Energy management in virtual machine placement operation by using leach routing algorithm

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Abstract
Today, cloud computing systems are regarded as an achievement based on internet space making use of computer technology. In these systems, by using powerful and affordable processors with the help of a software program called server computation structure, as opportunity was provided to steer data centers toward a vast quantity of computing services. This system is built on the idea of physical machines and how they interact with one another. Since a large volume of data is exchanged in these systems, virtual machines are offered to achieve a better control and management of these physical machines. For this reason, one of the important issues in the course of virtual machine recognition and activation is the application of virtual machine placement, so that the best physical machines can be chosen to perform users' operation accordingly. Therefore, virtual-machine-placement-operation-based control system is able to optimally reduce the amount of energy consumed in a network. Thus, we aim to conduct placement operation by means of Leach routing algorithm in this research. The results obtained from the evaluation clearly indicate the ability of this model to reduce energy consumption in the process of virtual machine placement.

Keywords:
cloud computing, placement, virtualization, virtual machine, leach routing algorithm

1. Introduction

Today, the internet and world of information technology have become a vital part of human life, in that this part is growing and developing every day. For this reason, in live with the increasing growth, problems like dynamic and immediate access, fast processing, power of focusing on organizational projects in an attempt to maintain servers, cost saving, and most importantly the security of stored data have come up. One of the best techniques to overcome such problems is to come up with a structure of dada control known as cloud computing systems. By using the concept of cloud computing, we can steer essential data and programs toward centers offering cloud services in order to reduce cost of investment, operational risks, complexity, maintenance, and increase comparability. Generally speaking, cloud computing systems provide organizations with an opportunity to operate their programs on cloud servers rather than buying a number of servers in order to satisfy computational needs, and simply pay for the amount of their use from this network. What can provide the possibility under cloud context is known as virtualization technology (Catom et al., 2016).

It should be noted that virtualization technology and use of virtual machines are actually the basis of cloud computing systems. The structure of this technique is in a way that virtual machines are run on select physical machines, following placement operation (selection of a proper host for virtual machines). The main purpose of virtual machine placement in cloud computing systems is to optimize the amount of energy consumed in placement operation and to prevent the dissipation of available resources in hardware systems (Makehi and Dahal, 2016).

The important point regarding operation of the machines is that the process of virtual machine placement becomes more complicated as cloud computing environments grow in number every day. For this reason, as we mentioned earlier, we aim to propose optimization parameters for desired energy consumption in virtual machine placement operation and eventually prevent the dissipation of resources of an optimal placement system by means of this research and application of Leach routing algorithm. Leach routing algorithm is able to help virtual machines with optimal use and prevention of resource dissipation in cloud computing centers. This algorithm is also able to run virtual machine placement via clustering operation.

2. Virtual machine placement

One of the most important operations in cloud computing systems is the problem of virtual machine placement, because it is the technique by which we can determine the best physical machine to perform user operation. Today, due to an increase in the complexity of cloud computing systems, virtual machine placement operation has taken on special importance (Majhi and Dhal, 2016). In general, the problem of virtual machine placement consists of three parts namely placement, virtual machine, and virtualization. In what follows, these parts are addressed.

2.1. Virtualization

Virtualization operation distinguishes hardware from software and has advantages such as server consolidation

Manuscript received July 5, 2017
Manuscript revised July 20, 2017

and migration. As a matter of fact, virtualization is a technique by which multiple operating systems are run simultaneously on a single virtual server. This technique has many uses in new data centers and includes benefits such as application isolation, resource sharing, fault-tolerance, portability, increased system efficiency, and finally cost reduction.

Generally, virtualization technique is used for its remarkable saving in the cost of a CSP at various levels including software virtualization, storage systems, external/internal systems and finally servers. In general, virtualization does not violate the traditional law "one application, one server", yet it is a technique by which multiple operating systems can be run at a time on a single server. [Fig. 1] represents the components of virtualization technique.

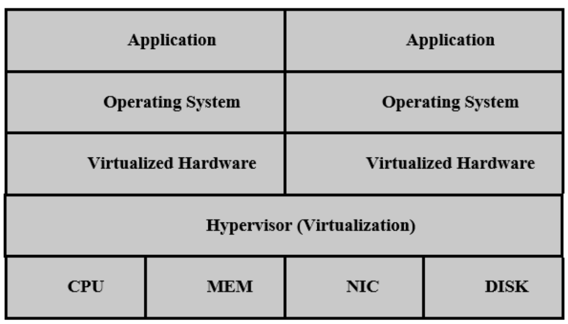

Fig. 1 Components of virtualization technique

2.2. Virtual machine

In general, virtualization technique classifies physical resources of each server into multiple virtual machines with different operating times. The purpose of converting physical resources into virtual machines is to increase flexibility and accessibility of resource management, because this technique would lead to the optimal use of resources. It should be noted that the process of the optimal use of resources is only undergone on physical machines (server consolidation) by virtual machine sharing. These machines have different characteristics including resolution and separation of applications, mobility and ease of test. In general, virtual machines are divided into two types, processor and system. But after all the purpose of both types is to improve the process of using resources, simplify, increase security, reduce complexity, comparability, etc. [Fig. 2] represents the layer architecture of virtual machine.

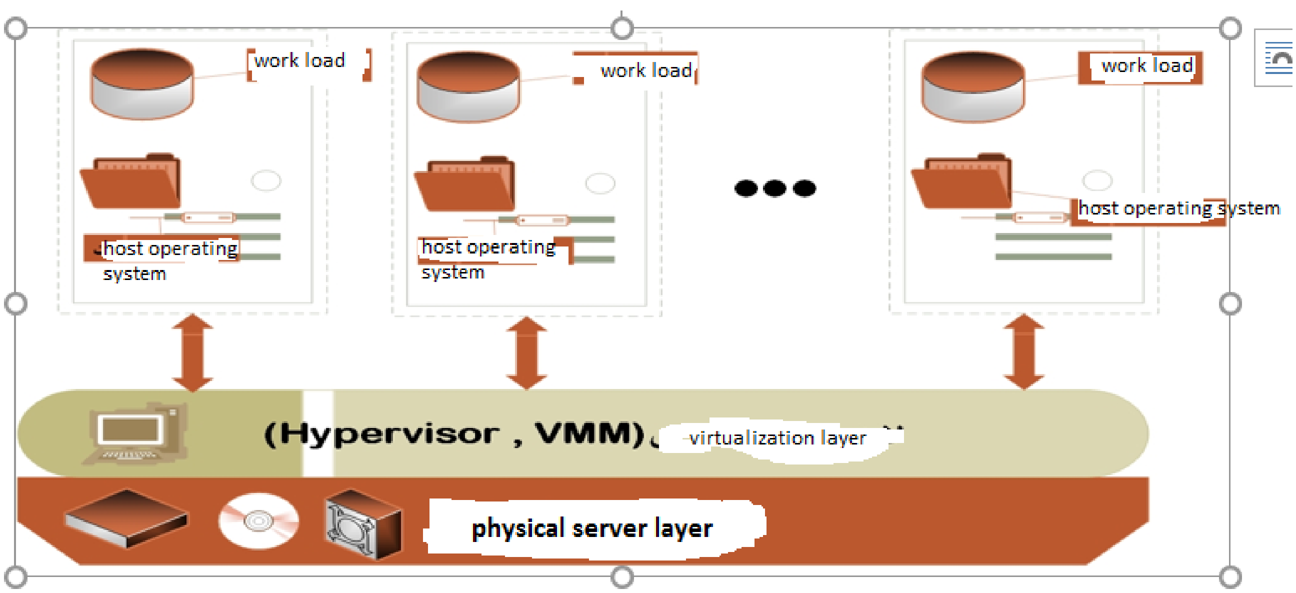

Fig. 2 Layered architecture of virtual machine

2.3. Virtual machine placement

Due to increased complexity of cloud computing systems, virtual machine placement takes on special importance. In general, in dealing with placement, a variety of goals are concerned, namely reduction of consumption power rate, reduction of the number of physical machines used in network, reduction of resources dissipated, and rise of general system performance intended by cloud environment providers. Virtual machine placement operation is generally undertaken in order to find the best physical machine for placement of host virtual machine. These operations are critical operations because they are taken to determine the most suitable physical machine or server for virtual machine in question. Overall, virtual machine placement operations are performed in two ways, direct and indirect (based on migration operation). Thus, each proposed model with greater mobility benefit will be eventually chosen as placement model. As a result, in order to apply placement pattern, we need to check out three main factors in a network;

1- maintain adequate resources for acceptance of new virtual machines

2- find new capable host with adequate capacity of accepting a target virtual machine

3- speed up virtual machine placement by replacing migration operations

3. Related works

Virtual machine placement operation is seen as one of the most important issues discussed in the process of cloud computing. For this reason, researchers have offered various models and techniques to operate virtual machine placement until now. In general, main challenges relating to cloud computing networks are load balancing, identification of a proper place, and management of access to resources. Hence the analysis of essential energy rate for these system is considered a suitable technique of running virtual machine placement operation (Choudhary, et al., 2016).

In Erol and Iftar (2016), a method was proposed for a desirable stability (change of system stability in time-delay mode), which is based on continuous pole placement algorithm. Although this algorithm is based of continuous placement in static feedback state, these researchers managed to use it for a dynamic feedback. If we can optimally and immediately satisfy the needs such as load balancing, quality level of service providing, and reduction of operation costs in the course of virtualization and offer good maps for doing this operation, we can perform placement operation properly.

In Quttouma et al., (2016), a smart system based on mapping performance of CSPs is offered. Among the important characteristics of cloud computing, discussion of network security comes along. Thus, in Majhi et al., (2016) an automatic system was configured to ensure security in cloud environments. The purpose of this research is to increase the security of placement operation and security of cloud environment per se. reduction of energy consumption in cloud computing networks on large scale can increase unacceptable error in a network. Therefore, cloud computing networks require modification of energy consumption pattern of active physical machines. (Osmani and Sing, 2016) addressed techniques of energy consumption reduction.

One of the optimization algorithms for the problem of optimal energy reduction is adaptive three-threshold energy-aware algorithm, ATEA. According to this algorithm, datacenter is divided into four classes. Moreover, BinPacking technique is able to provide the least number of objects required for cloud computing network. Since this algorithm is able to strictly detect the location of resources and physical machine, so it can increase the level of system efficiency and productivity (Kaaouache and Bouamama, 2015).

4. suggested method

As we said from the beginning, virtual machine placement is an optimal way to improve energy consumption and control available resources in cloud computing systems. For this reason, a variety of methods were proposed to set up placement systems in cloud environments. We aim to propose a placement system based on leach routing algorithm. The foregoing routing algorithm takes some existing nodes (physical machines) in a network as virtual machine (cluster head).

However, for applying this algorithm, the network is divided into a few clusters, in that all physical machines have equal chance to be chosen as cluster head for this state. The activity of the algorithms is based on determination of Euclidean distance and cluster head selection. Therefore, having determined and enlightened virtual machine (cluster head), target physical machine is chosen to perform virtual machine placement operation by determining distance between physical machines in the cluster in question and active virtual machine. Equation (1) represents how distance in each clusters is calculated.

Equation (1) $distance(i) = \sqrt{(VM(i).x - PM(i).x)^2 - (VM(i).y - PM(i).y)^2}$

Where;

$VM(i).x$= point x relating to active virtual machine

$PM(i).x$= point x relating to physical machine

$VM(i).y$= point y relating to active virtual machine

$PM(i).y$= point y relating to physical machine

In general, Leach routing algorithm has four basic steps for clustering and activating virtual machine and identifying optimal physical machine.

- proposal phase (randomly introducing machines for CH selection).

- cluster formation phase (creating clusters from available machines for CH)

- timing phase (essential timing for activity of active CH)

- transfer phase (transferring information from CH to physical machine)

One of the most important factors in the application of leach routing algorithm in order to propose an optimal placement system is prevention from imposing high load head (algorithm with quantitative lead head) to network, because there is no need for a heavy routing table. The weakness of this algorithm is revealed when available physical machines are likely to be chosen as target physical machine with great distance from virtual machine. Thus, for fixing this problem, we used the process of calculation of remaining capacity level and clustering based on receiving separated requests (separation of requests in accordance with the volume of requests). In the end, we managed to propose an algorithm based on combination of leach routing algorithm and separation process of submitted requests in order to perform virtual machine placement operation.

5. Result evaluation

In the present research, we managed to offer a model of virtual machine placement by applying Leach routing algorithm and controlling way of message delivery operation in clouding computation environment. In what follows, we address the results obtained from the factors the number of submitted request, the number of received message, and rate of network energy consumption. [Table 1] represents data relating to the simulation of placement systems proposed in this research.

Table 1: Information about simulation

number	factor
100*100	Network dimension
50	Number of physical machine
random	Type of physical machine position
50150-100-	Number of execution
0.27778 w	Energy consumption for each packet

5.1. Number of submitted requests

According to [Table 3], it is evident that Leach routing algorithm proceeds with its operation in accordance with six different clusters. Given the form of the request sent to the network, it reaches the minimum level in cluster 2 and the maximum level in cluster 4 for three different executions of network. However, the important point to make is that the number of the increase and decrease of the submitted request is not the reason for the decrease or increase of energy consumption rate for each cluster, because there is no agreement between the number of the submitted request and the number of the message received for each cluster. [Table 2] represents the numerical information on the number of request sent to each cluster.

Table 2: Numerical information about the number of request submitted to network

Cluster 6	Cluster 5	Cluster 4	Cluster 3	Cluster 2	Cluster 1	Title
39	48	77	65	24	40	**50 executions**
80	93	137	119	61	100	**100 executions**
117	132	206	185	87	158	**150 executions**

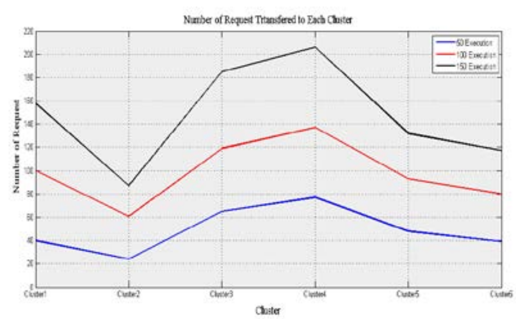

Fig. 3 Number of request submitted to network

5.2. Number of received message

One of the factors influencing the increase or decrease of energy consumption rate for each physical machine is the amount of message received by them during network execution. Now, given (4), it is evident that the minimum and maximum numbers of received packets are attributed to cluster 2 and cluster 5 respectively, though according to [Fig. 3] the maximum number of submitted request is attributed to cluster 4. Therefore, it can be easily said that the maximum rate of energy consumption for each three network execution is attributed to cluster 5. [Fig. 4] represents the output number of received message for each cluster. Moreover, [Table 3] also represents numerical information about the number of message received by network.

Table 3: Numerical information about the number of message received in a network

Cluster 6	Cluster 5	Cluster 4	Cluster 3	Cluster 2	Cluster 1	Title
496	605	566	473	72	116	**50 executions**
1014	1182	1012	873	181	301	**100 executions**
1483	1678	1540	1353	246	471	**150 executions**

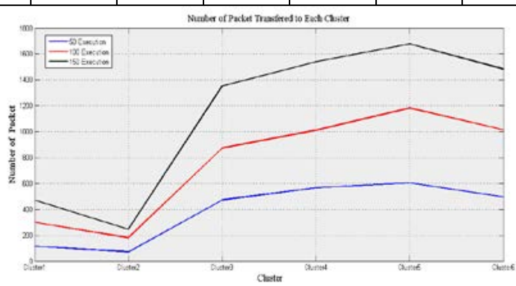

Fig. 4 Number of message received in a network

5.3. Rate of energy consumption

As mentioned from the beginning of the research, the factor energy consumption rate is regarded as the main and most important factor in examining performance of virtual machine placement operation. Given [Fig. 5]. And what was said in the previous section (3.5), it is clearly evident that cluster 2 used the least energy rate, as cluster 5 used the maximum energy rate in the course of the three-fold executions. However, it is evident that energy consumption rate is directly linked with the number of execution message and the number of network execution time. Thus, the output proposed by [Fig. 5] clearly represents how the purposed model works. Moreover, [Table 4] represents numerical data about energy consumption rate in a network.

Table 4: Numerical information relating to network energy consumption rate

Cluster 6	*Cluster 5*	*Cluster 4*	*Cluster 3*	*Cluster 2*	*Cluster 1*	*Title*
/7778 137 W	/0556 168 W	/2222 157 W	/3889 131 W	20 W	/2222 32W	**50 executions**
/6667 281 W	/3333 328 W	/1111 281 W	/5000 242 W	2778 50/ W	/6111 83W	**100 executions**
/9444 411 W	/1111 466 W	/7778 427 W	/8333 375 W	3333 68/ W	/8333 130 W	**150 executions**

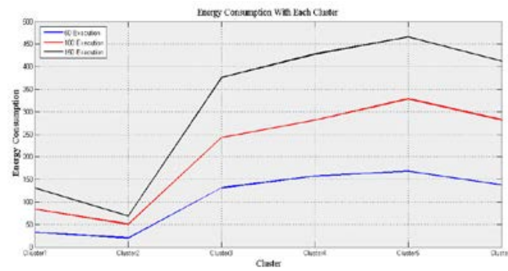

Fig 5. Network energy consumption rate

6. Conclusion

The aim of conducting this research was to come up with a model of virtual machine placement based on Leach routing algorithm in order to provide energy consumption management of cloud computing networks. For this reason, we assumed that Leach routing algorithm and submitted request separation technique are able to control the rate of energy consumption of virtual machine placement operation as optimal as possible and keep it at optimal level. Therefore, we analyzed this network on the basis of three factors namely number of submitted request, number of received message, and energy consumption rate. According to the results, it is evident that the more the number of network execution and the time of network execution, the more the rate of energy consumption will be. [Fig. 6] represents the overall state of energy consumption for virtual machine placement. Moreover, [Table 5] also represents information about three main factors in virtual machine placement.

Table 5: Numerical information about three main factors of network

Total rate of energy consumption (W)	Total number of received message	Total number of submitted request	Title
W 646/6667	2328	293	**50 executions**
W 1267/5000	4563	590	**100 executions**
W 1880/8332	6671	885	**150 executions**

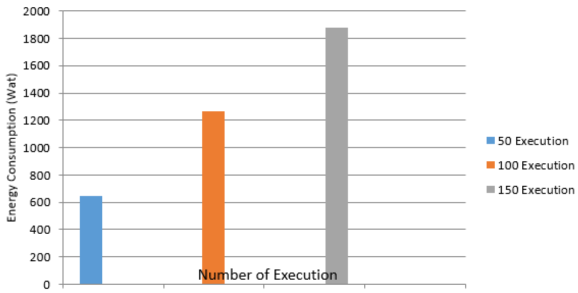

Fig. 6 Total rate of network energy consumption

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