CLOUD SIM

Cloud Sim is actually a software framework that supports modeling, simulation and experimentation of various cloud computing related phenomena. It supports modeling and simulation of various cloud computing aspects like virtualization, energy efficient computing, networking in cloud computing, message passing, scheduling algorithms, user defined algorithms related to cloud and various other types of cloud computing simulations. It was developed by the team of Prof. Raj Kumar Buyya at Cloud Computing and Distributed Systems Laboratory (earlier GRIDS Lab.), Department of Computer Science and Software Engineering, University of Melbourne, Australia ^{[1][2]}.

Cloud Sim is an open source free ware software framework that can be downloaded through Internet and can be used to perform different simulations related to cloud. Researchers and scientists can also add the new classes in the basic Cloud Sim package and then the functionality of those classes in their simulations ^{[1][2]}.

VI. ARCHITECTURE OF CLOUD SIM

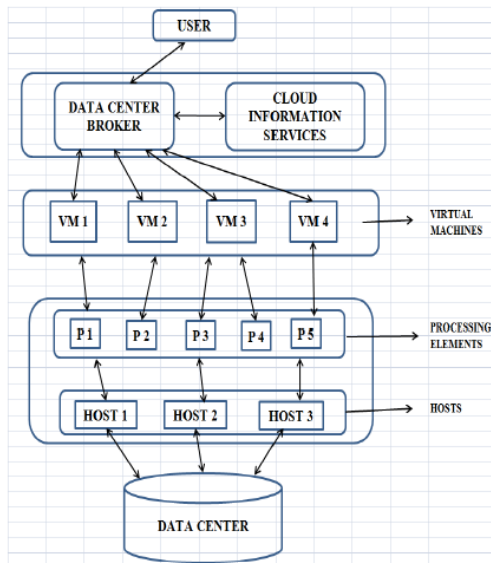


Fig. 1: Architecture of CLOUD SIM (Cloud Computing Environment)

In normal scenarios, each User accesses a physical Machine with computing capabilities to carry out his operation. But in Cloud Computing environments, all Resources are kept in the form of a centralized Repository or Pool and the Users will access this Pool for his Resources.

The entity where all the computational capabilities, physical Machines and Data reside is the Data Center. A Data Center may consist of various Physical Hosts, each having computational capacity, either same or different. Depending upon the number of Processing Elements (PE) these Hosts possess, Virtual Machines (VM) are initialized [7].

Virtualization creates a layer of Abstraction between the Users and the Physical Machines. Using the PE of Hosts, VM are initialized over these Hosts. Data Center Broker acts as an interface between the Cloud system and the Users. User requests (Process) are commonly termed as Cloudlets. Depending upon the size of Process, User request may be divided into multiple Cloudlets. Now, these Cloudlets are forwarded to Data Center Broker. Now, Data Center Broker will look for suitable VM's for execution of these Cloudlets. This allocation of Cloudlets to VM and VM to PE of Hosts will be done on the basis of the scheduling algorithm specified while initializing the simulation of the given scenario [7].

The various components in the architecture include:

Cloudlet: This class represents the task to be executed. An object of this class is the process that will be executed by the system. A cloudlet is characterized by a number of parameters like cloudlet ID, length, PE required for execution, input size, output size and utilization model [4] [7].

Cloudlet Scheduler: It is an abstract class that represents the policy used by the system for scheduling of cloudlets to the VM's for execution. Any scheduling policy to be defined must extend this class [1] [2].

Cloud Sim supports mainly two types of Cloudlet Scheduling policies, namely Space Shared Policy and Time Shared Policy.

Cloudlet Scheduler Space Shared Class represents the space shared policy in which the cloudlets are executed on VM's one by one. A cloudlet assigned to VM should leave the VM only after completion of its execution [1] [2].

Cloudlet Scheduler Time Shared Class represents the time shared policy in which the cloudlets are assigned to VM's simultaneously [1] [2] and they share the VM resources for their execution by continuously switching between one another.

Data Center: This class represents the infrastructure provided by the cloud service provider to the users. It encapsulates the collection of homogeneous or heterogeneous hosts on which the VM's are created and the user's requests are executed [4] [7].

Data Center Characteristics: This class represents the static characteristics of the resources [1] [2] like architecture, OS, cost of resources, time zone and management policies (Space Shared and Time Shared).

Data Center Broker: It acts as an interface between the CSP and the user. It normally acts on behalf of the user and on the basis of user's requests and Quality of Service (QoS) specified, identifies the suitable services provided by the system and then provides those services to the users. It is normally used to abstract the process of VM management from users [4] [7].

Host: A host represents a physical entity in the cloud environment that has memory, storage and collection of PE on which the VM's are going to be created. A collection of hosts together forms the backbone of a Data Center. A host also has a policy for allocation of PE to VM, commonly called as VM Scheduling techniques. A host can be characterized by parameters like Host ID, RAM, Bandwidth, Storage, PE List and VM Scheduling Policy [1] [2].



Processing Element (PE): It represents the CPU units, normally defined in terms of MIPS. All PE of the same host have the same MIPS rating ^{[1][2]}.

Virtual Machine (VM): It represents a VM that runs on a host in parallel with other VM's. It executes the Cloudlets input by the users. The Cloudlets processed by the VM's depends upon the Cloudlet Scheduling policy specified in the Cloudlet object ^{[4][7]}.

Each VM is characterized by a VM ID, User ID to which the VM belongs, MIPS required, Number of PE, RAM, Bandwidth, Size, VM Name and Cloudlet Scheduling Policy.

VM Allocation Policy: It is used to select the host on which the VM will be placed for execution. Normally, the host with the lowest number of PE in use is selected for allocation of VM ^{[1][2]}.

VM Scheduler: It is an abstract class that represents the policy used for allocation of PE to VM (VM Scheduling). A class that can act as a VM Scheduling Policy must extend this class. Cloud Sim supports two types of VM Scheduling policies, namely Space Shared Policy and Time Shared Policy ^{[1][2]}.

VM Scheduler Space Shared Class represents the space shared policy in which the PE are allocated to VM on fixed basis. It does not support the sharing of PE between VM. A PE will only be freed up by a VM, if the operation of VM has been completed successfully ^{[1][2]}.

VM Scheduler Time Shared Class represents the time shared policy in which the PE are allocated to VM in such a way that a number of VM's can share the common PE's to carry out their operation. This policy suffers from 10% performance degradation because of the number of switches that takes place during execution of VM's one after another until their completion ^{[1][2]}.

PE List: This list represents the collection of Processing Elements available to a host for allocation to VM's ^{[1][2]}.

Host List: This list represents the collection of hosts available to a Data Center on which the VM's are going to be executed ^{[1][2]}.

Cloudlet List: This list represents the collection of Cloudlets or Tasks to be executed by VM's in the given system ^{[1][2]}.

VII. SCHEDULING IN CLOUD SIM

Scheduling refers to the process of assigning the PE of Hosts to VM for their initialization. It is known as VM Scheduling. It also refers to the process of assigning the Cloudlets to running VM for execution. It is known as Cloudlet Scheduling. In both cases, scheduling is classified as Space Shared and Time Shared ^{[1][2]}.

Space Shared VM Scheduling: In Space shared VM Scheduling, PE's are explicitly allocated to a VM ^{[4][7]}. It means if a PE is allocated to a VM, it cannot be accessed by other VM until the current VM releases it.

Time Shared VM Scheduling: In Time shared VM Scheduling, VM's share the PE's. If a PE is capable to fulfill the requirements of multiple VM's simultaneously, then in case of Time shared VM Scheduling, this can be allowed and multiple VM's will execute in parallel over the same PE or set of PE's ^{[4][7]}.

Space Shared Cloudlet Scheduling: In Space shared Cloudlet Scheduling, if a Cloudlet is assigned to a VM for execution, then no other Cloudlet will be executed by that VM until the current Cloudlet will not be dispatched by the VM ^{[4][7]}. Multiple Cloudlets cannot execute in parallel over a VM, even if the VM is capable enough to do so.

Time Shared Cloudlet Scheduling: In Time shared Cloudlet Scheduling, multiple Cloudlets can execute in parallel over a single VM. This will be possible, if the VM has computing capabilities large enough that it can execute multiple Cloudlets in parallel over it ^{[4][7]}.

In each scenario, both Cloudlet Scheduler as well as VM Scheduler will operate in either type. So, there are 4 possible scenarios for this ^[7], as:

1. Both VM Scheduler and Cloudlet Scheduler are Space Shared
2. VM Scheduler is Space Shared and Cloudlet Scheduler is Time Shared
3. VM Scheduler is Time Shared and Cloudlet Scheduler is Space Shared
4. Both VM Scheduler and Cloudlet Scheduler are Time Shared

Let us suppose, we have a Dual Core Physical Machine (2 Cores means 2 PE's). We need to execute 8 Tasks / Cloudlets say T1, T2, T3, T4, T5, T6, T7 and T8 on 2 Virtual Machines say VM1 and VM2.

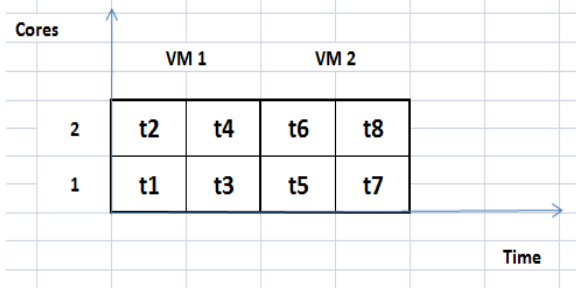


Fig. 2: Cloudlet Scheduler Space Shared – VM Scheduler Space Shared

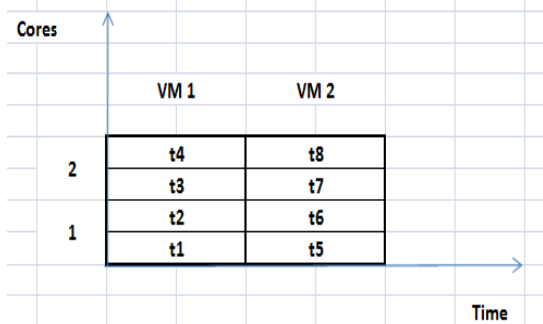


Fig. 3: Cloudlet Scheduler Time Shared – VM Scheduler Space Shared

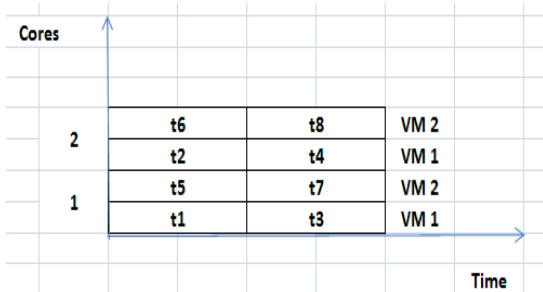


Fig. 4: Cloudlet Scheduler Space Shared – VM Scheduler Time Shared

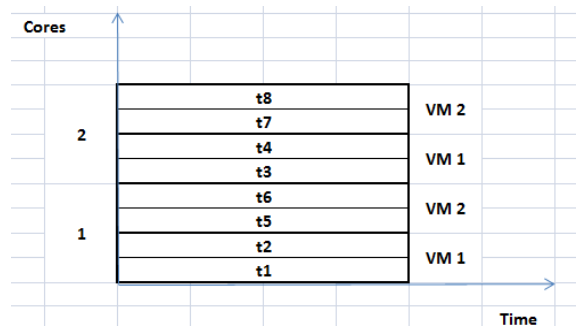


Fig. 5: Cloudlet Scheduler Time Shared – VM Scheduler Time Shared

VIII. SIMULATION OF SCHEDULING ALGORITHMS IN CLOUD SIM

In order to test the Cloud Sim for the above 4 scheduling scenarios, we had simulated a Cloud Computing environment in Cloud Sim with the following specifications of various entities, as:

Table 1: Simulation Parameters

ENTITY	SPEFICATION	VALUE
Data Center	Architecture	X 86
	OS	Linux
	VM Manager	Xen
Host	MIPS	5000
	PE	1
	RAM	1740 MB
	Storage (MB)	163840
	Bandwidth (Kbps)	10000
	VM Scheduler	Space Shared & Time Shared
VM	MIPS	1000
	PE	1
	RAM	512 MB
	Storage (MB)	10000
	Bandwidth	1000
	VM Manager	Xen
	Cloudlet Scheduler	Space Shared & Time Shared
Cloudlet	Length	1000
	File Size	300
	Output Size	300
	PE	1

Performance Parameters: In the simulated environment with above entity specifications, 30 VM's are to be initialized and then 100 Cloudlets are to be executed over the initialized VM's. There are 3 Data Centers, each having 4 Hosts with the above specifications.

Let, "SV – SC" represents Space Shared Scheduling of VM's as well as Cloudlets, "SV – TC" represents Space Shared Scheduling of VM's and Time Shared Scheduling of Cloudlets, "TV – SC" represents Time Shared Scheduling of VM's and Space Shared Scheduling of Cloudlets and "TV – TC" represents Time Shared Scheduling of VM's as well as Cloudlets.

Here, the performance of these Scheduling Algorithms will be tested on the basis of the following parameters, as:

Number of VM's initialized: It specifies the number of VM's that had been initialized in the Cloud Computing environment on the basis of the simulation parameters specified above. It might be possible that all VM's may not initialize in all cases, depending upon the Scheduling algorithm used.

Environment Initialization Time: It refers to the time required by the simulator to set up the Cloud Computing environment on the basis of the simulation parameters specified above.

Average Data Center Debt: Data Center Debt refers to the utilization of the Resources managed by a Data Center.

Average Response Time: It refers to the time period for which the Cloudlet will have to wait in order to be assigned to a VM for execution.

Average Waiting Time: It refers to the time period for which the Cloudlet will have to wait in the system for being executed even a VM has been assigned to it.

RESULTS

Table 2:

Comparison of Number of Virtual Machines (VM's) Initialized

S. No.	Approach	No. of VM's Initialized
1	SV – SC	12
2	SV – TV	12
3	TV – SC	30
4	TV – TC	30

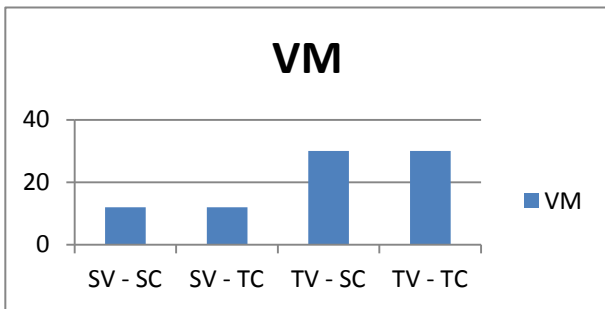


Fig. 6: Number of VM's Initialized

Table 3:

Comparison of Environment Initialization Time

S. No.	Approach	Environment Initialization Time
1	SV – SC	0.3
2	SV – TV	0.3
3	TV – SC	0.3
4	TV - TC	0.3

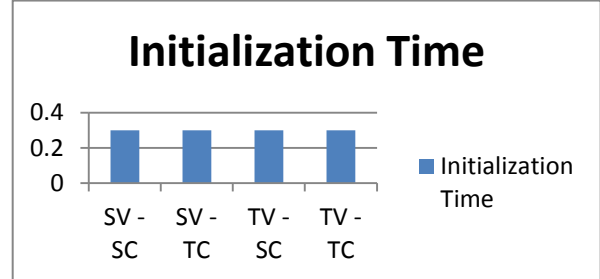


Fig. 7: Environment Initialization Time

Table 4:

Comparison of Average Response Time

S. No.	Approach	Avg. Response Time
1	SV – SC	3.68
2	SV – TV	0
3	TV – SC	1.2
4	TV - TC	0

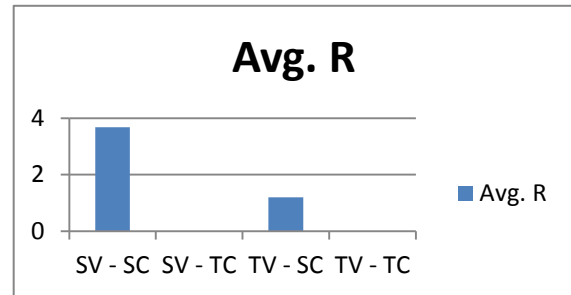


Fig. 8: Average Response Time

Table 5:

Comparison of Average Waiting Time

S. No.	Approach	Avg. Waiting Time
1	SV – SC	3.68
2	SV – TV	7.4
3	TV – SC	1.2
4	TV - TC	2.4

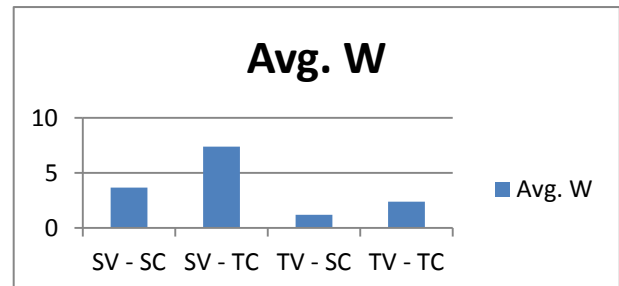


Fig. 9: Average Waiting Time

Table 6:
Comparison of Data Center Debt

S. No.	Approach	Avg. Data Center Debt
1	SV – SC	4102.4
2	SV – TV	4102.4
3	TV – SC	10256
4	TV - TC	10256

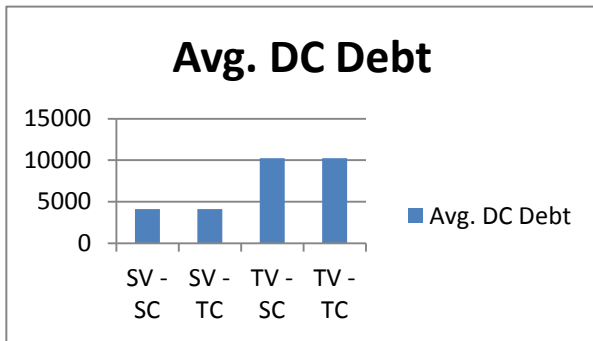


Fig. 10: Average Data Center Debt

IX. CONCLUSION

Cloud Computing is widely being used as the most suitable platform for providing Services and shared Resources to the Users with ease. It reduces the Cost of utilization, as it only requires Internet, uses underlying Network infrastructure without new infrastructure being deployed and User will have to pay for what they had utilized.

Cloud Sim provides an easy, effective and efficient way for Researchers and Students working in the domain of Cloud Computing to design, implement and test their algorithms by simulating the Cloud Computing environment and judging whether their developed algorithm is working properly or not.

It is very easy to learn, understand and work on Cloud Sim because it is totally developed in JAVA. JAVA is very common object oriented programming language that had been used around the world by Developers over the last 25 years. Anyone who is good in JAVA can start working on Cloud Sim from the word go. Lastly, it can be said that Cloud Sim is a cost effective platform for those who want to work on Cloud Computing to developing new algorithms and techniques related to this field but not having any funding or support from any agencies for deploying and configuring the real Cloud Computing environment.

In case of Space Shared Scheduling, Response Time and Waiting Time will always be same, while in case of Time Shared Scheduling, they will be different. This is because in Space Shared Scheduling, if a Cloudlet is assigned to a VM for execution, VM will dispatch that Cloudlet only after executing it completely. In case of Time Shared Scheduling, multiple Cloudlets execute over a single VM, so Waiting Time will be more as compared to Space Shared Scheduling. Generally, Time Shared approach is better as compared to Space Shared approach. But here, Space Shared algorithm performs far more superior than Time Shared approach.

In case of Space Shared VM Scheduling, as numbers of VM's initialized are less in number, so Data Center Debt in such cases is on the lower side, as Resources are used in limited manner. In case of Time Shared VM Scheduling, numbers of VM's initialized are more as compared to Space Shared Scheduling, so the Data Center Debt in such cases is higher because more utilization of Resources has been made by the executing VM's.

REFERENCES

- [1] Calheiros R. N., Ranjan R., Rose C. A. F. D. & Buyya R., "CloudSim: A Novel Framework for Modeling and Simulation of Cloud Computing Infrastructures and Services".
- [2] Buyya R., Ranjan R. & Calheiros R. N., "Modeling and Simulation of Scalable Cloud Computing Environments and the CloudSim Tool-Kit: Challenges and Opportunities".
- [3] Mell P. & Grance T., "The NIST Definition of Cloud Computing", NIST, September 2011.
- [4] Mondal M. A., Choudhary S. & Islam M. S., "Performance Analysis of VM Scheduling Algorithm of CloudSim in Cloud Computing", International Journal of Electronics and Communication Technology (IJECT), 49 – 53, Volume – 6, Issue – 1, January – March 2015 [2230 – 7109].
- [5] Householder R. A. & Green R. C., "Impacts of Multi – Class Oversubscription on Revenues and Performance in the Cloud", International Journal of Cloud Computing, 15 – 30, Volume – 2, Number – 1, January – March 2014 [2326 – 7550].
- [6] Rathore V. S., Pateriya R. K. & Gupta R. K., "An Efficient Virtual Machine Scheduling Technique in Cloud Computing Environment", International Journal of Modern Education and Computer Science (IJMECS), 39 – 46, Volume – 3, March 2015.
- [7] Himani & Sandhu H. S., "Comparative Analysis of Scheduling Algorithms of Cloud Sim in Cloud Computing", International Journal of Computer Applications (IJCA), 29 – 33, Volume – 97, Number – 16, July 2014 [0975 – 8887].