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A Survey of Various Cloud Simulators

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***Abstract*—** Cloud computing is a model for enabling convenient and on-demand network access to a shared pool of configurable computing resources like networks, servers, storage, application and services that can be rapidly provisioned and released with minimal management effort or service provider interaction. These resources are pooled for the usage of customers to cater the elastic need of resources of customers due to varying workload. Clients need to pay only for the amount of resources they use. The need of the hour is to reduce the cost of cloud and increase its efficiency. As the cost of cloud resources is very high, so the solution is to use Simulation tools for designing a cloud service and form experiments with the same. This paper compares various simulating tools namely CloudSim, Green Cloud, MDCSim and Cloud Analyst based on their features, advantages and disadvantages.

***Keywords*—**Cloud; Simulation; CloudSim; Green Cloud; MDCSim; CloudAnalyst

I. INTRODUCTION

Cloud Computing refers to the software services delivered to end users over the internet as well as the backend and system software supporting them[1]. There are three cloud delivery models, Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) deployed as public, private, community, and hybrid clouds.[2] All these services are provided over internet. There are four deployment models available in cloud computing namely public cloud, private cloud, community cloud and hybrid cloud. The reason behind vast spread of cloud technology is cost efficiency, easy scalability, good reliability, easy maintenance and mobile access. There are also some limitations such as availability of service, data confidentiality and auditability, data transfer bottlenecks, performance unpredictability, scalable storage and bugs in large distributed systems. Simulation tools are available to design and develop customized cloud computing models. These tools are mostly used by developers, students and researchers. There are large number of simulation tools available in market such as CloudSim, Cloud Analyst, Green Cloud Simulator, MDCSim XEN, OpenNebula etc. Some of these tools are studied and the compared as below.

II. NEED OF SIMULATOR

In cloud computing, simulation tools offers significant benefits to customers as well as providers. These tools allow customers to test their services in controllable environment with free of cost and to check the performance before publishing to the real clouds. For providers, these tools allow the check of various leasing as per different price and load which will help in resource optimization.[3] In the absence of these tools, the customers and providers must rely on imprecise evaluation or hit and try approaches. Other benefits of using Simulation tools are as follow:

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A. *Practical Feedback*

Designers can design a cloud system using simulation tools to check correctness and efficiency of the design before they actually construct the system. Thus the pros and cons of system design can be studied before a system is built anfd thus it allows for designing of alternative designs and modification at an early stage. The changes made in the system's design are reflected instantly thus make it useful tool for designing and testing a cloud service.

B. *Problem consideration at different level of abstractions*

Simulation tools allow designer to adopt both top to bottom approach as well as bottom up approach thus problem can be considered at different level of abstractions. This helps in reducing complexity of the system. As the designer better understands the operation of the higher level components through the use of the simulator, the lower level components may then be designed and subsequently simulated for verification and performance evaluation.

C. *Effective means for teaching or demonstrating concepts to students*

Some of the simulators provide Graphical User Interface (GUI) to its users which make it very easy to understand the relationship between various components under considerations through graphics and animations. It becomes very easy for students and beginners to understand the simulated elements using such tools.

D. *Problem Different experiment possible and Reduced Restrictions*

As the hardware cost of cloud is very high which is endured by service provider, it is very difficult to set up hardware for the purpose of study or design testing. Also the curremt level of technology is not able to test certain conditions due to

environmental or technical limitations. A simulation can give you results that are not experimentally measurable with our current level of technology. A simulator tool can be used to test a design several times with different or same parameters with only restrictions of imagination, programming skills and CPU efficiency.

E. Reduced Cost as no Capital cost is involved

As some of cloud simulation tools are available as open source, thus no capital cost is involved in setting us a cloud on it.

F. Evaluation of risk at an early stage

In the case of Cloud computing, where access to the infrastructure incurs payments in real currency, simulation-based approaches offer significant benefits, as it allows Cloud customers to test their services in repeatable and controllable environment free of cost, and to tune the performance bottlenecks before deploying on real Clouds. At the provider side, simulation environments allow evaluation of different kinds of resource leasing scenarios under varying load and pricing distributions. Such studies could aid the providers in optimizing the resource access cost with focus on improving profits. In the absence of such simulation platforms, Cloud customers and providers have to rely either on theoretical and imprecise evaluations, or on try-and-error approaches that lead to inefficient service performance and revenue generation.[4]

III. CLOUD SIMULATORS

Simulation software is based on the process of modeling a real phenomenon with a set of mathematical formulas. It is, essentially, a program that allows the user to observe an operation through simulation without actually performing that operation. Simulation software is used widely to design equipment so that the final product will be as close to design specs as possible without expensive in process modification.[5]
There are various simulator tools for cloud. Some of them are as follows:

A. CloudSim

CloudSim can be used by researchers and industry based developers to test the performance and effectiveness of cloud applications in a controlled and easy to set up environment. It provides a generalized and extensible simulation framework that enables modeling, simulation and experimentation of emerging cloud computing infrastructure and application services. It is developed in CLOUDS laboratory at Computer Science Engineering department, University of Melbourne.

Features of CloudSim:

- support for modeling and simulation of large scale Cloud computing data centers
- support for modeling and simulation of virtualized server hosts, with customizable policies for provisioning host resources to virtual machines
- support for modeling and simulation of energy-aware computational resources
- support for modeling and simulation of data center network topologies and message-passing applications
- support for modeling and simulation of federated clouds
- support for dynamic insertion of simulation elements, stop and resume of simulation
- support for user-defined policies for allocation of hosts to virtual machines and policies for allocation of host resources to virtual machines[6]

Architecture:

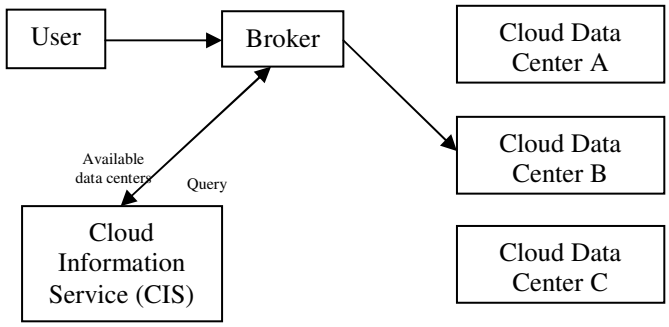

Figure 1. CloudSim Architecture

Advantages:

- Time effectiveness: CloudSim can be used with Netbeans using Java it requires very less effort and time to implement cloud based application provisioning test environment.
- Flexibility and applicability: Developers can model and test the performance of their application services in heterogeneous cloud environments(Amazon EC2, Microsoft Azure) with little programming and deployment effort.[3]
- Very few pre-requisites: To use CloudSim, User only needs basic understanding of Java and OOP concept.

Many leading organizations and universities around the world are using CloudSim for [i] Cloud Resource Provisioning, [ii] Energy efficient management of data center, [iii] Optimization of cloud computing, and [iv] Research activity.

Limitations: No Graphical User Interface

B. MDCSim

MDCSim is based on CSIM Platform. MacSim is a heterogeneous architecture timing model simulator that is developed from Georgia Institute of Technology. It simulates x86 and NVIDIA PTX instructions and it is a trace driven cycle level simulator. It models detailed micro-architectural behaviors, including pipeline stages, multi-threading, and memory systems. [7] It can simulate homogeneous ISA multi-core simulations as well as heterogeneous ISA multi-core simulations. It also supports, asymmetric multi-core

configurations (small-cores + medium-cores + big-cores) and SMT or MT architectures as well. It is Java/C++ based.

Advantages:

- It is fast simulation tool.
- Can be used to simulate heterogeneous as well as homogeneous environments.
- Multicore simulation also available

Limitations:

- No Graphical User interface
- Commercial, not open source.
- No support for energy efficient simulation

C. CloudAnalyst

In CloudSim, no GUI was available which leads to absence of visualization of results. To solve this problem, users can use CloudAnalyst as it is very easy to use and has the ability to produce the output in graphical form.[8]

User can easily repeat experiments with same and different parameters and can view graphical results. The underlying architecture of CloudAnalyst is same as cloudSim with an addition of graphical representation.

D. GreenCloud

GreenCloud is a sophisticated packet-level simulator for energy-aware cloud computing data centers with a focus on cloud communications. It offers a detailed fine-grained modeling of the energy consumed by the data center IT equipment, such as computing servers, network switches, and communication links.

GreenCloud can be used to develop novel solutions in monitoring, resource allocation, workload scheduling as well as optimization of communication protocols and network infrastructures. It is released under the General Public License Agreement and is an extension of the well-known NS2 network simulator.[9] The main motivation behind development of GreenCloud is lack of detailed simulators in the market. It allows simulating environment for energy aware cloud computing data centers. It focuses on communication within a cloud that is all communication processes are simulated on packet level.

Features of GreenCloud

- Focus on cloud networking and energy awareness
- Simulation of CPU, memory, storage and networking resources
- Independent energy models for each type of resource
- Support of virtualization and VM migration
- Network-aware resource allocation
- Complete TCP/IP implementation
- User friendly GUI
- Open Source[8]
- The script used is C++/OTcl.

Advantages:

- Open Source
- Allow energy efficient simulation
- Full support of TCP/IP
- Prerequisites are basic C++ and Terminal Command Language(TCL)
- Easy to install using Virtual Machine.

Limitations:

- High Simulation time, generally Tens of minutes
- Limited graphical support

IV. CONCLUSION

After the study of different simulator tools, it can be said that each tool is efficient and useful in specific circumstances. CloudSim can be used for almost all type of configuration but it doesnot provide GUI. GreenCloud is used for energy aware simulation of cloud computing. CloudAnalyst is an extension to CloudSim but it provides a good Graphical User Interface. MDCSim is used for an environment which contain heterogeneous infrastructure.

Parameter	**Simulator tool**			
	CloudSim	***CloudAnalyst***	***Green Cloud Simulator***	***MDCSim***
Platform	SimJava	SimJava	NS2	CSIM
Language/Script	Java	Java	C++/OTcl	C++/Java
Availability	Open Source	Open Source	Open Source	Commercial
Simulation time	Seconds	Seconds	Tens of minutes	Seconds
Graphical Support	Limited	Full	Limited	None
Support of TCP/IP	None	None	Full	None
Power Saving modes	None	None	DVFS, DNS or both	None
Support for heterogenity and multi-core	None	None	None	Full
Pre-requiste	Java, OOPs	Java, OOPs	C++, TCL	Java, OOPs

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