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A Survey on Modeling and Simulation of Cloud Computing

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Abstract

Cloud computing has been significantly dragging the attention of government agencies, multi-national companies, researchers and top businesses. Cloud computing aims towards delivery of reliable application service requested by the user requirements. Another important point is to identify the upcoming data centers. The application has different provisioning, configuration, deployment requirements. Using web browsers the customers can utilize resources like power and information. Furthermore, it has become a hard task to judge the performance of the cloud environment due to increase in deployment and allocation strategies in Cloud computing. Recently, modeling and simulation play major role in the research community to handle the performance problems. Many simulators like Cloud Sim, Teach Cloud, CDOSIM, I Can Cloud, SPECI, Ground Sim and DC Sim toolkits have been introduced to test the performance of the Cloud environment. We have made a detailed survey on the Cloud simulators by comparing their features to find the best simulator for attaining better results.

Keywords: Cloud computing, Simulation, Cloud Sim, Grid Sim, iCan Cloud, DC Sim

Introduction

Cloud computing can also be defined as parallel, distributed system that contains a group of interconnected virtualized personal computers which are dynamically provisioned and presented as one or more than one computing resources based on service-level-agreements (SLA) introduced through interaction between the providers and customers [1]. Cloud computing can be seen in two perspectives: Cloud application and Cloud infrastructure which acts as the main building block of Cloud applications. IT companies are adopting cloud model for reducing the workload, operating and expenditure cost. Due to the favorable reasons cloud is being adopted in top companies. As the cloud provides various advantages such as scalable on-demand

resource, where the user tends to discover the platform that is being used to find how optimized and profitable execution of their application takes place. To make the resources in the cloud more beneficial, the applications must get adjusted to its new world and scheduling results must be obtained for efficient performance. In the same way providers of the cloud must explore scheduling policies and configurations for the list of workloads given by the corresponding application. Estimating the cloud computing on real-time is not an easy task due to the following reasons,

1. The cloud shows varying demands and resources. It is considered to be a hard task to iterate experiments and estimate different results due to resources exhibiting unreliable nature.
2. Various factors are involved in finding out the performance of the cloud by user's quality of service, differ in workloads, and multiplex communication of many networks.
3. Time consuming plays a vital role when the real experiments take place in distributed platform.
4. To run the tests several times are beyond the bounds of possibility.

The most perfect solution is to use a simulation framework, which is used at no cost, test in an iterative fashion and adjust the performance gridlock before deploying on a real environment. To estimate the allocation policy and scheduling performance of cloud infrastructure (software, hardware) for all the applications having different requirements, hence cloud provides varying workloads, system size and energy consumption or dissipation. To overcome this problem, we introduce various simulation toolkits. None of the distributed system simulators provide an environment which can be used directly for modeling. Therefore, CloudSim is an extensible simulation toolkit used for modeling and simulation of cloud applications. This paper first presents the background information of the simulators. Section 3, of this paper explores various simulators in cloud computing, which includes CloudSIm, TeachCloud, CDOSIM, iCanCloud, SPECI, GroundSim and DCSim. Section 4, shows the comparison of the simulators with respect to platform and language and in section 5, the proposed system of our research was carried out using the CloudSim toolkit along with its implementation.

Services Provided By The Cloud Computing

Infrastructure, Platform, Software are the services provided to consumers in a pay-as-you-go model. Technically the services are termed as Infrastructure-as-a-service (IaaS), Platform-as-a-service (PaaS), and Software-as-a-service (SaaS).

Infrastructure As A Service

This type of service provided to cloud computing is also known as HaaS (Hardware as a Service) Infrastructure means the physical components such as hard disk, RAM in computer those are offered as a service to the user by the third party server. The final user makes use of these services by a virtual computer provided by the server in the presence of internet. Accessibility of the resources is done globally. There are three models in IaaS which are given below,

1. **Private cloud:** This cloud infrastructure is operated for an organization. It may be managed by the third party or the organization and may exist on or off premise.
2. **Public cloud:** This cloud infrastructure is made available to the public or a big industry and which is owned by an organization selling cloud services.
3. **Hybrid cloud:** This cloud infrastructure is a composition of two or more clouds just like private, community or public.
4. Few examples of emerging Cloud infrastructures are Amazon EC2, Google App Engine and Microsoft Azure [2].

Software As A Service
The user accesses this software using the server. This software is provided by third party server. Accessibility of the resources is done globally and not necessary to download this software directly in the computer. For better explanation, consider this example of Google chat was provided by the Google. It is not required to download the chat software, where as we can access this software globally by logging into a Gmail account.

Platform As A Service
PaaS offers a development platform for developers. The users write their own code and the Platform-as-a-service provider uploads that code and presents it on the web. Example of PaaS is SalesForce.com. PaaS provides services to develop, test, and deploy applications in the development environment. PaaS is considered as faster and cost effective model.

Background

Before the evolution of Cloud computing, it was grid computing ruling the IT world. With Grid computing, the task is shared among many computers and the service is provided by the server. Underutilized resource in one server is used by another server using a virtual connection. Internet is being used in cloud computing to finish the task using computer system. An unknown third party server provides service in case of Cloud computing, where as in Grid computing a known server provides the service. Services provided by server can be paid or unpaid service. Here all the services mean everything is given to you for granted, but it will not be with you. IT companies give resources which will be rented from the service provider in the presence of Internet.

A detailed study was done in the simulation of distributed systems and those tools were used for its research. Some of the simulators used in Cloud Computing are GridSim [3], SimGrid [3], MicroGrid, OptorSim, GangSim and CloudSim [4]. The first five simulators mentioned in a sequence are grouped together under Grid computing and which are used to evaluate the expenditure of implementing the applications in cloud infrastructure. GridSim is a Java based simulation toolkit. GridSim was introduced to list down the issues of performance in real time distributed environment. SimGrid is a simulation framework for distributed applications in Grid platform. GangSim is a Grid based simulation toolkit for modeling resources and

virtual organizations. CloudSim is a simulation framework available for cloud computing. CloudSim has its own platform which is used to model data centers, scheduling, allocation policies and service brokers. This framework is built on top of the GridSim.

Cloud Simulators

Cloud simulators are required to decrease the complexity and separate quality concerns. In this section, a few of the cloud simulators that are used to evaluate the performance of the cloud computing system are described here and analyze the quality issues under different condition [5].

Cloud Sim

CloudSim was invented as CloudBus Project at the University of Melborne, Australia. It is newly generated extensible simulation framework which provides modeling and simulation of upcoming cloud environments includes storage, VMs, bandwidth and provide interfaces for memory. Provisioning of hosts to VMs takes place and does dynamic system monitoring, execution of applications. In the (figure 1) which contains different layers including [6], User code, CloudSim, GridSim and SimJava. The user code layer has common entities like number of machines present, its specifications and applications, scheduling policies, VMs, number of users present and application types. The major features of CloudSim are,

1. Flexibility of defining configurations
2. Ease of use
3. Cost benefits

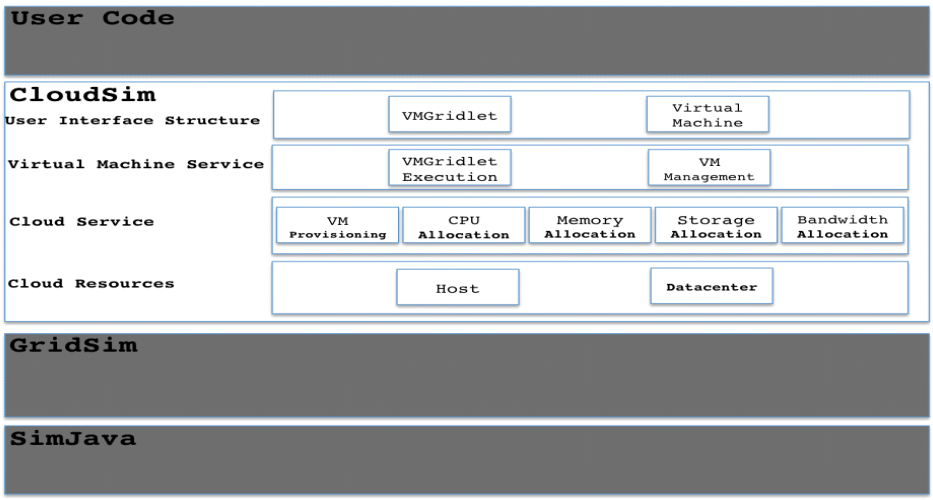

Figure 1: Architecture of CloudSim

Many other similar works were done to enhance the CloudSim and areas as given below,

Cloud Analyst
Cloud Analyst was enhanced from Cloud Sim. This simulator is used for testing the working of internet applications and also enables to perform iteratively in a series with a slight change in the parameters.

Green Cloud
Green Cloud is another example of Cloud Sim enhancement. The main motive is to provide a provisioning system for measuring cloud performance. It is an advanced packet-level simulator. Green Cloud is an extension of network simulator Ns2 [7]. Therefore, it provides fine-grained modeling of the energy conserved by the server, network switch and interaction links.

Network Cloud Sim
Network Cloud Sim is an extension of Cloud Sim that presents various applications like computing, high performance, workloads and e-commerce [8].

Teach Cloud
Teach Cloud is a simulator created for educational purpose. This simulator has a specific graphical user interface through which studying students and researchers can change the configuration of cloud and implement simple experiments [9]. It makes use of the platform of CloudSim and new concepts are introduced on it like,

1. Develop a new graphical user interface toolkit.
2. Add workload generator for CloudSim simulator.
3. Introduce parts related to BPM and SLA.
4. Introduce Cloud network models.

CDO Sim
CDO Sim is a cloud deployment option simulator used to simulate the cost of the cloud deployment option (CDO), service level agreements and response time. Integration of the fine grained model is done. It is said to be best simulator for predicting the cost and performance in advance. [7] CDOSim is designed to overcome the drawbacks in other simulators.

iCan Cloud
iCan Cloud simulator is based on SIMCAN. It is the software framework used to store networks. The graphical user interface is present for carrying out those experiments are designed to run easily. The existing systems are modeled manually. Execution of single experiments on multiple machines takes place simultaneously [10]. It has special functionality to predict in advance the cost and performance of any application.

SPECI
Simulation Program For Elastic Cloud Infrastructures (SPECI) is used to analyze large data centers with respective to the size and design policy of middleware as the inputs [10]. Two packages are there in SPECI: data center layout and topology,

components for execution of experiments. The experimental phase is built on SimKit which provides random distribution and scheduling.

Ground Sim
Ground Sim is another event driven simulator that requires single thread for simulation of the scientific application of cloud and grid environment. Full concentration is offered on IaaS, but can also support PaaS model. Further investigation was carried out in the same real time environment by combining GroundSim into ASKALON [11].

DC Sim
DC Sim means Data Center Simulator. This simulator is used to virtualize the data center, offer Infrastructure-as-a-service to many users. Data centers are becoming equally famous for provisioning of resources. The cost of the data centers got increased with an increase in the capacity.

Comparision of Various Variants of Cloud sim

The number of the simulation environment for public use is comparatively less nowadays. Cloud Sim is the most widely used simulator on comparing with other simulators. In figure 2, a comparative study was done in cloud computing simulators with respect to the language, platform and networking. In the study of the various tools most of them are software based and are developed in Java language. Cloud Sim is an event based simulator which is used to avoid building and processing of small size simulation objects that are individually released under the open source GPL license. Such kinds of methods are used to reduce the time, increase scalability, but it doesn't reach the exact accuracy as expected. Cloud Sim provides short time in simulation of cloud for large data centers because of its event based nature.

Simulator	Underlying Platform	Programming Language	Software/Hardware
CloudSim	GridSim	Java	Software
CloudAnalyst	CloudSim	Java	Software
GreenCloud	Ns2	C++, OTcl	Software
NetworkCloudSim	CloudSim	Java	Software
EMUSIM	AEF, CloudSim	Java	Software
SPECI	SimKit	Java	Software
GroudSim	-	Java	Software
DCSim	-	Java	Software

Figure 2: Comparison of Cloud computing Simulators

Proposed System

In this paper, we propose a research on modeling and simulation of private cloud infrastructure for scientific computing. With the help of comparative study of all the simulators in section 3, we were able to decide the best simulator for our research. So we decided to carry out the simulation using Cloud Sim toolkit. In the existing system only one application is being considered. "Myki" is a smart card based public transportation system used to automate ticketing on all channels of public transport. The proposed system is a multi-user and multi-application process. Any number of applications can work on simultaneously.

Implementation

The main procedure is carried out in two modules, Module 1- Simulation phase and Module 2- Deployment phase. Simulation phase is explained in a five step process which starts with,

1. Identifying the inputs to attain the end user goals: In house developed reactor design and analysis, Radiation dispersion, Weather modelling, Mathematical application, Finite element analysis.
2. Refine the end user goals in the form of graph and analyze for conflicts.
3. Qualifying scalability and performance.
4. The simulation is allowed to run and refine the model iteratively.
5. Real-world testing and experimenting with derived architecture.

Using Cloud Sim toolkit modeling and creation of one or more VMs on a simulated node of a data center and mapping jobs suitable to VMs. The fundamental classes in Cloud Sim are given in figure 3. The common feature is the availability of virtualization engine that allows in the creation as well as management of multiple, independent and co-hosted virtualized services on a data center node. It offers basic classes for describing data center, virtual machine, computational resources and policies (e.g. Scheduling and provisioning). The simulation model is achieved and evaluated for analyzing the performance. .

Data center: Models the core infrastructure level service (hardware). Normally, data centers are composed of set of hosts which is responsible for managing VMs during the life cycles. Host means a component that represents a physical computing node in a cloud. Each host has multiple processors. The host can simultaneously instantiate multiple VMs and allocate cores based on predefined processor sharing policies.

Cloudlet: Basically means your task/application of users. Models the cloud based application services which are commonly deployed in the data center. Every application has a pre-assigned instruction length (specific program length will be provided to cloudlet) VM scheduler: Determine how processing cores of a host are allocated to the VM. The policy takes into account how many processing cores will be integrated into each VM and how much of the processing core's capacity will effectively be attributed for a given VM. The two types of policies are:

1. **Space-shared policy:** One processor works with first VM then once it has finished the task, we give the rest to second VM. They will be used sequentially one by one.
2. **Time-shared policy:** Processor will be switching between the VM simultaneously.

How do Cloud Sim works?

1. Initialize the Cloud Sim package- init()
2. Creation of data centers: Data center class is available, call its constructor or its function to create datacenter and pass the requested parameters.
3. A broker is created: It is the interface between user and provider. After that VMs will be created and the cloudlet which are submitted by the user are created. Then simulation is started- Start Simulation() is used to start the simulation. When we start all the tasks are mapped to the VMs and to finish it will do call Stop Simulation(). Later gives the output as how it's being mapped to them, time taken by the cloudlets to execute and on which VM the task has been executed.

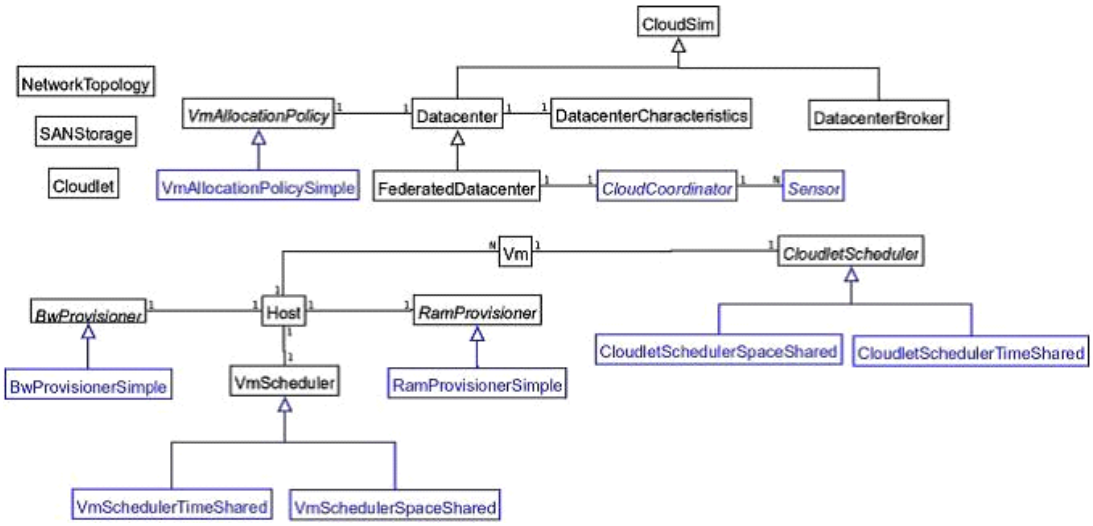

Figure 3: Class Diagram of Cloud sim

Deployment phase is used to deploy the perfect architecture that is produced in the real- time environment of cloud infrastructure. Figure 4 and Figure 5, shows an example of the data center configuration and the final report produced at the end of the simulation.

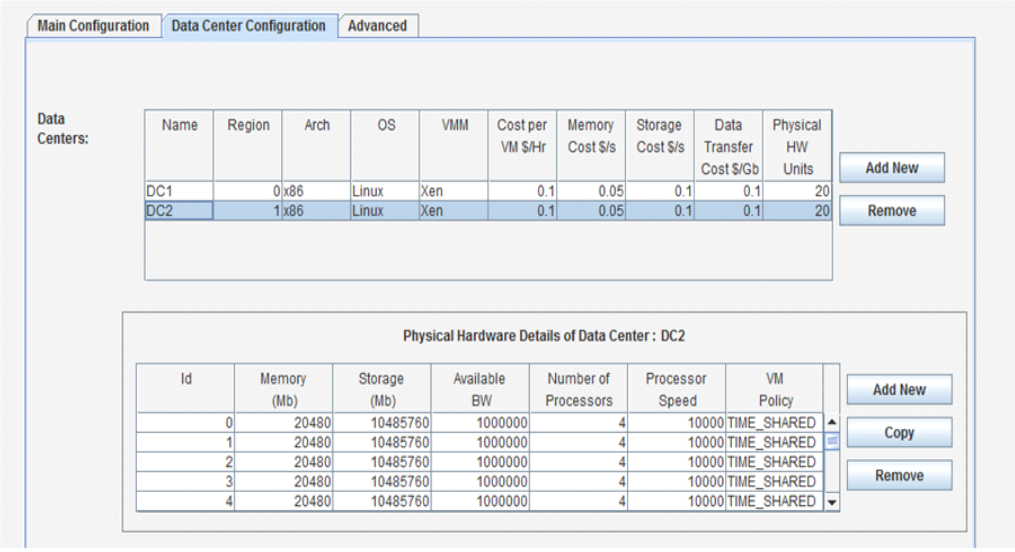

Figure 4: Data Center Configuration

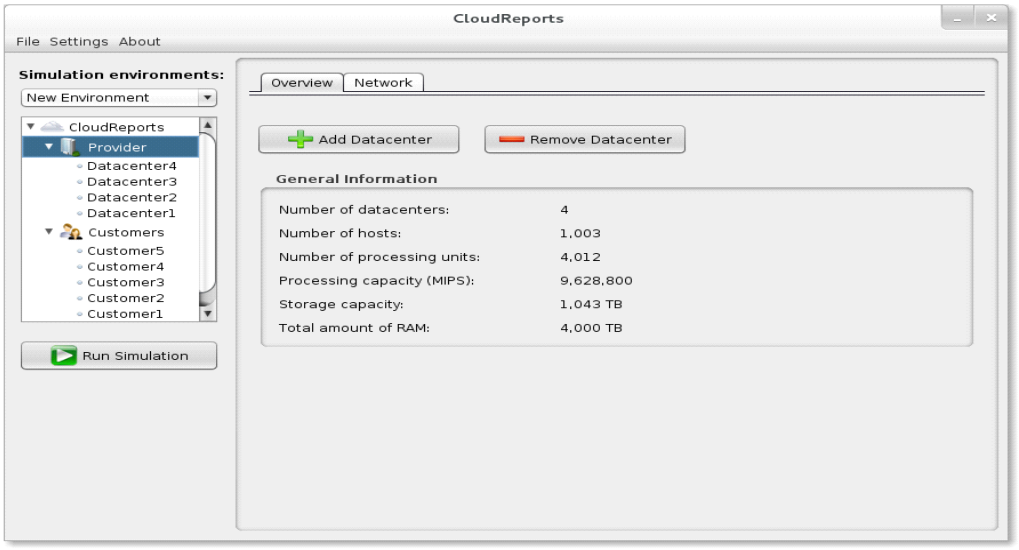

Figure 5: Cloud sim Report

Conclusion

Cloud computing is one of the emerging fields in IT industries. The general features of Cloud computing offer on-demand application service, multi-tendency, security, scalability and elasticity. It is recommended to test the performance and security issues faced by the cloud during the implementation. The evaluation is carried out as customers are very much concerned regarding the security. By simulation, the approach has become very easy to find the results even before deploying in real time environment. Several simulators have come into existence for attaining better

performance results of Cloud environment, including Cloud Sim, Teach Cloud, CDOSIM, iCan Cloud, SPECI, Ground Sim and DC Sim.

In this paper, we provide an overview and special features of all the simulators. Among the all simulators Cloud Sim is the most relevant for faster application. Hence, we have decided to model and simulate private cloud Infrastructure using Cloud Sim toolkit. Researchers are carrying out their process to introduce new tools and models for simulation of cloud computing.

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