Study of Comparison of Various Cloud Computing Simulators

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Abstract — Green Cloud computing is one of the "Best Affordable Innovation" that is it is one of such technologies that completely fits into the pulse of business market and science and technology fields. The main objective of Green Cloud Computing is to fulfill and transform the base and framework of clouds that incorporates extensibility, excellence in quality of performance, and also reduces energy utilization. To achieve the objectives of Green Cloud Technology it has to be simulated using various simulation tools. Simulation Tools are one of the important mechanism through which the system is fabricated that is represented by any given model and they are becoming more and more important in estimation of the Green Cloud model.

The paper presents a study of various simulation tools and comparison of various tools on basis of their performance and future scope of various tools.

Index Terms — Green Cloud, Simulation tools, Cloud Simulator, Green Data Center Simulator, Green Cloud Simulator, DVFS.

INTRODUCTION

In Recent Times, Cloud computing paradigm [1] has rapidly gained the attention of various communities including researchers, businesses, consumers, and government organizations. The main question of Green Cloud Computing is that it has to diminish the resource usage with satisfying both the quality of service of requirements and strength. Various simulation tools are used to evaluate the performance of Green Clouds and optimize the performance of Cloud primary element. For good performance of Green Clouds proper Simulation algorithms are to be used including various parameters and factors like Dynamic Voltage Frequency Scaling Technique along with various workload techniques like Heterogeneous and Homogeneous Consolidation Technique. Major Simulators designed specifically for Cloud computing environment and those currently available for Cloud Specific Simulation Solutions are CloudSim [2] and GreenCloud [3] and MDCSim [4] all of which view datacenter resources as a collection of Virtual Machine (VM). All these simulators synthesize either a very over simplified utilization models without any connecting assignments or confined network standards within the data center. All these three simulators equips customers operation illustrations as the easiest matter representing calculative essentials for the various values. Various scheduling algorithms such as the round-robin, backing filling, and gang scheduling algorithms [5] can be implemented in the virtual machine deployment process. An experimental evaluation of various simulation tools are presented required for various simulation procedures.

Characteristics of Various Simulators on Basis of Previous Work Done

Simulation tools are characterized on the basis of parameters like Virtual Machine Technology, High Performance Computations, Dynamic Voltage Frequency Scaling and Simulation Time:

Network CloudSim

Network Cloud Sim Simulator structure supports designing of the real Cloud data centers and mapping different strategies such as HPC, e-commerce and workflows. It is assembled with major rational operative methods than any other available Cloud simulators. The main constituents of simulation framework are achieved as part of an extensively used Cloud simulator, and to support applications with communicating elements or tasks such as MPI, and workflows. To enable fast simulations the parameters are made configurable which allows the experimenters to simulate diversified range of network topologies.

Green Cloud Simulator

Green Cloud Simulator is an extension of NS2 simulator. One of the important characteristic of GreenCloud simulator is the accurate designing of communication aspects of the data center network. Being constructively par amounted of NS2, it implements a full TCP/IP protocol reference model which allows integration of different communication protocols such as IP, TCP and UDP with the simulation. The only drawback of Green Cloud Simulator is that it confines its scalability to only small data centers due to very large simulation time and high memory requirements.

MDC Sim

MDCSim[4] is a commercial discrete event simulator developed at the Pennsylvania State University. It helps the analyzer to model unique hardware characteristics of different components of a data center such as servers, communication links and switches which are collected

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from different dealers.

Among all the three simulator tools CloudSim is the most prominent tool to be used as it has low simulation overhead and moreover its network package maintains a data center topology in the form of directed graph.

GENERAL COMPARISON OF CLOUD COMPUTING SIMULATORS

Following is the comparison of various Clouds computing simulator on basis of their characteristics. Table1 shows the various parameter and on basis of those parameters result of various simulators [3]

Parameters	MDCSim	CloudSim	GreenCloud
Communication Network	Limited	Limited	Full
Graphical Support	None	Limited(Cloud Analyst)	Limited(NetworkAnimator)
Availability	Commercial	OpenSource	OpenSource
Platform	CSIM	SimJava	NS2
Application Models	Computation	Computation and Data Transfer	Computation DataTransfer and Exec.deadline
Simulation Time	Seconds	Seconds	Tensof Minutes
Language/ Script	C++/Java	Java	C++oTcl
Physical Models	None	None	Available using plug in
Energy Models	Rough	None	Precise(servers + networks)
Support Of TCP/IP	None	None	Full
Power Saving Modes	None	None	DVFS, DNS And both

1. **Communication Network –** Cloudsim and MDCSim executes limited communication model generally calculating on basis of transmission delay and bandwidth. The communication network supported by Green Cloud Simulator is full as it allows conquering the dynamics of widely used network communication protocol like TCP,UDP, IP etc.

2. **Graphical Support –** MDC Simulator does not support GUI. The GreenCloud may be enabled to produce a trace files recognized by the network animation tool Nam [7] which visualizes a simulated topology and a packet flow after the simulation is completed. CloudSim simulator uses an external tool CloudAnalyst [8] is developed.

3. **Availability –** MDCSim simulator is currently not available for public while both CloudSim and Green Cloud simulators are released under open source GPL License.

4. **Platform –** MDCSim and CloudSim simulators are the event based simulators which actually shuns the building and processing of small simulation objects individually. The Green Cloud simulator is actually developed as an extension to NS2 simulator which is coded in C++ with layer of OTcl libraries implemented on top of it.

5. **Application Models –** All three simulators mainly implements user application models as the computational requirements. The Green Cloud simulator implements along with computational requirement, data transfer and deadlines

6. **Simulation Time –** The time required for simulation generally depends on both hardware and software as well. MDCSim and CloudSim are event based simulators so simulation time is in seconds. The Green Cloud Simulator achieves reasonable simulation time.

7. **Language/Script –** The language/ script of the simulators means the platform in which the simulators perform the implementation.

8. **Physical Models –** There is no direct support for simulating physical processes in case of both CloudSim and MDCSim. For Green Cloud Simulators the physical models uses available plug in.

9. **Energy Models –** The MDCSim performs the rough estimation of all the energy models and the CloudSim simulator does not account the energy spent in the models. The GreenCloud Simulator gives precise estimation using both servers and networks.

10. **Support Of TCP/IP –** The MDCSim and the CloudSim simulator doesnot support TCP/IP while the Green Cloud Simulator supports full support of TCP/IP.

11. **Power Saving Modes –** Both the simulator MDCSim and CloudSim does not support any type of power saving modes while the Green Cloud Simulator supports three power saving modes i.e. DVFS, DNS and even both.

Architecture of Various Simulator Tools

For the simulations to be performed using various simulator tools its architecture have to be designed. By architecture of

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simulation tools it is also meant that various planning strategies required for doing the simulation. Following are the architectures of different simulator tools:

i. **CloudSim** - The Cloud Sim Simulator is presently the most high-tech distinct happening simulator for clouds. It has many characteristics due to which all the researchers use this simulator for doing the simulations. Fig 1 shows the basic modules of the Cloud Sim Architecture with the main features of NetworkCloudSim (shown by dark boxes) [6].

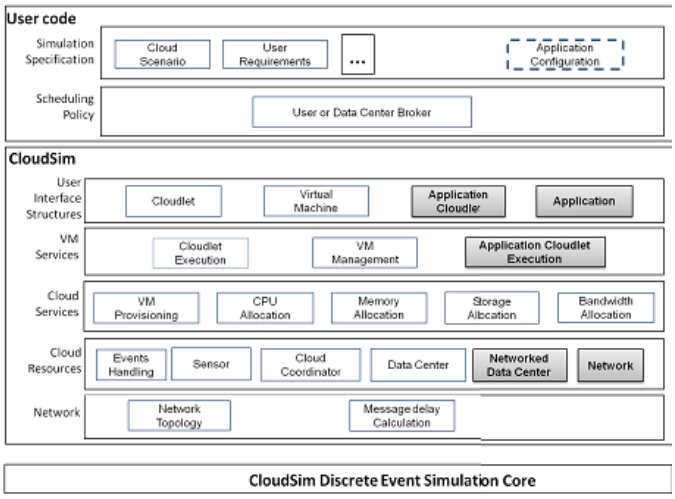

Figure 1: The CloudSim Architecture with NetworkCloudSim elements

The lowermost layer of the CloudSim architecture handles the communication between CloudSim entities and components. All components in CloudSim communicate through message passing operations. The second layer consists of several sub-layers that copies the core elements of Cloud computing. The bottommost sublayers copies datacenter, Cloud coordinator and network topology between different datacenters. These components help in designing IaaS infrastructure. The VM and Cloud Services provide the functionality to design resource (Virtual Machine (VM)) management and application scheduling algorithms. Cloud Sim simulator is an event based simulator wherein different system model entities are communicated. In Network CloudSim users can easily add their own complex metrics for sharing bandwidth between multiple active flows.

ii. **GDCSIM** – GDCSim is a Green Data Center Simulator that is a simulation tool which combines the simulation of management technique with a simulation of physical behavior of data center. GDCSim simulator conceptualizes both modular and extensible entities. Modularization assures that the different components of GDCSim can be used independently and Extensibility assures that new models and assumptions can be easily plugged into the simulator. Fig2 shows the basic module of GDC Sim architecture[9]

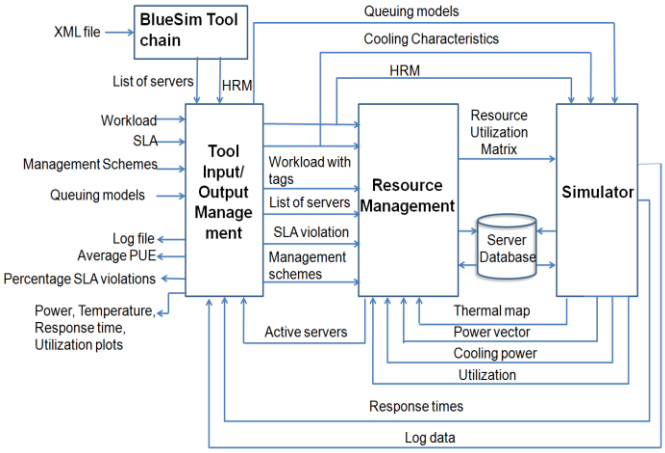

Figure 2: GDCSim Tool Architecture.

GDCSim tool consists of four chief modules:

1. BlueSim Tool- It is a simulation package that basically combines various software for simulations. Its main objective is to generate an array of different configuration of data centres. Three main sub modules of BlueSim Tool are Preprocessing Module, Processing and Post Processing.
2. Input/Output Management Tool- I/O Management Tool module have two main functions. Firstly it serves as a user interface for the complete procedure. Second is to store an array of a data center for different active server sets. As per the user inputs the required output is generated which becomes the feedback for Resource Management and Simulator as well.
3. Resource Management- Resource Management sub module consists of various algorithms for workload management, power management, cooling management and coordinated workload, power and cooling management. The use of these algorithms is generally caused by the action of two main events. The output from this module includes active server set, workload schedules, power modes and cooling schedules. These outputs are compiled together to form a Resource Utilization Matrix which is so sent to simulator.
4. Simulator- The Simulator consists of four sub modules. Queuing Module, Power Module, Thermodynamic Module and Cooling Module. The output of simulator

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module is the compilation of all the four sub modules and combining the execution of the parameters in a log file and providing those outputs as a feedback.

iii **Green Cloud Simulator –** Green Cloud Simulator is actually an augmentation to NS2 simulator which is completely developed for the study of cloud computing. Figure 3 presents the architecture of Green Cloud Simulator[3]. The structure of Green Cloud Simulator is outlined onto three tier data center architecture. Servers are the most essential of a data center that are responsible for task execution. In Green Cloud the server components implements single core nodes that have a preset on processing power limit in MIPS or FLOPS. Various Sub modules of the simulator are Core network, Aggregation Network and Access Network which includes switches and links that forms the interconnection material which delivers workloads to any of the computing servers in time for the execution. The Green Cloud Simulator implements energy model of switches and links aiming at apprehending the effects of both DVFS and DPM techniques [10].

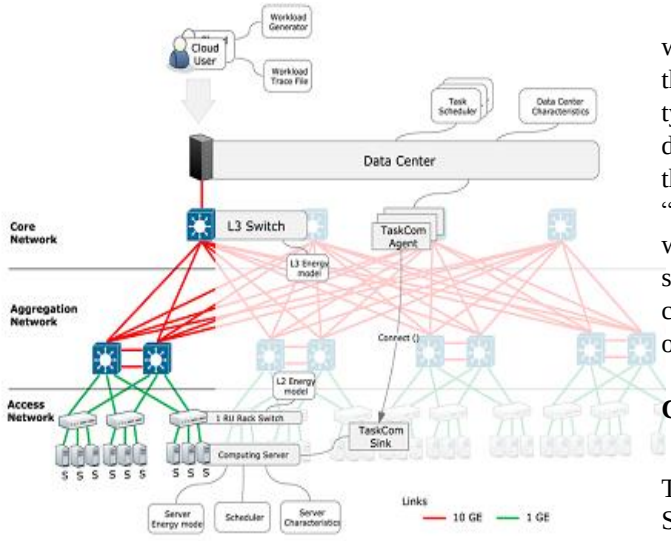

Figure 3: Green Cloud Simulator Tool Architecture.

Performance Evaluation of Simulators

Performance evaluation of simulator means process of examination that result in measurement. CloudSim allows implementation of the complex scheduling and task execution schemes involving resource virtualization techniques. NetworkCloudSim provides a facility to users to design their own routing algorithms, and configure network and switching latencies. Green Cloud offers an improvement in the simulation precision keeping the simulation time at the reasonable level. For comparison reasons, the number of computing nodes is fixed to 1536 for all three topologies, while the number and interconnection of network switches varied.

Table2 summarizes the main simulation setup parameters.

	Parameter	Data center architectures		
		Two-tier	Three-Tier	Three-tier high-speed
Topologies	Core nodes (C_1)	16	8	2
	Aggregation nodes (C_2)	–	16	4
	Access switches (C_3)	512	512	512
	Servers (S)	1536	1536	1536
	Link (C_1–C_2)	10 GE	10 GE	100 GE
	Link (C_2–C_3)	1 GE	1 GE	10 GE
	Link (C_3–S)	1 GE	1 GE	1 GE
	Link propagation delay	10 ns		
Data Center	Data center average load	30%		
	Task generation time	Exponentially distributed		
	Task size	Exponentially distributed		
	Simulation time	60 minutes		

Table2 Simulation Set Up Parameters

The workload generation events and the size of the workloads are exponentially distributed. The average size of the workload and its computing requirement depends on the type of task. Balanced workloads load computing servers and data center network proportionally. The workloads arrived to the data center are scheduled for execution using energy-aware "green" scheduler. This "green" scheduler tends to group the workloads on a minimum possible amount of computing servers. CloudSim implementation leads to higher communication delays and thus, high response time. Modelling of network is an essential part of Cloud Simulations.

CONCLUSION AND FUTURE DIRECTIONS

This paper is a normal case study of various Cloud Computing Simulators. In this paper normal study is done on the basis of previous work done. Various types of simulators are discussed along with their architectures and characteristics. Simulators are designed to implement various migration policies and resource allocation policies of virtual machines.

As future work we intend to simulate various other strategies and use these simulators for implementation of various experiments thus obtaining satisfactory results. The strategy is made to examine and clarify results and constitutes new approaches and proposals for implementing green cloud computing.

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BIOGRAPHY

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