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E-learning Optimization by Improving Education Cloud Using the Grid

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Abstract - **Today, it is attempted to present less complicated e-learning. With the growth of cloud computing in any field of application especially in distance education, the necessary infrastructure for migrating to the cloud is provided. Keeping coordination between educational content and educational sites, providing high quality education and resource sharing are among the characteristics of the cloud space. Cloud computing trough providing proper architecture allows the educational environments to provide an updated, efficient and dynamic based on their policies and rules. In this study, a specific supersaturated education cloud is used that allocates more logical resources than the available physical resources. The number of tasks performed by a supersaturated cloud is several times greater than the common clouds. In order to maximize the efficiency of a supersaturated cloud, tasks should be provided for the cloud continuously. On the other hand the requests on the grids are declined due to energy savings. Thus the grid and the cloud can be complementary technologies that in case of combination, the cloud reduces the tasks created by the grid. Thus by creating a grid on cloud by installing the middleware grid on cloud machines the cloud and grid deficiencies are compensated and the advantages are increased.**

Keywords - *Cloud Computing, Grid Computing, e-Learning, Educational Cloud.*

1. Introduction

Most studies that have been implemented in the field of e-learning by researchers have been focused on two issues. The first issue is cloud computing in education that is focused on distance learning, the information system software, educational system design, development of information resources and online users. The second issue that is network integration and e-learning is focused on building the university e-learning system, e-learning model in university network, e-learning system based on the operational model and e-learning network. But so far no considerable research is done in the field of e-learning improvement using cloud computing. In order to provide a full role for cloud computing advantages, in this study by attaching cloud computing to e-learning, it has been attempted to build and improve a cloud e-learning system.

2. Methods

One of the problems with educational clouds is low efficiency. In this study it has been attempted to increase educational cloud efficiency by creating a specialized cloud and using the proposed method of grid on cloud as well as simultaneous use of cloud and grid advantages. In this chapter first of all the grid on cloud method is discussed, Then the method of using the grid on cloud in the cloud is addressed, finally implementing the proposed method of grid on cloud and its comparison with the common cloud method are discussed in detail.

2.1 Grid on Cloud

There are two methods to increase the effectiveness of cloud on the educational grid known as node grid (NG) and instance grid (IG). Node is a physical machine or host that has several virtual machines and the tasks of the clients are entrusted to run virtual machines to be done. Each virtual machine is called an instance. In the node grid method the grid controller which is the same as the host machine's operating system is responsible to manage the resources. But in instance grid and instance or virtual machine provides the resources for the grid. The structure of the clouds that use the grid on cloud methods are presented in Figure (3-1) [8].

2.1.1 Node Grid Method

In the node grid method the middleware of the grid is installed on the node controller which is the operating system of a physical machine so that the node controller would control the grid itself. The advantage of node grid method is that the grid is available without the need for the any instance to start working. Also, if the host machine has a multicore processor, the node controller does not limit the number of processor cores. Therefore the controller can increase the efficiency on its own. The drawback of the node grid method is that it is time consuming to install and set up the grid. Cloud management costs also increase by the number of nodes controllers [13].

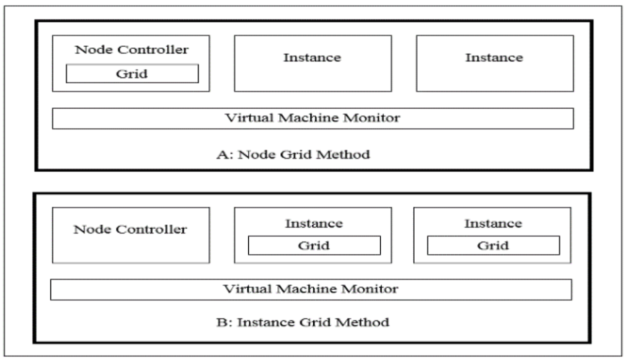

Figure. 1.The grid on cloud method structure

Grid node method is effective because it is able to share and divide the controller load of the node. For measuring the system load it is possible to use different criteria such as the number of tasks or the performance of the processor. The system load may not be shared between the instances allocated to the node controller, i.e. the number of the tasks may not be equal to the running instances [4].

2.1.2 Instance Grid Method

In the instance grid method the middleware of the grid is installed on the node controller separately. In the instance grid method it is necessary to control the initiation of every sample properly but the management of such control is not realistic for a manager. Thus since the cost of operation is not low, the instance grid method requires a system that operates the grid automatically. In addition, it is necessary to distribute the tasks among the instances properly. If the congestion is causing an input/ output bottleneck, the entire cloud efficiency will be reduced. Since the instance grid method depends on the load distribution, it is better to use it when the total load is distributed [15].

The proposed method

As mentioned in the node grid method if the total load method is used, the efficiency will increase because this number of tasks is not limited by the number of cores. Also when the total load is used, the grid middleware can analyze the utilization of resources. On the other hand the problem with the instance grid method is that the necessity to control the proper initiation of each specimen is not realistic. Also the operating cost of the instance grid method and in case of congestion decreases cloud efficiency. Thus according to the abovementioned factors and comparisons carried out between the two stages of the instance and node grids, in this method the node grid method is used to create the educational cloud.

3. Methodology

In the simulation two separate projects have been created. The first project implements an educational cloud by grid on cloud method.The second project performs an educational cloud in the usual way and without the involvement of the grid. Both projects used absolutely identical simulation environment. To implement grid on cloud method normally the middleware such as BOINC are used but due to the impossibility to create the natural conditions of work, in this implementation it has been attempted to perform the task of the grid middleware by simulation.

In both projects first the initial values are determined. Thus the number of the data centers is determined and equalized with 1. Then the number of users is determined and equalized with 1. Then the host machine is defined and a host machine is built. In the next step the virtual machines are defined and four virtual machines are created. Now it is time to define tasks. The tasks to be performed should be sent to the educational cloud, in both projects the number of tasks is equal and the duration of the tasks are equal as well. In this simulation both projects are implemented 5 times with 10, 20, 30, 40 and 50 tasks and after each replication the evaluation criteria were recorded and compared with each other.

For the scheduling sector in the second project the scheduling algorithm is written in common way and after defining the initial parameters. But the situation is different in the first project. In the first project the grid on cloud method is used. As noted earlier in this study the node grid method is used in the implementation of the grid on cloud. This means that the node controller is responsible for resource management which is the same as the host operating system. Therefore in addition to CloudSim classes, the grid classes are added to the project and then entered to the Host class and its scheduling and resource allocation algorithms are written.In fact, scheduling tasks and resource allocation instead of being performed by the virtual cloud monitor is assigned to the node controller by a sub-program which is written in the location of the node controller.

4. Results and Analysis

The simulation is performed for two separate projects. All works are done by netbeans software Version 7 through CloudSim simulator. The system has the IntelCoreI3-370M processor with 4 GB of RAM memory. The first project is to implement an educational cloud using the grid on cloud method of node grid type which is the model proposed by this study. The second project is the implementation of an educational cloud by common method. Conditions of the simulation parameters in both projects are the same and based on Table I.

In the conducted simulation there is a physical machine as the host with a processor on which four virtual machines are created. The applicable bandwidth between machines is considered between 1,000 and 2,000 Mbps. Each machine computing power is between 500 and 2000 million instructions per second. The time limit of the tasks is considered between 100 and 1500 milliseconds. Each of the projects is implemented 5 times with 10, 20, 30, 40 and 50 tasks and the results of both projects are evaluated and compared each time.

Table 1. Parameters' Conditions

The Number of VM's	Bandwidth	Each machine computing power	Number of tasks	The length of the tasks	The number of processors
4	1000-2000	500-2000	10-50	100-1500	1

The criteria evaluated after each performance include:

- The average time to perform the tasks
- The cost of implementation of the tasks
- The cost of providing service to the service provider
- Imbalance coefficient

Now the criteria are analyzed and compared after the implementation of the project

4.1 The First Test: Comparing the Mean Time to Implement the Procedures

In the first test the efficiency of educational cloud with grid on cloud method in the average run time of the tasks with similar parameters is compared with the cloud method. With 10, 20, 30, 40 and 50 tasks the cloud method implements the tasks with the average run times of 2.34, 3.53, 5.45, 7 and 8.6 seconds and the grid on cloud method implements the tasks with the average run times of1.99, 3.26, 4.97, 6.50 and 8.10 seconds respectively. As it can be observed the grid on cloud method has better execution time than the cloud method alone.

In Figure.2.the chart comparing the average time to implement the tasks in both methods is presented. As it can be observed although by changing the number of tasks in some cases the average implementation of tasks are close to each other (eg, when number of tasks is 20) but the grid on cloud method has a better performance and has better average run time.

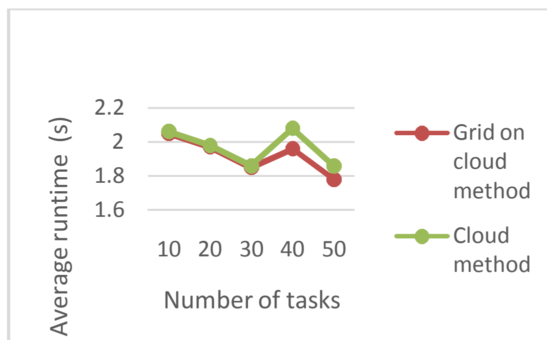

Figure 2. Comparing the runtimes

4.2 The Second Test: Comparing The Running Costs of Tasks

In the second test the grid on cloud method efficiency in terms of running costs with the same parameters is compared with the cloud method. The running costs criterion is discussed from the viewpoint of the user such that with reducing the run time in the cloud environment, the cost received from the user is reduced and in fact the cost criterion of implementing the tasks, earning and benefit is considered based on the user perspective. The cost criterion of the implementation of the tasks is obtained by the first test. Thus for each second of implementing the tasks in the cloud environment two dollars is obtained from the user. The cost criterion of the implementation of the tasks is obtained by the equation (1):

$$D*C_t=C_T \quad (1)$$

D: the duration of the task
C_t: the cost of each second of performing the task
C_T = costs of performing the task

With 10, 20, 30, 40 and 50 tasks the cloud method implements the tasks with the average cost of 4.68, 7.06, 10.90, 14.0 and 17.20 dollars and the grid on cloud method implements the tasks with the average cost of 3.98, 6.53, 9.94, 13.00 and 16.20. As it can be observed the grid on cloud method has lower run cost than the cloud method.

Figure.3. also compares the running costs of the tasks in both methods. As it can be observed although by reducing the number of tasks in some conditions the costs of both methods are close to each other (eg, when number of tasks is 20) but the grid on cloud method has a better performance and has lower cost.

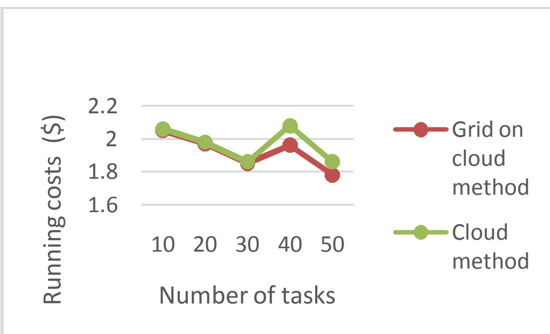

Figure 3. Comparing the running costs of the tasks

4.3 The Third Test: Comparing the Cost of Providing Service to the Service Provider

In the third test the grid on cloud method efficiency in terms of cost of providing service to the service provider with the same parameters is compared with the cloud method. It is assumed that each resource has certain cost for the service provider.The grid on cloud method attempts to increase the earning of the provider by implementing the tasks on more expensive machines (it is assumed that some machines have higher costs for the provider and some have higher costs). As it can be observed for the virtual machines 0-3 the cost of providing service is considered 2, 510 and 4 dollars. It should also be noted that these costs are typically associated with the processing speed of the machines and as the machine processing speed is increased, the cost is higher. To examine the test the time of the virtual machine works is multiplied by the cost it has for the provider and then the resulted values are compared with each other.

It should be noted that in simulation operation for each of the tasks the simulation operation is repeated 10 times and the average results are compared. With 10, 20, 30, 40 and 50 tasks the cloud method has the costs 85.06, 309.46, 685.81, 1344.88 and 2113.79 dollars and the grid on cloud method has the costs 83.85, 308.93, 653.88, 1183.2 and 1792.45 for the service provider respectively. As can be seen with 10 and 20 tasks the evaluation results are not much different, but with the increasing number of tasks and when the tasks reach 50 the results are more different. Thus it can be observed thegrid on cloud method has lower and better service cost than the cloud method.

In Figure.4.the chart of providing service in both methods is presented. As it can be observed, at the beginning that the number of the tasks is low, the results are very close to each other but as the number of the tasks increases the difference is significant. At the end of the chart it can be observed that the grid on cloud method performs better and has lower service cost.

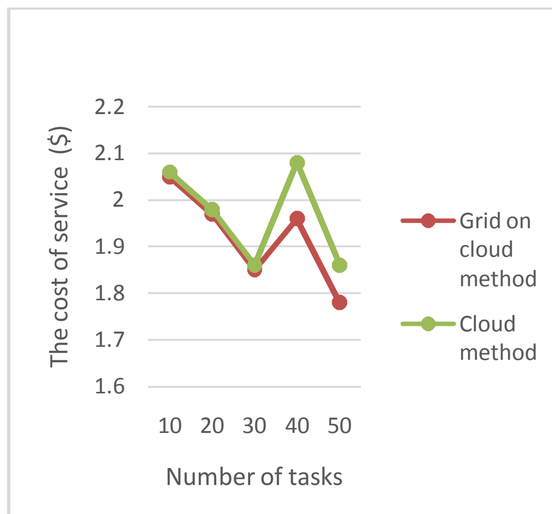

Figure. 4. Comparing the cost of service for the service provider

4.4 The fourth Test: Comparing the Imbalance Coefficient

In the fourth test the grid on cloud method efficiency in terms of the imbalance coefficient with the same parameters is compared with the cloud method. Since the source computational power and the length of the task are the criteria, the difference between the minimum and maximum implementation of the tasks and the average is very low and the imbalance coefficient has lower value than the cloud method. With 10, 20, 30, 40 and 50 tasks the cloud method has the imbalance coefficients 2.06, 1.98, 1.86, 2.08 and 1.86 and the grid on cloud method has the imbalance coefficients 2.05, 1.97, 1.85, 1.96 and 1.78 respectively. As it can be observed with 10, 20 and 30 tasks the evaluation results are not much different but with the increasing number of tasks and when the tasks reach 50 the results are more different.

Figure.5. presents the comparison of imbalance coefficient in both methods. As it can be observed at the beginning that the number of the tasks is low, the results are very close to each other but as the number of the tasks increases the difference is significant. At the end of the chart it can be observed that by increasing the tasks to 50 the difference in imbalance coefficient changes slightly but in all chart the grid on cloud method has better imbalance coefficient than the cloud method.

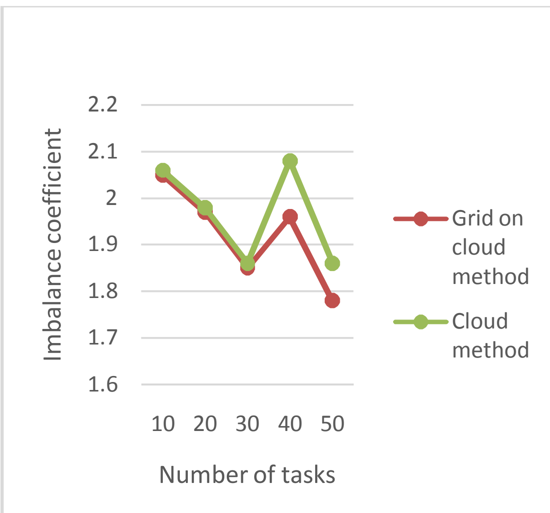

Figure. 5. Comparing the imbalance coefficient

5. Conclusion

In this chapter the grid on cloud method was compared with the cloud method in three tests on a virtual education class and the results were presented as four different tests. As it was observed, the grid on cloud method outperformed the cloud method at all tests and thus the efficiency of cloud based educational classes was increased by grid on cloud method.

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