Volume 5, Issue 5, May 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Virtual Machine Scheduling on Clouds Using DVFS

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Abstract: Cloud computing is not a new technology but a new delivery method for the services on pay per use basis. As per various standard definitions of cloud computing: "Cloud Computing is the delivery of application softwares, infrastructure and platform as a service over the Internet accessible from the web browser and desktop with the end user not having any knowledge of the service providing system, platform, as well as of where the software and data are residing on the servers on a pay-per-use basis." Cloud computing offers reduced investment, expected performance, high availability, scalability, accessibility and mobility and many more services. For any application to be executed over the cloud, proper utilization of hardware machines to respond the application back depends upon the administrator policy of Voltage frequency scaling and machine scheduling. Virtual machines can be defined as a software based machine emulation technique to provide a desirable on-demand computing environment for users. So in this research paper we propose a novel VM scheduling mechanism to keep the energy consumption on server side as minimal as possible while keeping the performance considerably stable as per the requirement of the application, which in turn will lead to the power saving to provider, less heat generated to the environment and indirect cost benefits to the client.

Keywords: Cloud computing, CloudSim, DVFS, Grid computing, IAAS, Middleware, PAAS, SAAS

I. INTRODUCTION

The use of Internet and new technologies nowadays, for business and for the current users, is already part of everyday life. Any information is available anywhere in the world at any time. That was not possible few years ago. Nowadays it have arisen a lot of possibilities of access to public and private information like internet speed access or the deployment of mobile dispositive that allow the connection to Internet from almost everywhere. People run applications and store data in servers located in Internet and not in their own computers. And every day its being used more this services that are called cloud computer services. That name is given because of the metaphor about Internet, as something than the user see like a cloud and cannot see what's inside.

A. Client-Server Architecture

Client-server architecture (client/server) is a network architecture in which each computer or process on the network is either a client or a server. Servers are powerful computers or processes that manage disk drives (file servers), printers (print servers), or network traffic (network servers). Clients are PCs or workstations on which users run applications. Clients depend on servers for resources, such as files, devices, and processing power. An integrating resource between the clients and servers is called middleware. It performs the following tasks:

- Translation between the different protocols
- Optimization of the load-balancing
- Security control
- Management of the connections

B. Cloud Computing

"Cloud Computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide those services. Cloud resources are delivered to the end-users through web services. This simple model results in the following attractive features:

- **Elasticity**: Since physical resources are dynamically allocated to the consumers according to their needs, clouds services can scale on -demand.
- **Cost Effectiveness**: Resources sharing improves utilization of physical resources and thus reduces the associated cost.
- **Pay-as-you-go Pricing Model**: Cloud services have consumption-based metering and billing; this property makes them more affordable for small businesses and startups.
- **Global-scale Accessibility and Usability**: Cloud consumers have access to a virtually unlimited physical resource pool through web.
- **Easy Maintenance**: All non-functional requirements of IT, such as maintenance of hardware and software, are fulfilled by cloud providers, therefore consumers can concentrate on their functional business requirements.

i) Cloud Services:

- **Software as a service (SaaS)**

Software as a service features a complete application offered as a service on demand. A single instance of the software runs on the cloud and services multiple end users or client organizations. The most widely known example of SaaS is salesforce.com, Google Apps.

- **Platform as a service (PaaS)**

Platform as a service encapsulates a layer of software and provides it as a service that can be used to build higher-level services. PaaS offerings can provide for every phase of software development and testing, or they can be specialized around a particular area such as content management. Commercial examples of PaaS include the Google Apps Engine, which serves applications on Google's infrastructure. PaaS services such as these can provide a powerful basis on which to deploy applications, however they may be constrained by the capabilities that the cloud provider chooses to deliver.

- **Infrastructure as a service (IaaS)**

Infrastructure as a service delivers basic storage and compute capabilities as standardized services over the network. Servers, storage systems, switches, routers, and other systems are pooled and made available to handle workloads that range from application components to high-performance computing applications. Commercial examples of IaaS include Joyent.

ii) Isolation Levels:

Companies may make a number of considerations with regard to which cloud computing model they choose to employ, and they might use more than one model to solve different problems. With respect to deployment model and isolation levels, clouds can be categorized into the following three categories:

- **Public Cloud**

Public clouds are run by third parties, and applications from different customers are likely to be mixed together on the cloud's servers, storage systems, and networks. Public clouds are most often hosted away from customer premises, and they provide a way to reduce customer risk and cost by providing a flexible.

- **Private Cloud**

Private clouds are built for the exclusive use of one client, providing the utmost control over data, security, and quality of service. The company owns the infrastructure and has control over how applications are deployed on it. Private clouds may be deployed in an enterprise datacenter, and they also may be deployed at a colocation facility. Private clouds can be built and managed by a company's own IT organization or by a cloud provider. This model gives companies a high level of control over the use of cloud resources while bringing in the expertise needed to establish and operate the environment.

- **Hybrid Cloud**

Hybrid clouds combine both public and private cloud models . They can help to provide on-demand, externally provisioned scale. The ability to augment a private cloud with the resources of a public cloud can be used to maintain service levels in the face of rapid workload fluctuations. This is most often seen with the use of storage clouds to support Web 2.0 applications. A hybrid cloud also can be used to handle planned workload spikes. Hybrid clouds introduce the complexity of determining how to distribute applications across both a public and private cloud.

II. DYNAMIC VOLTAGE FREQUENCY SCALING

Dynamic voltage-frequency scaling (DVFS) is perhaps the most appealing method incorporated into many recent processors. Energy saving with this method is based on the fact that the power consumption in CMOS circuits has a direct relationship with frequency and the square of voltage supply. Thus, the execution time and power consumption can be controlled by switching between a processor's frequencies and voltages. Although this approach was initially designed for single processor task scheduling [1], it has recently received much attention in multiprocessor systems as well [2, 3]. DVFS technique and task scheduling can be combined in two ways:
(1) schedule generation
(2) slack time reclamation.

In schedule generation, tasks graph are (re)scheduled on DVFS-enabled processors in a global cost function including both energy saving and make-span to meet both energy and time constraints at the same time [4, 5]. In slack time reclamation, which works as a post-processing procedure on the output of scheduling algorithms, the DVFS technique is used to minimize the energy consumption of tasks in a schedule generated by a separate scheduler. However, the existing methods based on the DVFS technique have two major shortcomings:
(1) most of them focus on schedule generation and do not adequately take the slack time reclamation approaches into account to save more energy; and
(2) the existing slack time reclamation methods use only one frequency for each task among the discrete set of a processor's frequencies. Using one frequency usually results in uncovered slack time where the processor and other

devices only waste energy. Multiple Frequency Selection DVFS (MFS-DVFS) is to execute each task with a linear combination of more than one frequency, such that the combination results in using the lowest energy by covering the whole slack time of the task.

III. PROPOSED WORK

Dynamic Voltage Frequency Scaling or DVFS is the mostly used energy aware resource allocation policy in the cloud environment. But DVFS is not optimized to suite all the application needs in the most energy efficient way. So we propose a modification in DVFS to give an energy as well as cost effective resource allocation to any client application to the cloud environment. In addition to power cost at server side, cooling is another issue in a cloud infrastructure that must be addressed due to negative effects of high temperature on electronic components or hardware. So Energy efficiency is one of the most critical issue to the handled in cloud infrastructure. Energy efficiency of the server side VM scheduling mechanism depends upon the resource allocation policy and VM selection policy accompanied with some other factors of performance.
Updation or refinement of any of the affecting component of server energy efficiency leads to the overall energy conservation of the system.

In our research paper we emphasize on:

- Analyzing normal energy consumption of cloud provider for a workload.
- Understanding the VM scheduling and Allocation policy.
- Finding the major component responsible for energy consumption.
- Refining the process of VM scheduling for energy conservation.
- Verifying our proposed method with more than one workload.

IV. EXPERIMENTAL RESULT ANALYSIS

We have simulated our proposed work using Cloudsim Simulator. It is a java based simulator for cloud computing research. Cloudsim stands for cloud simulator [6]. Cloud is a new online service delivery method as described in earlier chapters of thesis. Simulator is a tools which do not really implements the things but virtually creates the desired working environment for the research and enables us to design, check and verify our proposed methods, procedures and models. CloudSim, which is a toolkit for the modelling and simulation of Cloud computing environments provides system and behavioural modelling of the Cloud computing components. Simulation of cloud environments and applications to evaluate performance can provide useful insights to explore such dynamic, massively distributed, and scalable environments. The principal advantages of simulation are:

- Flexibility of defining configurations
- Ease of use and customisation
- Cost benefits: First designing, developing, testing, and then redesigning, rebuilding, and retesting any application on the cloud can be expensive. Simulations take the building and rebuilding phase out of the loop by using the model already created in the design phase.
- CloudSim is a toolkit for modelling and simulating cloud environments and to assess resource provisioning algorithms.

A. Cloudsim

CloudSim is a simulation tool that allows cloud developers to test the performance of their provisioning policies in a repeatable and controllable environment, free of cost. It helps tune the bottlenecks before real-world deployment. It is a simulator; hence, it doesn't run any actual software. It can be defined as 'running a model of an environment in a model of hardware', where technology-specific details are abstracted [7].
Overview of CloudSim functionalities:

- 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.

B. Simulation Results

During our simulation we simulated DVFS algorithm and found the results for energy consumption in that approach. Then we modified the algorithm as per our proposed method and found the results for the same work load which outperforms the existing results of generic DVFS algorithm:

i) Results for High-performance model:

- **DVFS algo:** The result on high performance model using DVFS algorithm are as shown in the Fig. 4.1.

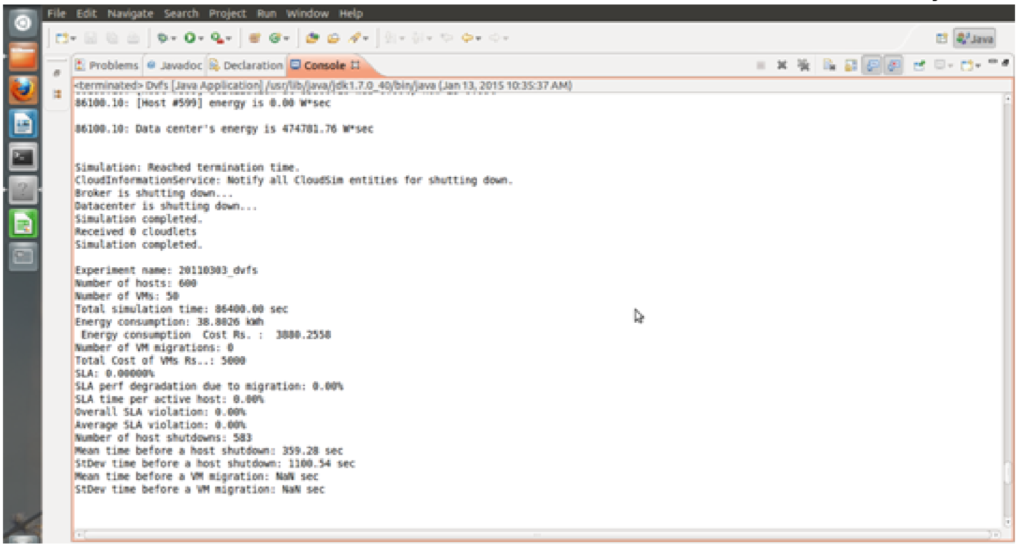

Fig. 4.1 High performance model using DVFS

- **Modified DVFS algorithms:** The results for the same workload when applied modified DVFS are shown in Fig. 4.2.

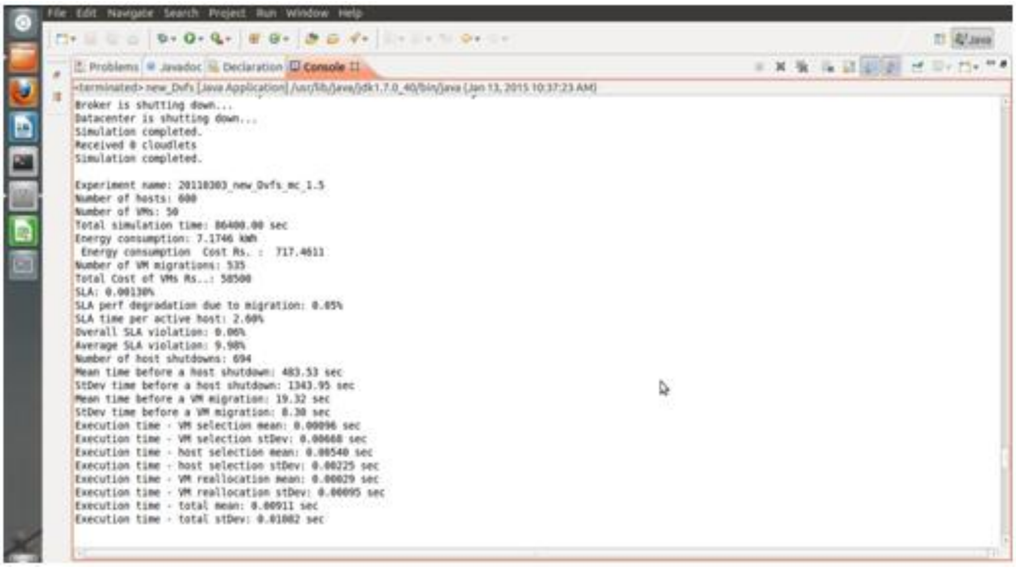

Fig. 4.2 High performance model using modified DVFS

ii) Results for Average-performance model:

- **DVFS algo:**Result on Average performance model using DVFS algorithm are shown in fig.4.3.

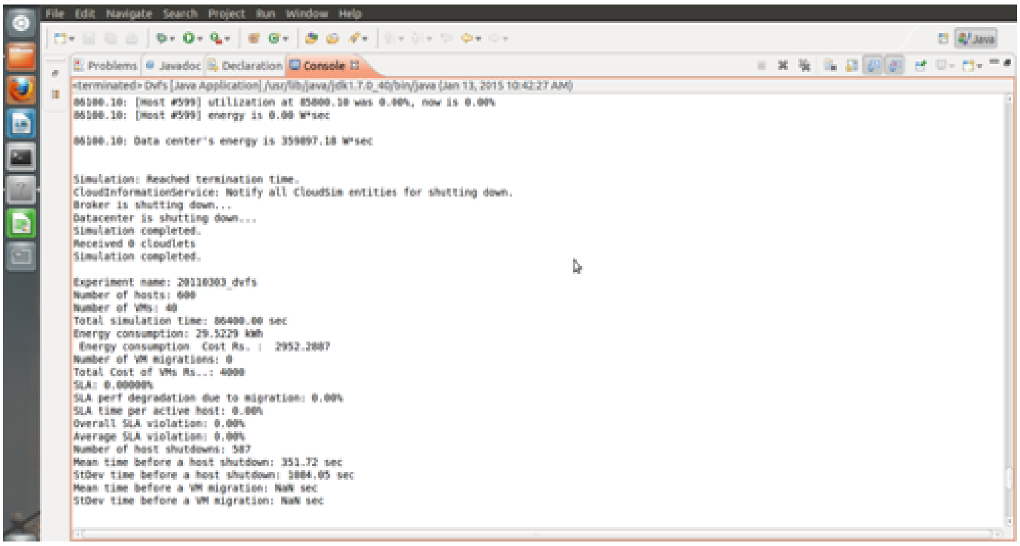

Fig. 4.3 Average performance model using DVFS

- **Modified DVFS algorithms:** The results for the same workload when applied modified DVFS are as shown in fig. 4.4:

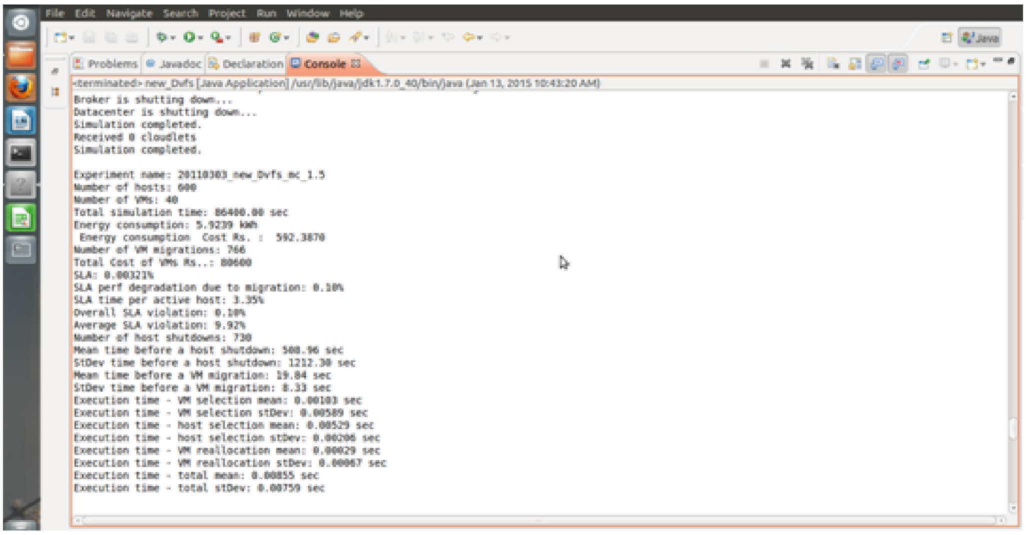

Fig. 4.4 Average performance model using modified DVFS'

iii) Results for Low-performance model:

- **DVFS algo:** The result on low performance model using DVFS algorithm are as shown in the fig. 4.5.

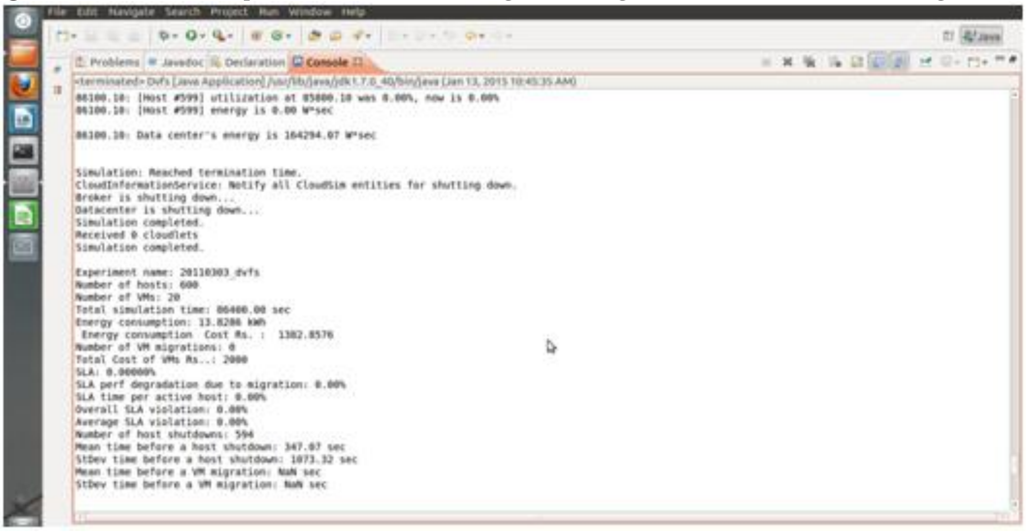

Fig. 4.5 Low performance model using DVFS

- **Modified DVFS algorithms:** The results for the same workload when applied modified DVFS are as shown in fig. 4.6:

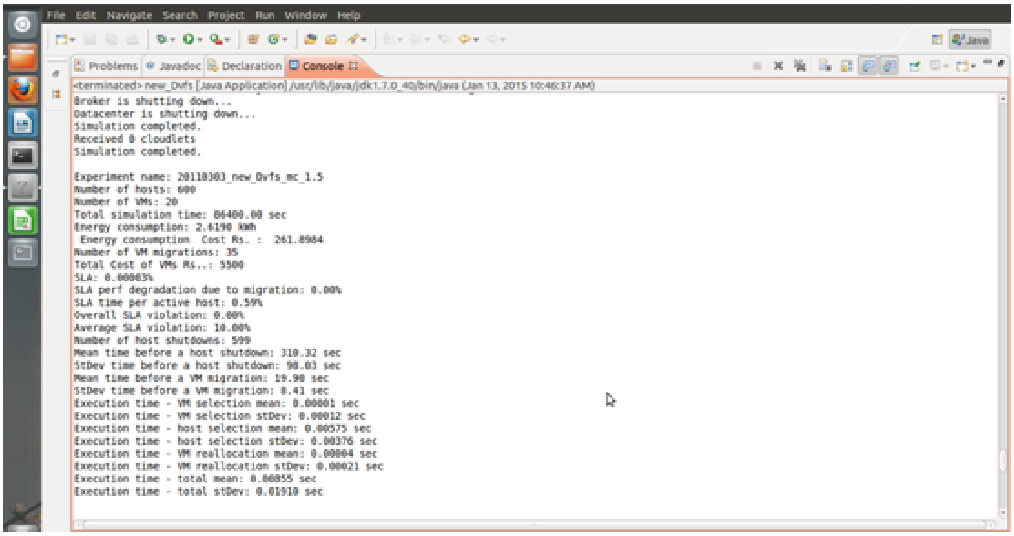

Fig. 4.6 Low performance model using modified DVFS

V. CONCLUSION AND FUTURE SCOPE

A. Conclusion

Giving an energy efficient resource allocation solution to any application sent for execution to cloud will lead to less energy consumption from cloud provider's point of view which in turn may lead to cost-effective service delivery to the client from the service provider.

In the proposed model as we applied the cost-aware migration to the applications over the cloud the resultant overall energy consumption reduced considerably. The reduced energy consumption leads to less input cost which in turn gives more return on investment or we can say reduced operational cost to the provider. In turn of these easily running services the cloud providers will be able to deliver more cost effective services to the applicant.

B. Future Work

Cloud computing is the future for organizations. The tangible benefits that provide will make eventually all the organizations partially or totally move their processes and data to the Cloud. A lot of efforts will be put in return to provision the appropriate security to make business on cloud environments. Although virtualization is already established, virtualization in the Cloud is still an immature area. The focus of future work should aim to harden the security of virtualization in multi-tenant environments. Possible lines of research are the development of reliable and efficient virtual network securities to monitor the communications between virtual machines in the same physical host environment. To achieve secure virtualized environments, isolation between the different components is needed. Future researches should emphasize to provide new architectures and techniques to harden the different resources shared between tenants.

The hypervisor is the most critical component of virtualized environments. If it will be compromised, the host and guest OSs could potentially be compromised too. Hypervisor architecture that aim to minimize the code and, at the same time, maintain the functionalities, provide an interesting scope for future research on secure virtualized environments and the Cloud, especially to prevent against future hypervisor rootkits.

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