**Power Consumption Analysis Across Heterogeneous Data Center using Cloudsim**

Pradeep Singh Rawat

Dehradun Institute of Technology

Dehradun, India

[pradeep\_kec09@yahoo.com](mailto:pradeep_kec09@yahoo.com)

DR. Priti Dimri

Associate Professor and Head

Department of Computer Science and Applications

G.B. Pant Engineering College, Ghurdauri, Pauri

pdimri1@gmail.com

Varun Barthwal

Hemwanti Nandan Bhuguna

Garhwal University

Srinagar, India

v[aruncsed1@gmail.com](mailto:aruncsed1@gmail.com)

***Abstract—*** C***omputing paradigm plays an important role to study the scientific applications. Here we focus on tool based simulation of Cloud computing Infrastructure for power aware analysis. We introduce the cloud computing paradigm for resource like data center which is enabled with DVFS (dynamic voltage frequency scaling) with power aware deployment across the Globe in different geographic region. In this paper we find out the best policy across data center with minimum power consumption. The management of resources and scheduling of applications in such large-scale distributed systems is a complex undertaking in case of Cloud computational environment. It is hard and even impossible to perform scheduler performance evaluation in a repeatable and controllable manner as resources and users are distributed across the Globe in different organizations with their own power consumption policies. The CPU utilization of each host is kept under the specified utilization threshold. In case of heterogeneous non-power aware data center, all hosts consume maximum Power all the time. To overcome this limitation, we used a Java-based discrete-event cloud simulation toolkit called CloudSim to identify the power saving across the data center. It provides primitives for creation of application tasks, mapping of tasks on resources, and their power aware and non power aware management. To demonstrate suitability of the CloudSim toolkit, we have simulated a Cloud environment. We deploy the cloudlet or cloud Task on cloud resources which include machine list, MIPS rating of machines, power consumption policy, for energy saving switch on or switch off process is used for host associated with data center.***

Keywords- MIPS, Cloudlet, Cloudsim, DVFS, VM, CPU;

# INTRODUCTION

Cloud computing is the Internet based computing in which all computational operation is made to be performed over the cloud. We know that for resource management more cost need to be pay which may include cost paid for power across data centre, storage, computing, and network resource. So it is better to use the resources on rent basis rather than to buy our own resources. Each organization wants to make busy their employee for innovation and high quality resource utilization. Cloud Computing is improving efficiency of IT infrastructure utilization. Simplest definition of cloud computing is "To provide IT as a service" is called cloud computing. This is the part of distributed computation. The main component of IT is hardware, software (application, system) are provided as a service by the cloud Computing. While using cloud computing cloud vendors can provides the secure pool of resources which include the storage and computing server with in the data centre. It provides the massive distributed environment which may dynamic in nature. To control this type of distributed system we need to study some simulation Tool. Simulation tool which are used for distributed application based on object oriented programming. Simjava, Grdilet, Cloudsim, CloudAnalyst are the cloud simulation tools. These Tools provide the clue to us how to deploy application and what are the IT requirements for the application. These tools follow the layered architecture i.e. user can add their own layer over the user code level. Simulation tool provides the prior information about cloud resources which are required for application deployment. We can use our own policy at data center level to share the MIPS of the physical processing element. Using simulation tool we can setup the different cloud configuration with internet characteristics. Processing power of the CPU to run their application is provisioned in time and space shared mode. We take an example of social networking application to deploy at different region with different internet characteristics, data center configuration.

# RELATED WORK

Distributed system consist a collection of inter connected and virtualized computers. These are dynamically provisioned and presented as one or more unified computing resources. Service level agreement of cloud computing resources depends on negotiation between service provider and consumers [1]. Cloud broker acts as a mediator. Resources are provided on demand by cloud provider as per the requirement of cloud application. For an example Amazon EC2 provides the IaaS cloud computing service model to run the cloud based application [ 10]. Consumers can use the platform to develop the application i.e. we follow here the cloud service model i.e. PaaS E.g. Google Application Engine provides the platform to run the Gmail application [1 1]. In similar way to provide the software as service we use cloud model SaaS. Hence end user of cloud need not focus on management of cloud resource but to develop the innovative application. Experimentation methodologies in cloud environment help the researcher to deploy the application in a real platform with minimum cost and good server utilization. Simulation is one of such alternative and this is the focus of this work. There are many simulation tools on which the cloudsim is based supports to test the distributed application. These Tools 2012 2nd IEEE International Conference on Parallel, Distributed and Grid Computing are helpful for the object oriented modeling of cloud resources, Some of these simulators are GridSim [3], MicroGrid [4], GangSim [ 15], SimGrid [5] and CloudSim [6], To study the grid computing system first three simulators are used. CloudAnalyst toolkit layered over Cloudsim is helpful for modeling and simulation of cloud computing system. We can estimate the cost for following pay as you go model for distributed application running over cloud infrastructures [ 12][ 13], GridSim Toolkit can be used for performance evaluation of distributed environment and simulation of dedicated link based network.

GridSim toolkit is a Java-based simulation toolkit that supports modeling and simulation of heterogeneous Grid resources. It allows users spread across multiple organizations to use their own policies for scheduling applications. It supports multiple application models. It provides primitives for creation of application tasks, mapping of tasks to resources, and managing of tasks and resources [3], Cloudsim Toolkit provides the capability to setup the cloud environment and run cloud task on it. It can model the powerful cloud resource to provide IT solution for huge cost implications of IT infrastructure. CloudSim provides the virtualization engine to manage the entire life cycle of virtual machine. CloudSim Toolkit (follow the layered architecture) is based on distributed simulator GridSim. Datacenter configuration feature in CloudAnalyst is extended from Cloudsim toolkit. At infrastructure level cloud main resource datacenter can be model to provide the storage and computing server for cloud task run. Datacenter serve the request to user base located in different geographical region. CloudAnalyst toolkit features are presented in the next section.

# CLOUDSIM

Cloud user can deploy the large scale application over the real cloud without taking any responsibility for resource management and resource provisioning. Cloudsim toolkit provides the modeling and simulation of cloud computing system and application provisioning policy implementation. We can model the cloud component using this simulation tool kit. Cloud main resource datacenter can be model and configured across the different time zone. Internet applications are accessed by users around the world. This Simulation tool provides the repeatable and controlled environment to setup our own virtual cloud computing environment with different cloud component properties. Using cloudsim toolkit we evaluate the performance of SaaS modeler on the basis of estimated finish time like social networking application. We get the simulation results for Cloudlet running over the cloud environment implemented over the cloudsim at user code level. These results are helpful in quality of service improvement. Finish time of Cloudlet run act as a performance evaluation parameter for cloud task or Cloudlet. Cloudsim Toolkit provides the flexibility to the user to implement his own resource provisioning policy. To construct the virtual cloud computing environment we use the layered architecture of cloudsim and implement the virtual cloud environment at user code level. We inherit the features of bottom layers of the tool. In this paper Cloudsim is used as a simulation cloud resource data center with different power consumption policy with fixed virtual machine, fixed host configuration. One to one mapping is performed between cloudlet and virtual machine across the data center with number of physical processing element.

# A CASE STUDY

## SIMULATION POWER AWARE AND NON POWE AWARE DATA CENTER

We are simulating cloud resource with host configuration that contain one PEs. Deploy application on real cloud infrastructure so discrete event simulation plays its role. Scientific application may benefit from cloud because they typically present non-uniform usage patterns across the cloud infrastructure. We employed a layered and modular architecture for cloud simulation to leverage existing technologies and manage them as separate components. Create user and resource entities like heterogeneous data center connected via network topology, user using Cloudsim toolkit to evaluate performance using power associated parameter across heterogeneous data center. Here we setup the virtual cloud computing infrastructure which includes the configuration parameter shown in section IV. Virtual Machine have same MIPS rating i.e. 250,500,750,1000 and machine have 1 PEs. Each host have maximum 3000 MIPS rating. We get the simulation results for different scenario of cloud resource entity, cloud resource properties shown in table I,table II and table III in section IV. Simulation results are corresponding to the 3 power consumption policy across the data center. Max power limit is 250 W and number of host across data center, number of virtual machine and number of cloudlets are 10,20,20 respectively.

# SIMULATION INPUT PARAMETERS

|  |  |
| --- | --- |
| Number of Cloudlet | 20 |
| Pes no | 1 |
| Input file size | 300 |
| Output file size | 300 |
| Host Number | 10 |
| Max Power | 250 W |
| Vm Number | 20 |

Table I Common Cloud resource properties

Above Table I include the Cloud resource properties i.e. cloudlet properties, host and virtual machine properties. Max power at datacenter that can be consume by the host using different resource provisioning policy. For good quality of service and one to one mapping between cloudlet and virtual machine no of cloudlet equal to no of virtual machine.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| MIPS Rating | Pes no | RAM | Band width | Image size | VMM |
| 250,  500,  750,  1000 | 1 | 128 | 2500 | 2500 | Xen |

Table II. Virtual Machine properties

Above Table II include the Virtual resource properties i.e. number number of physical processing elements, all parameter associated with virtual machine, machine identification, and each machine have number of PEs with unique MIPS rating. MIPS rating associated with the virtual machine is the fraction of MIPS associated with each host. Cloudlet or cloud task mapped on VM utilize the processing power, storage capability allocated to the corresponding virtual machine.

|  |  |  |  |
| --- | --- | --- | --- |
| Host MIPS | Host RAM | HOST Storage | Host band width |
| 1000,  2000,  3000 | 10000 | 1000000 | 100000 |

Table III. Data center Host properties

Above Table III include the host properties associated with data center. Three MIPS rating is used across the host which fraction is allocated to number of virtual machine. Host properties at data center include the storage, computing network resources which includes RAM, Bandwidth, and secondary storage space.

# SIMULATION RESULTS

|  |  |  |
| --- | --- | --- |
| Policy name | Cloudlet Length(MIPS) | Energy consumption |
| DVFS | 15 | 0.00 kWh |
| 150 | 0.00 kWh |
| 1500 | 0.00 kWh |
| 15000 | 0.02 kWh |
| 150000 | 0.25 kWh |
| 1500000 | 2.47 kWh |
| Non Power Aware | 15 | 0.00 kWh |
| 150 | 0.00 kWh |
| 1500 | 0.00 kWh |
| 15000 | 0.10 kWh |
| 150000 | .86 kWh |
| 1500000 | 8.53 kWh |
| Threshold | 15 | 0.00 kWh |
| 150 | 0.00 kWh |
| 1500 | 0.00 kWh |
| 15000 | 0.03 kWh |
| 150000 | 0.20 kWh |
| 1500000 | 1.97 kWh |

Table IV. Simulation Result for three different scenario for power consumption across data center

Above Table IV shows the simulation results for three different scenario for power consumption across data center. Simulation results are corresponding to the variable number cloudlet deployed on virtual machines with constant properties for three different policy for power consumption. Host properties are also fixed for 3 scenarios. Simulation results shown in table IV describe that we got the best results for the Threshold condition i.e. smaller than two others. These values are 2.47 kWh, 8.53 kWh, 1.97 kWh respectively. Simulation results shown in table IV gives the clue that while deploying application on cloud we should follow the threshold policy to minimize the power consumption.

# EXPERMENTAL RESULTS FOR VARING PARAMETER ACROSS GRID ENTITY ASSOCIATED

WITH GRID INFRASTRUCTURE

Figure 1. Result for DVFS across datacenter

Figure 1. Describe the variation of power consumption across data center while increasing the number of cloudlet associated with virtual machine with fixed MIPS ratings. Variation is proportional to each other i.e. power versus number of cloudlet with DVFS policy across data center.

Figure 2. Result for Non Power Aware across datacenter

Figure 2. Describe the variation of power consumption across data center while increasing the number of cloudlet associated with virtual machine with fixed MIPS ratings. Variation is proportional to each other i.e. power versus number of cloudlet with Non Power Aware policy across data center.

Figure 3. Result for Threshold across datacenter

Figure 3. Describe the variation of power consumption across data center while increasing the number of cloudlet associated with virtual machine with fixed MIPS ratings. Variation is proportional to each other i.e. power versus number of cloudlet with Threshold policy across data center.

Figure 4. Result for comparison of three power consumption policy

Figure 4. Describe the variation of power consumption across data center while increasing the number of cloudlet associated with virtual machine with fixed MIPS ratings. Variation is proportional to each other i.e. power versus number of cloudlet with Threshold policy across data center, In figure 4 we have compared the three power consumption policy across data center.

# VIII. Conclusion

We discussed simulation based on object-oriented CloudSim toolkit and modeling for cloud resource, scheduling simulation of power consumption across data center using different policy. CloudSim simulates heterogeneous cloud resources with different capabilities, time zones, and conﬁgurations shown in the section V. It supports different power consumption policy across data center in which Threshold, DVFS(dynamic voltage frequency scaling) provide the best simulation result as shown in table V of section V. We have discussed the Cloudsim toolkit based simulation of cloud infrastructure with case study in section IV. Also, we are able to leverage the existing basic discrete-event infrastructure from SimJava while using the Cloudsim toolkit for simulation. This helped us in evaluating performance and scalability of our scheduling policies with different Cloud resource conﬁguration such as varying the number of resources, capability, cost, users, power aware, non power aware policy and processing requirements i.e. we setup MIPS rating for Cloud main resource. The results are promising and demonstrate the suitability of CloudSim for developing simulators for scheduling in parallel and distributed systems. To enable simulation cloud resource management and scheduling with economic models such as tenders and auctions for power consumption. We got the simulation results using scenario 3 different power consumption policies across data center. In section VI,VII simulation results indicates that while increasing the number of cloudlet in the multiple of 10 then Threshold and dynamic voltage frequency scaling (DVFS) provides the best results.

##### References

[1] R. Buyya, C. S. Yeo, and S. Venugopal, "Market-Oriented Cloud Computing: Vision, Hype, and Reality for Delivering IT Services as Computing Utilities", Proceedings of the 10th IEEE International Conference on High Perfonnance Computing and Communications (HPCC 2008, IEEE CS Press, Los Alamitos, CA, USA), Sept. 25-27, 2008, Dalian, China.

[2] Bhathiya Wickremasinghe, Rodrigo N. Calheiros, and Raj kumar Buyya, "A CloudSim-based Visual Modeler for Analyzing Cloud Computin Environments and Applications," Proceedings of the IEEE 24' International Conference on Advanced Networking and Applications, Sept. 2010.

[3] R. Buyya, and M. Murshed, "GridSim: a toolkit for the modeling and simulation of distributed resource management and scheduling for Grid computing," Concurrency and Computation: Practice and Experience, 14(13): 1175-1220, Nov. 2002.

[4] 1.. X. Song H, Jakobsen D, Bhagwan R, Zhang X, Taura K, A Chien, "The MicroGrid: A scientific tool for modeling computational Grids," Proc. of the ACM/IEEE Supercomputing Conference, IEEE Computer Society, Nov. 2001.

[5] A Legrand, 1.. Marchal, and H. Casanova, "Scheduling distributed applications: the SimGrid simulation framework," Proc. of the 3'd IEEE/ACM International Symposium on Cluster Computing and the Grid (CCGrid 07), May 2001, pp. 138-145.

[6] R. Buyya, R. Ranjan, and R. N. Calheiros, "Modeling and Simulation of Scalable Cloud Computing Environments and the CloudSim Toolkit: Challenges and Opportunities," Proc. of the 7thHigh Performance Computing and Simulation Conference (HPCS09), IEEE Computer Society, June 2009.

[7] F. Howell and R. Macnab, "SimJava: a discrete event simulation library for Java," Proc. of the I st International Conference on Web based Modeling and Simulation, SCS, Jan. 2008.

[8] Gustedt, E. Jeannot, and Martin Quinson, "Experimental

Methodologies for large-scale systems: a survey," Parallel Processing Letters, vol. 19, Sep. 2009, pp. 399-418.

[9] "Facebook," http://www.facebook.com.

[10] "Amazon Elastic Compute EC2), ''http://aws.amazon.comlec2/ Cloud

[11]"Google App Engine," <http://code.google.comlappengine/> (Amazon

2012 2nd IEEE International Conference on Parallel, Distributed and Grid Computing

[12] E. Deeiman, G. Singh, M. Livny, B. Berriman, and 1. Good, "The cost of doing science on the Cloud: the Montage example," Proc. of the 2008 ACMl IEEE Conference on Supercomputing, IEEE, Nov. 2008.

[13] M. Assun9ao, A. di Costanzo, and R. Buyya, "Evaluating the Cost Computing to Extend the Capacity of Clusters Benefit of Using Cloud," Proc. of the 18th International Symposium on High Performance Distributed Computing, ACM Press, June 2009.

[14] C. Vecchiola, S. Pandey, and R. Buyya, High-Performance Cloud Computing: A View of Scientific Applications, Proc. Of the 10th International Symposium on Pervasive Systems, Algorithms and Networks (I-SPAN 2009), Kaohsiung, Taiwan, Dec. 2009.

[15] C. Dumitrescu, and 1. Foster. "GangSim: a simulator for grid scheduling studies," Proc. of the 5th International Symposium on Cluster Computing and the Grid (CCGrid 05), IEEE Computer Society, May 2005.

[16] A. Weiss, "Computing in the Clouds," net Worker, vol. 11, Dec.2007, pp. 16-25.