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Simulators for Cloud Computing - A Survey

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ABSTRACT

Cloud Computing is a new paradigm which allows individuals and organizations to purchase resources like compute, storage, networking etc. as a utility with minimum human intervention. According to recent surveys more than half of the large to medium size organizations have already migrated to the cloud. This paper presents various cloud simulators which were developed over the years that are an energy effective way of conducting cloud research tasks. This paper almost ten cloud analyses simulators based on energy efficient criteria and the report is presented.

I. INTRODUCTION

Cloud computing is collection of distributed servers which provides services on demand [4]. The services may be software or hardware resources as client need. Basically cloud computing have three major components [5]. First is client, the end user interacts with client to avail the services of cloud. The client may be mobile devices, thin clients or thick clients. Second component is data center; this is collection of servers hosting different applications. This may exist at a large distance from the clients. Now a days concept called virtualization [2] [3] is used to install software that allows multiple instances of virtual server applications. The third component of cloud is distributed servers; these are the parts of a cloud which are present throughout the Internet hosting different applications. But while using the application from the cloud, the users will feel they are using this application from in their own machine. Cloud computing provides three types [1] of services as Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS). SaaS provides software to client which need not to install on clients machine. PaaS provides platform to build an applications like database. IaaS provides computational power to user to execute task from another node.

II. CLOUD SIMULATORS

Current research trend in cloud computing is concerned with energy aware computing i.e., reducing the power consumption and reducing the heat produced in the data centers. A cloud simulator helps to model various kinds of cloud applications by creating data centers, virtual machines and other utilities that can be configured appropriately, thus making it easier to analyze. Today many cloud simulators had been developed and are being actively used to conduct cloud research. Various cloud simulators are available. This paper discuss the tools such as CloudSim, CloudAnalyst, GreenCloud, NetworkCloudSim,EMUSIM,MR_CloudSim,SmartSim, DynamicCloudSim,CloudSimSDN and CEPSim.

2.1 CloudSim

CloudSim [7][9] is the most popular simulation tool available for cloud computing environment. It is an event driven simulator built up on the core of grid simulator GridSim [8]. Base programming language

for CloudSim is Java which is one of the famous object oriented programming languages. CloudSim modules are easy to extend as it is based on Java. CloudSim is open source and is free to extend. One unique feature of CloudSim is the federated policy, which is rarely available in any other simulators. CloudSim contains the following features:

- ✓ Support modeling and simulation of large scale computing environment.
- ✓ A self-contained platform for modeling clouds, service brokers, provisioning and allocation policies.
- ✓ Support for simulation of network connections among the simulated system elements.
- ✓ Facility for simulation of federated cloud environment that contains inter-network resources from both private and public domains.
- ✓ Availability of a virtualization engine that aids in the creation and management of multiple independent and co-hosted virtual services on a data center node.
- ✓ Flexibility to switch between spaces shared and time shared allocation of processing cores to virtualized services.

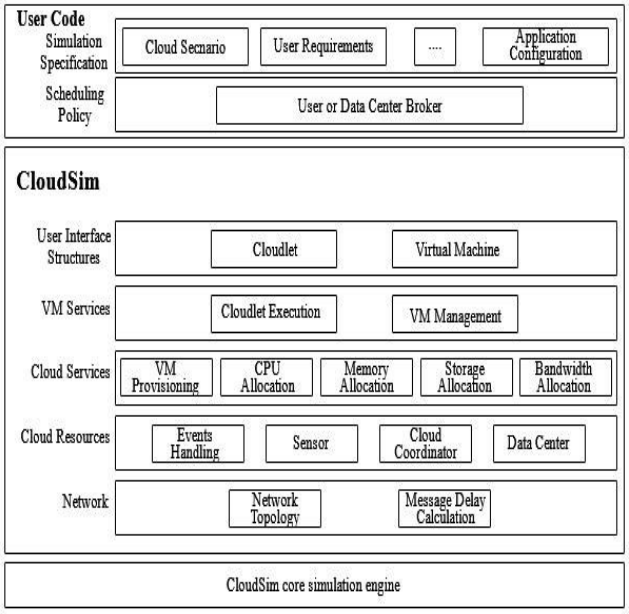

Figure 1. Architecture of CloudSim

Despite many features of CloudSim, one major drawback is the lack of Graphical User Interface (GUI). According to R. Kanniga Devi et al. [6] CloudSim is the frequently used (nearly 23 experiments and may be more) simulation tool for cloud research.

2.2 Cloud Analyst

Wickremasinghe et al. [7][11] developed a new simulator called Cloud Analyst which is based on CloudSim. Cloud Analyst was basically developed for evaluating the performance of large-scale distributed cloud applications having high user workload that are geographically distributed over several data centers.

Features of CloudAnalyst are the following:

- Easy to use Graphical User Interface (GUI).
- Ability to define a simulation with a high degree of configurability and flexibility.
- Being able to repeat the experiments with slight modifications.
- Generate graphical output in the form of charts and tables.
- Use of consolidated technology and ease of extension.

Architecture of CloudAnalyst[11] is as shown in following Figure 2.

CloudAnalyst provides an easy to use GUI to configure any geographically distributed system [10], such as description of application workloads, including information of geographic location of users generating traffic and location of data centers, number of users per data center and number of resources in each data center. CloudAnalyst can generate output in the form of chart or table that summarizes the huge amount of users and system statistics during the simulation time.

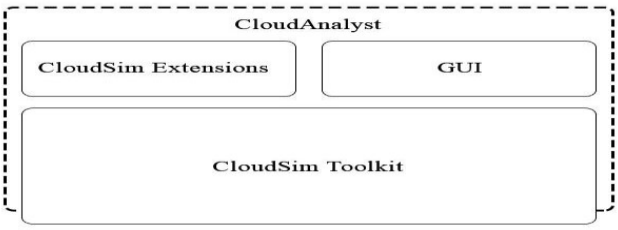

Figure 2. Architecture of Cloud Analyst

By using Cloud Analyst cloud application developers will be able to determine the best strategy for allocation of resources among data centers and selecting the optimal data center to serve specific requests and minimize costs associated with such requests.

2.3 GreenCloud

GreenCloud is a packet level simulator [12][14] developed by extending network simulator NS2 [13], and is specially made for energy-aware environment. GreenCloud is designed so that it can calculate energy consumption at any particular data center components such as link, switch, gateway etc. as well as communication between the packet levels. Further, it offers to know the workload distribution in the system.

Key features of GreenCloud are:

- Focus on cloud networking and energy awareness
- Simulation of CPU, memory, storage and networking resources
- Independent energy models for each type of resource
- Suport of virtualization and VM migration
- Network-aware resource allocation
- Complete TCP/IP implementation
- User friendly GUI
- Open Source

Architecture of GreenCloud [14] is as shown in following Figure 3. One of the drawbacks of GreenCloud is that it takes minutes of time for simulating a model and also consumes huge memory. As it takes more time for simulation, its scalability is restricted to small data center. Another possible drawback is the researcher should learn both C++ language and OTcl libraries to work with GreenCloud. This simulator is only suitable for work related to calculating energy consumption in data centers (cloud).

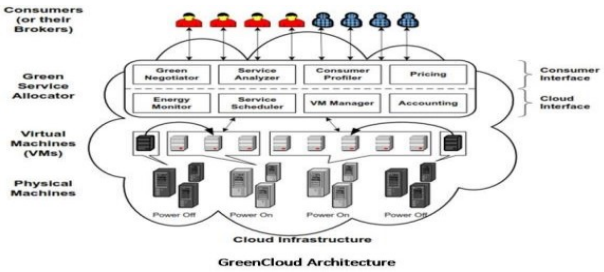

Figure 3. Architecture of GreenCloud

2.4 NetworkCloudSim

NetworkCloudSim [15] was proposed by Saurabh Kumar et al. [16] which is an extension of CloudSim. CloudSim and GreenCloud are basically built for single server architecture and becomes insufficient for real cloud model which involves deploying different types of applications from different customers. NetworkCloudSim supports communication between application elements and various network elements. Architecture of NetworkCloudSim [16] is as shown in following Figure 4:

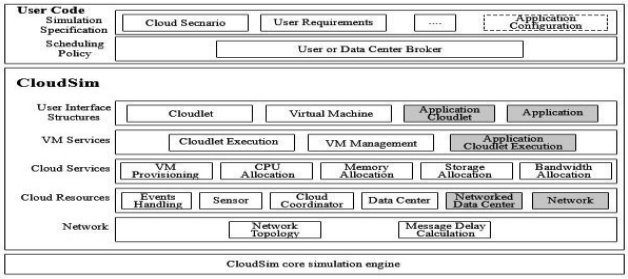

Figure 4. Architecture of NetworkCloudSim

NetworkCloudSim simulator supports more realistic and complex applications with communicating tasks such as parallel & data-driven applications and workflows.

2.5 EMUSIM

EMUSIM [17][18] is not only a simulator; it provides both the capabilities of an emulator as well as simulator of a cloud environment. It is developed for CPU intensive SaaS applications which are very costly for actual deployment. For these types of applications customer has to analyze the behavior of the application before subscribing for a cloud plan. EMUSIM is built up on CloudSim and Automated

Emulation Framework (AEF). Architecture of EMUSIM[18] is as shown in following Figure 5.

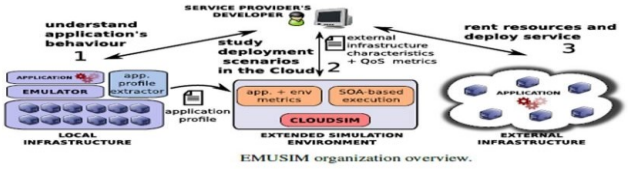

Figure 5. Overview of EMUSIM

EMUSIM, automatically extracts information from application behavior via emulation and then uses this information to generate the corresponding simulation model.

2.6 MR-CloudSim

MR-CloudSim [19] was developed based on CloudSim simulator. The unique feature of MR-CloudSim is its support for simulating MapReduce tasks and there by supporting BigData processing. CloudSim simulator does not support file processing, cost and time associated with it. In MR-CloudSim, authors changed some of the core classes in CloudSim to support MapReduce programming model.

2.7 SmartSim

SmartSim [20] is uniquely built for simulating applications for mobile cloud computing. SmartSim is the first ever simulator built that supports mobile cloud applications. Its main feature is to model mobile cloud application running in mobile devices. SmartSim supports both the system and behavior modeling of Smart Mobile Device (SMD) components such as application processor, memory, resources provision, computing resources utilization evaluation, dynamic processing management policies and computational intensive mobile application modeling for SMD. Architecture of SmartSim [20] is as shown in following Figure 6.

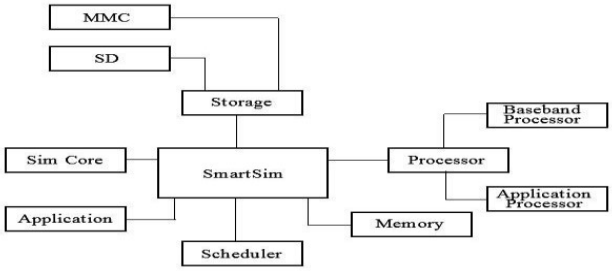

Figure 6. Architecture of SmartSim

2.8 DynamicCloudSim

DynamicCloudSim [21][22] is an extension of CloudSim which is able to simulate instability caused due to heterogeneous nature of cloud computing, dynamic changes due to several factors at runtime and failures during task execution. Drawbacks of DynamicCloudSim are it considers only one task at a time and data locality issues have not been addressed. Also failure model is limited in this simulator.

2.9 CloudSimSDN

CloudSimSDN [23][24] based on CloudSim is a lightweight and scalable simulation environment to analyse the network allocation capacity policies like measuring the network performance and host capacity allocation approaches simultaneously within a data center. Architecture of CloudSimSDN [24] is as shown in following Figure 7.

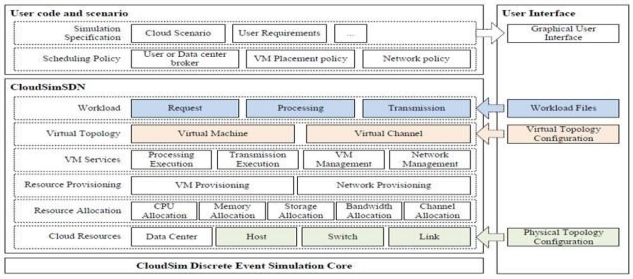

Figure 7. Architecture of SmartSim

2.10 CEPSim

CEPSim [25] (Complex Event Processing Simulator) is an extension of CloudSim that allows researchers to work with cloud applications that are modeled based on directed acyclic graphs used to represent continuous CEP queries. A key feature of CEPSim is it allows researchers to simulate queries in

heterogeneous cloud environments under different load conditions. One drawback of this simulator is dynamic query analysis is not supported.

III. ANALYSIS OF CLOUD SIMULATORS

The following ten cloud simulators have been compared based on 3 evaluation criteria namely: Base platform, Applicability, Drawback. The result and explanation of the comparative analysis of cloud simulators have been presented. As a general purpose simulator CloudSim is recommended based on its features and popularity in the research community.

Table 1. Analysis of Cloud Simulators

SIMULATION	BASE PLATFORM	APPLICABILITY	DRAWBACK
Cloud sim	simJava	Developres can model and test the heterogeneous cloud enivronments (Amazon EC2, Microsoft Azure)	lack of GUI (Graphical user Interface)
Cloud analyst	Cloud sim	Developres can model and test the heterogeneous cloud enivronments (Amazon EC2, Microsoft Azure)	Previous and proposed service broker policies.
Green Cloud	NS2	Developres can model and test the heterogeneous cloud enivronments (Amazon EC2, Microsoft Azure)	consumes huge memory
Network Cloud sim	Cloud sim	Built for single server architecture	Communication between application elements and various network elements.
EMUSIM	Cloud sim,AEF	Provides both the capabilities of an emulator as well as simulator	Automatically extracts information from application
MR_ Cloud sim	Cloud sim	Support for simulating Mapreduce tasks	Authors changed some of the core classes
Smart Sim	Cloud sim	Built for simulating applications for mobile cloud computing.	Supports both the system and behavior modeling of Smart Mobile Device (SMD)
Dynamic Cloud sim	Cloud sim	Large_ scale dynamic cloud computing environment	data locality issues have not been addressed.
Cloud sim SDN	Cloud sim	Lightweight and scalable simulation environment	lack of GUI (Graphical user Interface)
CEP_sim	Cloud sim	Used to test shared cluster	Dynamic query analysis is not supported

IV. CONCLUSION

This paper discussed the tools for simulating the real cloud environment. The brief description of ten different cloud simulator are discussed in this paper. Although there are several cloud simulators available, The choice of a simulator depends up on the type of problem as there are several simulators geared for certain types of research problems. As a general purpose simulator CloudSim is recommended based on its features and popularity in the research community.

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