Criteria for the CloudSim Environment

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Abstract

CPU is undoubtedly the most important resource of the computer system. Recent advances in software and system architecture have increased processing complexity, as computing is now distributed and parallel. CloudSim represents the complexity of an application in terms of its computational requirements. CloudSim \([9]\) is a complete solution for simulating Cloud Computing environments and building test beds for provisioning algorithms. This paper analyzes and evaluates the performance of cloud environment modeling using CloudSim. We describe the CloudSim architecture and then investigate the new models and techniques in CloudSim.

Keywords: CloudSim, Cloud computing, scheduling in Cloud

1 Introduction

The national institute of technology (NIST) has formulated a widely accepted definition that characterizes important aspects of cloud computing: Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. How Websites relate to memory use, processor, and small hardware depends on the type of server the website uses and this can be problematic. As data and website users are increasing, perhaps a server cannot

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respond to this traffic but cloud computing can because it uses several servers for responsibility. That means a server always exists to carry additional load or several servers are considered for various works. In the near future, we will not need OS, infrastructure, memory, storage, CPU or even application in our home and instead will meet these needs through the sharing of cloud service providers by connecting to the Internet. In the cloud, infrastructure, operating systems, hardware, and software requirements are provided as a service. There are three service models for cloud computing: Cloud infrastructure as a service (IaaS) cloud platform as a service (PaaS) and cloud software as a service (SaaS). Three things must be provided for cloud computing services which are thin client, grid computing, and utility computing. Today, cloud computing is one step ahead of utility computing and the provision of resources is on demand. In our CloudSim examples, we can change the virtual machine (VM) allocation policy, provision of resources, power consumption. For example, we can change the power folder for low power consumption and test it.

The following example are fetched from CloudSim examples folders [14]. Basic Examples: In this set, there are eight possible cloud examples which are determined by a single host with one or two data centers running one or two cloudlets on them, and using with or without using network typology. In one of these examples, cloud Scalability is simulated and the last two examples represent how to pause and resume a cloud simulation, such as Data center broker. Network Examples: This set consists of four examples that illustrating how to create one or two data centers with one host and network topology which executes one or two user cloudlets. Power Examples: In these examples, simulation of a heterogeneous non-power aware data center or heterogeneous power aware data center is shown. In one example, no optimization was performed on VM assignment. In other examples, there are various policies for assigning virtual machine (VM) such as median absolute deviation (MAD), VM allocation or the local regression (LR), VM allocation policy or minimum migration time (MMT), VM selection policy choosing the most suitable VM, and so on.

2 Scheduling in cloud

CloudSim is used to simulate the cloud and the cloudlet represents the applications. Cloud brokers assign cloudlets to virtual machines (VMs) and the virtual machine manager decides on which VM will host based on the VM allocation policy. The VMs then start executing cloudlets and scheduling
algorithms are introduced. We use Cloud to make better use of resources. The discussion of scheduling algorithms is more common in parallel computer systems in which a task is divided into several subtasks and each subtask is run by one processor. When VM performs a task, it seems to have performed that task in parallel. For this purpose, it uses fare share scheduling or capacity scheduling. In CloudSim, there is a class that simulates VM and a host can simultaneously multiply initial VMs. In this regard, the time and space shared policies are used to allocate the cores and each VM is in relation to a component that holds the VM specification, such as memory and scheduling algorithm. Also, workfloware tasks are composed of several sub-tasks.

3 Cloud computing

Cloud has emerged as an alternative to clusters and grids and many modern cloud services are provided using Internet Data Centers (IDCs) such as the Google search engine. Cloud computing is considered to be energy and ecological efficient. In Cloud computing, it is important to know how much energy a specific service or VM consumes. Today, the internet involves more than bandwidth resources. Computing and storage resources are shared through Cloud Computing offering virtual machines over infrastructure services, application programming interfaces (APIs) and support through service platformse, and Web-based applications to end users through software services.

4 CloudSim architecture

The architecture of the CloudSim includes the following layers: The system level in which cloud resources are located (IaaS), core middleware (PaaS) is higher level that includes VM management and deployment, SLA management and monitoring and QoS negotiation. Above this level, there is a User-Level middleware (SaaS) that includes environments and tools, workflows and Cloud programming, and the highest level is User Level that includes Cloud applications.

The second figure shows the layered implementation of the CloudSim software framework. The SimJava layer implements system components (such as services, host, data center, broker, virtual machines) the simulates communication between these components, and manages simulation clock. GridSim [9] supports high-level software components for modeling multiple
Grid infrastructures, including networks and Grid components (such as resources, data sets, workload traces, and information services) and SimJava avoids reimplemention of event handling and message passing among components.

The third figure shows the communication between core CloudSim entities. At the beginning of a simulation, each Data Center entity registers with the CIS (Cloud Information Service) Registry. Next, the Data Center brokers try to obtain the list of Cloud providers. The Data Center broker then deploys the application [11], and looks for the best VM to run the application.

5 Our experience

Initially, we implemented the program using one cloudlet for simplicity then ran the program with more cloudlets. Each VM has a virtual CPU and in CloudSim, the virtual CPU is called Processing Element (PE). The VM can have one PE or more which simulates the original multi-core CPUs. Here, we will describe the run of our program and the steps performed. First
Figure 2: Layereering of cloud architecture
Figure 3: Simulation data flow in CloudSim

, initialize the CloudSim package, it should be called before creating any entities (number of grid users, trace events, calendar, and initializing the CloudSim library). Second, create Data Centers as they are the resource providers in CloudSim and we need at least one of them to run a CloudSim simulation. when creating a Data Center, there are several considerations to follow: We must create a list to store one or more Machines and a Machine contains one or more Machines and a Machine contains one or more PEs or CPUs/cores, thus we must create a list to store the PEs before creating a Machine. So, we create a list for four PEs (four are required) for a quad core Machine and create another list for a dual core Machine. Next, Create a Host id with the list of PEs and add them to the list of Machines. Then, Create a Data Center Charcteristics object to stores data center properties of architecture, OS, list of Machines and allocation policy( time- or space-shared, time zone, and price of (G$/per unit of time). The last consideration for creating Data Center is to create a power Data Center Object. The third step of the program is to create a broker followed by the fourth step to creat VMs and Cloudlets to send to the broker. The fifth step is to Start the simulation and the final step is to print the results of the simulation.

There are several steps to creating a VM. First, create a container to store the VMs and this list is passed to the broker later. Second, Specify VM Parameters as image size, VM memory (MB), number of CPUs and VMM
name. Next, Create a VMs array. We use these values in our program: VM image size of 10000, VM memory (MB) of 512, and one CPU. We set the cloudlet length to 1000 and we set the cloudlet file size to 300. Our operating system is Windows and our system architecture is x86. We will calculate two values, the completion rate and the average execution time in our program. The completion rate, or percentage of work completed is equal to the total number of cloudlets divided by the number of successful cloudlets. The average execution time of each cloudlet is determined by the number of cloudlets divided by the execution time. We show the number of VMs illustrated by the red line and growth of the average execution time represented by the blue columns in Figure 4. The result of the first run of our CloudSim program can be in Table 1.

Figure 4: The number of VMs and growth of the average execution time.
Table 1: The results of the first run of our CloudSim program.

| Cloudlet ID | Status  | Data center ID | VM ID | Time | Start Time | Finish Time |
|-------------|---------|----------------|-------|------|------------|-------------|
| 4           | SUCCESS | 2              | 4     | 3    | 0.2        | 3.2         |
| 16          | SUCCESS | 2              | 4     | 3    | 0.2        | 3.2         |
| 28          | SUCCESS | 2              | 4     | 3    | 0.2        | 3.2         |
| 5           | SUCCESS | 2              | 5     | 3    | 0.2        | 3.2         |
| 17          | SUCCESS | 2              | 5     | 3    | 0.2        | 3.2         |
| 29          | SUCCESS | 2              | 5     | 3    | 0.2        | 3.2         |
| 6           | SUCCESS | 3              | 6     | 3    | 0.2        | 3.2         |
| 18          | SUCCESS | 3              | 6     | 3    | 0.2        | 3.2         |
| 30          | SUCCESS | 3              | 6     | 3    | 0.2        | 3.2         |
| 7           | SUCCESS | 3              | 7     | 3    | 0.2        | 3.2         |
| 19          | SUCCESS | 3              | 7     | 3    | 0.2        | 3.2         |
| 31          | SUCCESS | 3              | 7     | 3    | 0.2        | 3.2         |
| 8           | SUCCESS | 3              | 8     | 3    | 0.2        | 3.2         |
| 20          | SUCCESS | 3              | 8     | 3    | 0.2        | 3.2         |
| 32          | SUCCESS | 3              | 8     | 3    | 0.2        | 3.2         |
| 10          | SUCCESS | 3              | 10    | 3    | 0.2        | 3.2         |
| 22          | SUCCESS | 3              | 10    | 3    | 0.2        | 3.2         |
| 34          | SUCCESS | 3              | 10    | 3    | 0.2        | 3.2         |
| 9           | SUCCESS | 3              | 9     | 3    | 0.2        | 3.2         |
| 21          | SUCCESS | 3              | 9     | 3    | 0.2        | 3.2         |
| 33          | SUCCESS | 3              | 9     | 3    | 0.2        | 3.2         |
| 11          | SUCCESS | 3              | 11    | 3    | 0.2        | 3.2         |
| 23          | SUCCESS | 3              | 11    | 3    | 0.2        | 3.2         |
| 35          | SUCCESS | 3              | 11    | 3    | 0.2        | 3.2         |
| 0           | SUCCESS | 2              | 0     | 4    | 0.2        | 4.2         |
| 12          | SUCCESS | 2              | 0     | 4    | 0.2        | 4.2         |
| 24          | SUCCESS | 2              | 0     | 4    | 0.2        | 4.2         |
| 36          | SUCCESS | 2              | 0     | 4    | 0.2        | 4.2         |
| 1           | SUCCESS | 2              | 1     | 4    | 0.2        | 4.2         |
| 13          | SUCCESS | 2              | 1     | 4    | 0.2        | 4.2         |
| 25          | SUCCESS | 2              | 1     | 4    | 0.2        | 4.2         |
| 37          | SUCCESS | 2              | 2     | 4    | 0.2        | 4.2         |
| 2           | SUCCESS | 2              | 2     | 4    | 0.2        | 4.2         |
| 14          | SUCCESS | 2              | 2     | 4    | 0.2        | 4.2         |
| 26          | SUCCESS | 2              | 2     | 4    | 0.2        | 4.2         |
| 38          | SUCCESS | 2              | 2     | 4    | 0.2        | 4.2         |
| 3           | SUCCESS | 2              | 3     | 4    | 0.2        | 4.2         |
Completion rate: 1
Average execution time: 3.398000000000001

6 Analysis

The output of this program compares the implementation time of various parallel applications (named cloudlet) creating 40 cloudlets (with two or three Data Centers) and creating 20 VMs (1 to 20 for the number of virtual machines. We obtained this result where time with two Data Centers and four five VMs is three, the time is the same when the cloudlets run with three Data Centers and six to eleven VMs is the same, and when we have two Data Centers with zero to three VMs the time is the same and equal to four. We can change the cost of processing use memory use, storage use BW (bandwidth) use in our program. We quintuplicate these costs and obtain the same results. We run our program with 1000000 VMs and 160 cloudlets and obtain these results:
Table 2: The result of the second run of our CloudSim program.

| Cloudlet ID | Status  | Data center ID | VM ID | Time | Start Time | Finish Time |
|-------------|---------|----------------|-------|------|------------|-------------|
| 4           | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 16          | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 28          | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 40          | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 52          | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 64          | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 76          | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 88          | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 100         | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 112         | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 124         | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 136         | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 148         | SUCCESS | 2              | 4     | 12.99| 0.2        | 13.19       |
| 5           | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 17          | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 29          | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 41          | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 53          | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 65          | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 77          | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 89          | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 101         | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 113         | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 125         | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 137         | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 149         | SUCCESS | 2              | 5     | 12.99| 0.2        | 13.19       |
| 6           | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 18          | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 30          | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 42          | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| Cloudlet ID | Status  | Data center ID | VM ID | Time | Start Time | Finish Time |
|------------|---------|----------------|-------|------|------------|-------------|
| 54         | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 66         | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 78         | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 90         | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 102        | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 114        | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 126        | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 138        | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 150        | SUCCESS | 3              | 6     | 12.99| 0.2        | 13.19       |
| 7          | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 19         | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 31         | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 43         | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 55         | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 67         | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 79         | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 91         | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 103        | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 115        | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 127        | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 139        | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 151        | SUCCESS | 3              | 7     | 12.99| 0.2        | 13.19       |
| 8          | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 20         | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 32         | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 44         | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 56         | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 68         | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 80         | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 92         | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 104        | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 116        | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 128        | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 140        | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 152        | SUCCESS | 3              | 8     | 12.99| 0.2        | 13.19       |
| 10         | SUCCESS | 3              | 10    | 12.99| 0.2        | 13.19       |
| 22         | SUCCESS | 3              | 10    | 12.99| 0.2        | 13.19       |
| 34         | SUCCESS | 3              | 10    | 12.99| 0.2        | 13.19       |
| Cloudlet ID | Status   | Data center ID | VM ID | Time | Start Time | Finish Time |
|------------|----------|----------------|-------|------|------------|-------------|
| 46         | SUCCESS  | 3              | 10    | 12.99| 0.2        | 13.19       |
| 58         | SUCCESS  | 3              | 10    | 12.99| 0.2        | 13.19       |
| 70         | SUCCESS  | 3              | 10    | 12.99| 0.2        | 13.19       |
| 82         | SUCCESS  | 3              | 10    | 12.99| 0.2        | 13.19       |
| 94         | SUCCESS  | 3              | 10    | 12.99| 0.2        | 13.19       |
| 106        | SUCCESS  | 3              | 10    | 12.99| 0.2        | 13.19       |
| 118        | SUCCESS  | 3              | 10    | 12.99| 0.2        | 13.19       |
| 130        | SUCCESS  | 3              | 10    | 12.99| 0.2        | 13.19       |
| 142        | SUCCESS  | 3              | 10    | 12.99| 0.2        | 13.19       |
| 154        | SUCCESS  | 3              | 10    | 12.99| 0.2        | 13.19       |
| 9          | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 21         | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 33         | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 45         | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 57         | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 69         | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 81         | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 93         | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 105        | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 117        | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 129        | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 141        | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 153        | SUCCESS  | 3              | 9     | 12.99| 0.2        | 13.19       |
| 11         | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 23         | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 35         | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 47         | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 59         | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 71         | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 83         | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 95         | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 107        | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 119        | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 131        | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 143        | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| 155        | SUCCESS  | 3              | 11    | 12.99| 0.2        | 13.19       |
| Cloudelet ID | Status   | Data center ID | VM ID | Time | Start Time | Finish Time |
|-------------|----------|----------------|-------|------|------------|-------------|
| 0           | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 12          | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 24          | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 36          | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 48          | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 60          | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 72          | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 84          | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 96          | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 108         | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 120         | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 132         | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 144         | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 156         | SUCCESS  | 2              | 0     | 14   | 0.2        | 14.2        |
| 1           | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 13          | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 25          | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 37          | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 49          | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 61          | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 73          | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 85          | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 97          | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 109         | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 121         | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 133         | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 145         | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 157         | SUCCESS  | 2              | 1     | 14   | 0.2        | 14.2        |
| 2           | SUCCESS  | 2              | 2     | 14   | 0.2        | 14.2        |
| 14          | SUCCESS  | 2              | 2     | 14   | 0.2        | 14.2        |
| 26          | SUCCESS  | 2              | 2     | 14   | 0.2        | 14.2        |
| 38          | SUCCESS  | 2              | 2     | 14   | 0.2        | 14.2        |
| 50          | SUCCESS  | 2              | 2     | 14   | 0.2        | 14.2        |
| 62          | SUCCESS  | 2              | 2     | 14   | 0.2        | 14.2        |
| 74          | SUCCESS  | 2              | 2     | 14   | 0.2        | 14.2        |
| 86          | SUCCESS  | 2              | 2     | 14   | 0.2        | 14.2        |
| 98          | SUCCESS  | 2              | 2     | 14   | 0.2        | 14.2        |
| Cloudlet ID | Status    | Data center ID | VM ID | Time | Start Time | Finish Time |
|------------|-----------|----------------|-------|------|------------|-------------|
| 110        | SUCCESS   | 2              | 2     | 14   | 0.2        | 14.2        |
| 122        | SUCCESS   | 2              | 2     | 14   | 0.2        | 14.2        |
| 134        | SUCCESS   | 2              | 2     | 14   | 0.2        | 14.2        |
| 146        | SUCCESS   | 2              | 2     | 14   | 0.2        | 14.2        |
| 158        | SUCCESS   | 2              | 2     | 14   | 0.2        | 14.2        |
| 3          | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 15         | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 27         | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 39         | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 51         | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 63         | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 75         | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 87         | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 99         | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 111        | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 123        | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 135        | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 147        | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |
| 159        | SUCCESS   | 2              | 3     | 14   | 0.2        | 14.2        |

We observed that the time is four to five times higher when compared to the previous run and the number of successful cloudlet performances has improved dramatically.

7 Conclusion

We found that CloudSim supports a large scale simulation environment with little overhead and it exposes powerful features that could easily be extended for modeling custom Cloud environments. We described the CloudSim architecture and then investigated the new models and techniques in CloudSim. We calculated two values in our research, the completion rate and the average execution time in touch CloudSim.

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