Power Consumption Analysis across Heterogeneous Data Center Using Cloudsim

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Abstract— **Computing 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, to schedule the task on cloud computing environment is difficult in real time mode across the Globe in different organizations with their own power consumption policies. If there is a case of non homogenous and data center without awareness about power consumption, hosts coming under this category consume maximum power which is not in favor of green computing. To deal with these limitations, we will use a discrete-event cloud simulation toolkit to identify that how to save power utilized at infrastructure level. It provides the processing view for creation of application level task, indexing of cloudlets on shared pool of storage, computing and network resources in their power aware and non power aware management process. To demonstrate suitability of the CloudSim toolkit, we have simulated a Cloud environment. We deploy the Cloudlets on shared pool of resources provided by cloud service providers which include infinite computing power and network resources, 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.

I. INTRODUCTION

Cloud computing is the union of Internet technology, shared pool of resources which follow the multi tenant architecture across the globe. Cloud base computing paradigm provides the infinite computational power on demand with service level agreement between end users and cloud service providers. Organizations need not worry about the resource management because cloud service providers take the responsibility for on demand availability of resources. Cloud Computing follow the service oriented architecture which helps in power and energy savings, "To provide IT as a service". Concept of cloud computing is the union of the distributed, grid and parallel base computation. It provides anything as as a service i.e. on the basis of capability cloud computing include three key service model (SaaS, PaaS, IaaS). Cloud computing provides the features to shift from traditional data centres to data centres which follow the virtualization. Simulation tools which are used for cloud computing paradigm for research oriented work are based on object oriented concept. We know that Cloud computing is the union of Internet base technology, grid, distributed computing. So tools follow the stack base structure for all types of computation. For example Cloudsim, CloudAnalyst the main cloud simulation tools are based on Simjava, Grdilet which are used for modelling and simulation purpose. These Tools are helpful for study and analysis of scientific and engineering applications. The layered architecture followed by all these simulation tools provides the open environment to end users of cloud computing to add their own layer over the user code level. For real deployment of applications Tools provides the clue about the data centre configuration and host configuration within the data centres. When we talk about cloud computing i.e Cloud service providers want to provide infrastructure, platform and software as a service to users. Simulation tools improvise that what are parameters which we want to focus while shifting to the cloud. We can identify the best virtualized data centre configuration of our applications like as Social networking applications which required a large pool cloud resources.

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II. RELATED WORK

In present computing era distributed system is far better than traditional centralized system because distributed system has capability of fault tolerance, coordination and cooperation. Shared pool of resources may be provisioned using different static or dynamic load balancing policy as per requirement. For service level agreement data centre broker act as a mediator between cloud service provider and cloud users to assure the quality of services [1]. Resources are provided by cloud provider follow the pay as you go model for resource allocation. For an example Amazon EC2 for computational purpose [10]. IBM Bluemix provides PaaS computing service model to push an Applications using Cloud foundry or plug-in Integration with Eclipse Luna. Consumers can also use another use the PaaS i.e. Google Cloud provides the platform and infrastructure to run the Gmail application [11]. At user level to provide the capability of cloud service model SaaS is used. E.g. office 365 is provided by the Microsoft, it also provides storage as a service i.e. one drive. Simulation performed using cloud base tools in cloud environment are helpful for researcher to push their applications on real cloud platform with minimum cost, power saving and minimum time span. Microsoft outlook.com can be used as SaaS application. Simulation is an alternative to focus on real deployment parameters. Cloudsim which supports to test the distributed applications is stacked over different distributed computation simulation tools. These are helpful for object oriented modelling of storage, computing and network resources, Some of these simulators used to study the grid computing system E.g. first three simulators GridSim [3] MicroGrid [4], GangSim[15] are used for grid environment. Toolkit used for cloud computing environment includes CloudSim [6], CloudAnalyst. CloudAnalyst toolkit is layered over Cloudsim which is helpful for modelling and simulation of cloud computing system and cloud base applications like as social networking applications. We can estimate the cost for following pay as you go model for distributed application running over cloud infrastructures [12] [13], for performance evaluation of distributed environment GridSim Toolkit can be used

GridSim toolkit is a Java-based simulation toolkit that supports modelling and simulation of non homogeneous Grid resources. Users belong from different organizations can utilize the resources across the globe using different scheduling scheme. It provides operations for mapping and management of tasks to the resources [3], Cloudsim Toolkit provides the capability to setup the cloud environment to run cloudlets on virtual machines. Datacentre serve the request to user base located in different continent across the globe. Features of cloud toolkit are presented in the section III.

III. 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 scalable cloud computing environment with single and multiple data Centre [2]. We can model the cloud component using this simulation tool kit. Cloud main resources at data centre level include the storage and computing across the different time zone. Internet base application can be accessed by the end user around the world. This Simulation tool provides flexible environment to setup our own virtual cloud computing environment with different cloud configuration across the data centre and hosts. Using cloudsim toolkit we evaluate the performance of SaaS modeler on the basis of estimated finish time like applications used for social association. We get the simulation results for Cloud tasks using cloud simulation tool Cloudsim at user code level. These results are helpful in quality of service improvement. Finish time of Cloudlets or cloud tasks run act as performance measurement parameter of cloud environment configuration. 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 implementation work is performed at the 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. Indexing is performed between cloudlet and virtual machine with in the data center with number of physical processing element with different number of cores.

IV. CASE STUDY

A. *Simulation Power Aware And Non Powe Aware Data Center*

We are simulating virtual cloud environment with different host configuration that contain one physical processing element. For deployment of application on real cloud infrastructure discrete event simulators are used by the researchers, scientist and industrial experts. Scientific applications are benefitted by cloud computing environments because it provides infinite computing power in real time mode with distributed cloud resource infrastructure. We employed a layered and modular architecture for cloud simulation to leverage existing technologies and manage them as separate components. Users and cloud entities like heterogeneous data centers are connected via network topology, user using Cloudsim tool kit 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 has maximum 3000 MIPS rating. Simulation results for different scenarios provide the clue for real cloud deployment. Cloud resource properties associated with cloud entities are shown in table I, Table II and table III in section V. 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, and 20 respectively.

V. SIMULATION INPUT PARAMETERS

TABLE I. COMMON CLOUD RESOURCE PROPERTIES

a. Number of Cloudlet	b. 20
c. Pes no	d. 1
e. Input file size	f. 300
g. Output file size	h. 300
i. Host Number	j. 10
k. Max Power	l. 250 W
m. Vm Number	n. 20

Above Table I include the Cloud resource properties i.e. cloudlet properties, host and virtual machine properties. Max power at datacenter that can be consumed 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.

TABLE II. VIRTUAL MACHINE PROPERTIES

o. MIPS Rating	p. Pes	q. RAM	r. Bandwidth	s. Image size	t. VMM
u. 250, v. 500, w. 750, x. 1000	y. 1	z. 128	aa. 2500	bb. 2500	cc. Xen

Above Table II include the Virtual resource properties i.e. number of physical processing elements, all parameter associated with virtual machine, machine identification, and each used by cloud user, number of PEs with unique MIPS rating are provided the Cloud service providers. 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.

TABLE III. DATA CENTER HOST PROPERTIES

dd. Host MIPS	ee. Host RAM	ff. HOST Storage	gg. Host band width
hh. 1000, ii. 2000, jj. 3000	kk. 10000	ll. 1000000	mm. 100000

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.

VI. SIMULATION RESULTS

TABLE IV. SIMULATION RESULT FOR THREE DIFFERENT SCENARIO FOR POWER CONSUMPTION ACROSS DATA CENTER

nn. Policy name	oo. Cloudlet Length(MIPS)	pp. Energy consumption
qq. DVFS	rr. 15	ss. 0.00 kWh
	tt. 150	uu. 0.00 kWh
	vv. 1500	ww. 0.00 kWh
	xx. 15000	yy. 0.02 kWh
	zz. 150000	aaa. 0.25 kWh
	bbb. 1500000	ccc. 2.47 kWh
ddd. Non Power Aware	eee. 15	fff. 0.00 kWh
	ggg. 150	hhh. 0.00 kWh
	iii. 1500	jjj. 0.00 kWh
	kkk. 15000	lll. 0.10 kWh
	mmm. 150000	nnn. .86 kWh
	ooo. 1500000	ppp. 8.53 kWh
qqq. Threshold	rrr. 15	sss. 0.00 kWh
	ttt. 150	uuu. 0.00 kWh
	vvv. 1500	www. 0.00 kWh
	xxx. 15000	yyy. 0.03 kWh
	zzz. 150000	aaaa. 0.20 kWh
	bbbb. 1500000	cccc. 1.97 kWh

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 policies 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, and 1.97 kWh respectively. Simulation results shown in table IV gives the clue that for real deployment of applications on real cloud we should follow the threshold policy to minimize the power consumption. We should also keep in mind the application context.

VII. SIMULATION RESULTS FOR VARIABLE PARAMETERS ACROSS CLOUD ENTITY ASSOCIATED WITH CLOUD INFRASTRUCTURE

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 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.

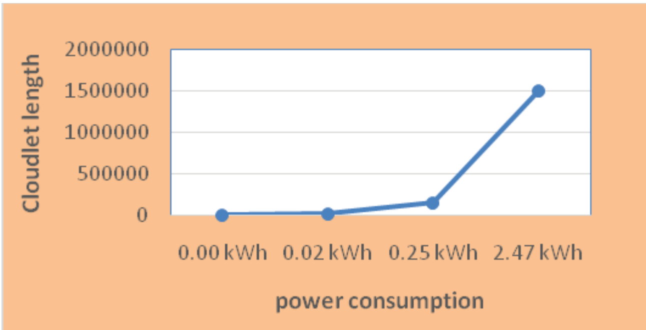

Fig. 1. Result for DVFS across datacenter

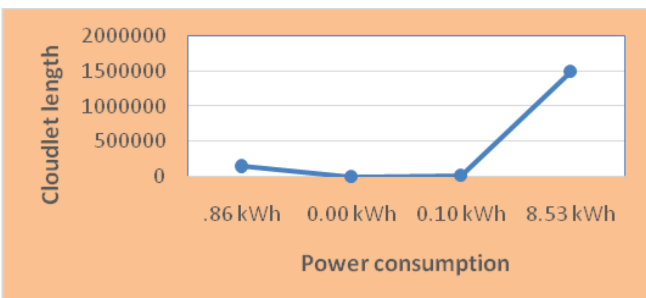

Fig. 2. Result for Non Power Aware across datacenter

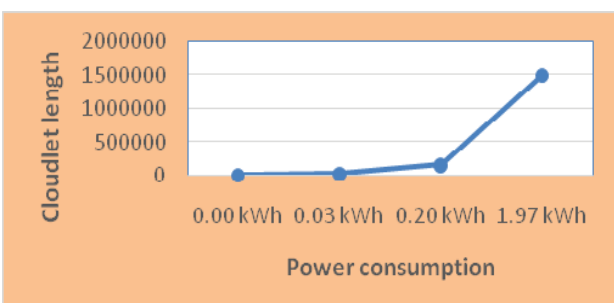

Fig. 3. Result for Threshold across datacenter

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 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.

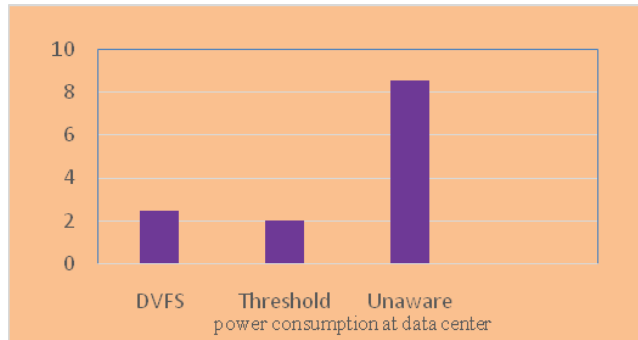

Fig. 4. Result for comparison of three power consumption policy

VIII. CONCLUSION

Simulation is based on object-oriented CloudSim toolkit and modeling for cloud resources, scheduling tasks on virtual machines with minimum power consumption across data center using different provisioning policy. CloudSim simulates heterogeneous cloud resources with different capabilities, time zones, and configuration 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 for power awareness with case study in section IV. Cloudsim toolkit for simulation help us for evaluating performance and scalability of our task scheduling algorithms with different Cloud resource configuration such as varying the number of resources, capabilities, costs for tenant, users, power aware, non power aware policy and processing requirements. Setting up MIPS rating for Cloud main resource i.e. data center. The results are promising and demonstrate that CloudSim is suitable for developing simulation for scheduling in distributed, parallel and shared pool of resources in a systems. It enables simulation of cloud resource management and scheduling with economic models such as tenders and auctions for power consumption. We got the simulation results using three scenarios for 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.

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