Journal of Theoretical and Applied Information Technology
28th February 2018. Vol.96. No 4

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

QOS-DRIVEN MIGRATION SCHEME BASED ON PRIORITY IN CLOUD COMPUTING

[1]A-YOUNG SON, [2]EUI-NAM HUH
[1,2]Kyunghee University, Department of Science and Engineering, Korea
E-mail: [1]ayths28, [2]jhonhuh@khu.ac.kr

ABSTRACT

Migration used many areas like resource management in cloud computing environment. Numerous schemes of resource scaling based on migration are designed in the Cloud Data Center (CDC) s. However, cloud service providers (CSPs) have not yet provided sufficient efficiency to meet user requirements such as energy efficiency, performance and cost. Furthermore, most of the previous researches did not consider the multi-metric. Thus, we have to consider combining decision method with Fuzzy and AHP for multi-metric. The simulations show that the hierarchical migration scheme is necessary to meet user requirement. In this paper, we proposed migration scheme based on priority in cloud computing. We also performed resource scaling based on fuzzy system and analyzed effect of metric to maximize energy efficiency. Finally, we demonstrated the proposed method by using different migration strategies.

Keywords: *Cloud computing, Resource scaling, Analytical Hierarchical Process (AHP), Fuzzy, Multi-Criteria Decision Making (MCDM), Data Center*

1. INTRODUCTION

Development of huge Cloud Data Centers (CDCs) has led to enormous energy consumption. Thus, it is necessary for data centers to periodically resource scaling for VM. For this reason, numerous schemes of resource scaling based on migration method are designed in the CDCs. However, cloud service providers (CSPs) have not yet provided sufficient efficiency to meet user requirements such as energy efficiency, performance and cost. The performance that migration takes depends on multi-metric like the resource utilization, and latency. In addition, most of the previous researches did not consider the multi-metric such as server state transition, and power.

Moreover, the existing resource scaling schemes have some challenges in QoS perspective such as high migration time, high consumption, and user low satisfaction.

Challenge 1. Consider only one or two objective of VM when resource scaling.

VM scaling techniques have been developed that seek to minimize cost [2], to maximize energy efficiency [1], to maximize performance and to meet SLAs. . In most of the mentioned related works, only one or two objective of VM are considered. For example, [3] and [4] mainly focus on availability and cost, while [5] focus on capacity, access frequency, and performance.

However, in order to meet user requirement, we should also be concerned with multi-metric according to multi-objective. To solve these challenges, we devise a novel optimal resource-scaling scheme considering relation of multi metric.

Challenge 2. how to rank based on these metric.

This is a problem of Multi-Criteria Decision-Making (MCDM) [6]. Each individual parameter affects the VM selection process for resource scaling its impact on overall ranking depends on its priority in the overall selection process.

Virtual machine scaling decisions can involve tradeoffs, for example, between energy and customer satisfaction, so methods implicitly or explicitly seek to meet an objective.

To address this problem, we propose an Analytical Hierarchical Process (AHP)-fuzzy based priority mechanism to solve the problem of assigning weights

In this paper, we propose to maximize energy efficiency while saving cost, by making scaling decisions. We also provide the relation of metrics to maximize energy efficiency according to previous

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

research analyzation for resource scaling and evaluation of proposed scheme

The contribution of this paper is as follows:

- Proposal of Resource scaling architecture and method based on fuzzy-AHP

- Categorization and evaluation of metrics that may influence multi-objective

Organization of the paper is as follows: In Section 2 provides information about related work on previous approaches solving some part of the problems. In Section 3, we propose architecture and migration method for resource scaling. Section 3 describes the scheme with its key components. Section 4 shows how metrics for various quality attributes can be modeled. Section 5 presents the priority mechanism that is explained by a case study example in Section 6 and finally we conclude this paper with future work

2. RESLATED WORK

2.1 Migration scheme in previous work

Live migration allows VMs to be moved between physical hosts in response to changing of workloads, therefore CDCs can have a dynamic infrastructure which can be built by virtualization technology pools and by allocating these resources on-demand or resource utilization. The purpose of most migration schemes [1~15] is to offer an resource management scheme with the minimum time. Regrettably, these schemes could lead to degradation of performance.
Table 1 shows a categorization of previous studies that are proposed for migration in cloud datacenters. As shown Table 1, migration schemes for only one or two objective of VM are considered.

Table 1 migration scheme in cloud computing

	Objective	Limitation
[1]	Maintained performance	the use of global searching without considering existing VM migration
[2]	Minimize the power consumption and cost	migration trigger may incur unnecessary migration
[3]	Minimization energy consumption while satisfying SLA	not clear about destination selection policy
[4]	Optimize total utility	search space may be extremely large
[5]	Optimize power cost	does not optimize power consumption
[6]	Eliminate hotspots	does not optimize power consumption
Common with our work	Consider power consumption when migrating VMs	
Difference from our work	Maximize efficiency according to objective	need to more research and evaluation considering various environment

2.2 Method of MCDM: Multi-criteria decision-making

To solve this limitation, we proposed migration scheme based on Multi-Criteria Decision-Making (MCDM) [6].
This method useful when the decision is applied in practice. Each individual metric affects the VM selection process for resource scaling its impact on overall ranking depends on its priority in the overall selection process. As shown Table, There are many MCDM.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 2 MCDM scheme

	Scheme	Output
Multi-criteria decision-making (MCDM)	ANP/AHP	Weights of alternatives
	Outranking – ELECTRE	A subset of alternatives
	SAW	Evaluation value of alternatives
	TOPSIS	Weights of alternatives
Multi-criteria optimization	Greedy	Near optimal services
	Matrix factorization	QoS estimation and a set of recommended services

A famous MCDM method , Analytical Hierarchy Process(AHP), used in many areas due to the ability to decision of alternative according to weight, in the order to conflicting objectives [9].
Researches has been successfully employed AHP in selection of one alternative from many area such as resource allocation, forecasting, and management of QoS as shown table 2.

2.3 Rating method based metric

MCDM method used widely based on multi metric in cloud computing.
Priorities for different alternatives and according to criteria judges the alternatives.
Initially priorities are sets according to importance to achieve the goal, after that priorities are derived for the performance of the alternatives on each criteria, these priorities are derived based on pair-wise assessments using judgments, or rations of measurements from a scales if one exists[16].

Table 3 rating method based on AHP

	Rating method	Metrics
[8]	AHP	Cost-control
[9]	AHP Fuzzy TOPSIS	Resource speed Storage capacity Availability Reliability Scalability Latency Throughput
[10]	Fuzzy	Accountability Agility Assurance Cost Security
[11]	Hybrid ANP	Accountability Agility Assurance Cost Security

2.4 Migration metric according to objective

Migration contributes to efficient resource management. In addition, It is used in many areas such as power reduction and server performance maintenance in Cloud Data Centers (CDCs).
To present scheme based on multi-metric, we categorize for previous studies according to objective, strategy metric
There are mainly two objective and their strategy that may participate in the decision process of migration and hence may affect the performance of cloud system.
For example, Minimizing time Strategy has some metric like transferred pages, network traffic, bandwidth, waiting time, number of migration, power and memory capacity are the metric of migration as shown table

Table 4 Categorization of Migration objective with metric

Objective	Strategy	Metrics
Performance efficiency	Minimizing time	Transferred pages
		Network traffic
		Bandwidth
		Waiting time
		Number of migration
		VM execution time
		VM RAM workload
	Increasing resource utilization	Resource utilization Response time
	Load balancing	Resource utilization

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

	Improving Reliability	Scalability
		Throughput
		Response time
Power consumption	Increasing resource utilization	Number of migration
		Running server/VM
		Resource utilization
		Power consumption
		Energy consumption
		frequency
	Reducing Bottleneck	Resource utilization
		bandwidth

Researchers have proposed resource-scaling scheme in cloud computing environment using paradigms like rating method..
In addition, the schemes each consider different metric when determining migration decision

3. PROPOSED SCHEME

3.1 OVERVIEW OF FLOW CHART

The QoS metric based Migration scheme executes the workloads is shown in Fig. 1.

Workload submitted by user. All the submitted workloads are analyzed based on their QoS requirements described in terms of SLA. Workload patterns are identified for better classification of workloads then pattern based clustering of workloads is done. QoS metrics for every QoS requirement of each workload are identified.

Based on level of measurement and other importance of the attribute for service, weights for every cloud workload are calculated. After that, workloads are re-clustered based on Fuzzy based clustering algorithm for better execution. Calculate the value of fitness function (MQos) for every workload then compare it with value calculated (MNon-Qos) by non-QoS (without considering QoS requirements)

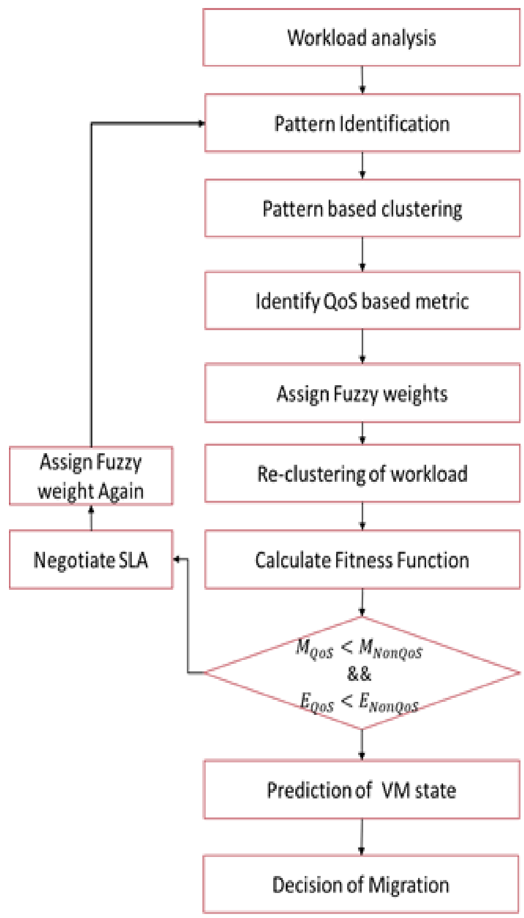

Figure 1 Overview of Flow chart for proposed scheme

$$M_{QoS} = Min \sum_{i=1}^{m} (Cost)_i \; X \; (execution \;\; time)_i$$

$$E_{QoS} = \min \sum (MSE)_i$$

The first layer is the analysis goals, which aims to find the relative service management index of all the Cloud services which satisfy the essential requirements of the user.
The second layer contains hierarchies of QoS attributes, both essential and non-essential. The bottommost layer contains the values of all the Cloud services for all the lowest QoS attributes in the hierarchy presented in the second layer.

3.2 STEP OF DECISION PROCESS BASED ON FUZZY-AHP

Cloud computing might support a several of service types using resource virtualization technology Therefore, a migration method should be considered with regard to diverse service environments and perspectives such as energy efficiency technology, resource management cost. Moreover, in general, the input metric for multi-objective such as performance, energy efficiency, is not limited. It consists of two main modules: Fuzzy –AHP System migration manager

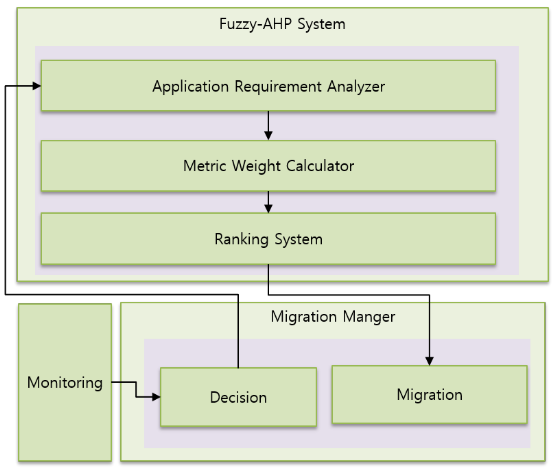

Figure 2 Fuzzy-AHP System

1. Fuzzy-AHP We determines VMs which need to scaling and selection of target machine under the constraint of resource. Fuzzy predicator is a learning module to keep finding adjust rule through resource monitoring. After fuzzy predictor phase, threshold of utilization range is stable through change of learning point.

2. Migration manager is responsible for monitoring the resource status of both virtual machines and physical machines, including the resource utilization, virtual machine configuration information (workload characteristics, VCPU number, memory size, image size) which is essential to make migration decisions. system is designed for making the decision on resource scaling situation whether or not. Depending on inputs: CPU computation, RAM computation, it can control resource scaling based on migration method. We set the relevant algorithms, which can be used to find the VMs which need to resource scaling, and its goal is to meeting QoS requirements which remaining in the physical machine can meet the QoS goal, but also the physical machine can have high resource utilization. It is responsible for making effective scaling decision.
We propose a new migration method that considers metric The proposed migration method follows four steps:

Step has four processes:
(1) Determine the decision table
(2) Construct pair wise
(3) Calculate the weight
(4) Calculate final scores

In this paragraph, we describe the AHP with migration that has shown an entire flow based on fuzzy-AHP method.
Moreover, we describe how to measure the decision. In exploring the optimal migration scheme, this paper will be limited to proposing an AHP design, establishing an optimal migration objective investment strategy, and discussing evaluation according to scenario.

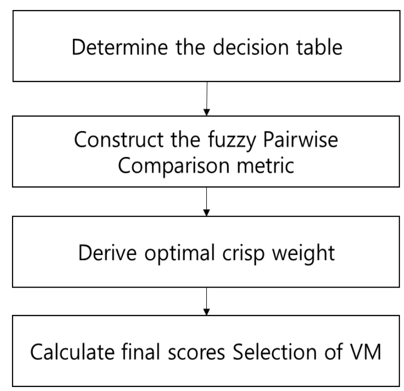

Figure 3 fuzzy AHP flowchart

3.2.1 Phase 1: Hierarchy structure for Migration

To select a VM , the most important step is how to evaluate the strategy. The quantitative migration methods [16]–[19] beyond the scope of the present paper. Therefore, we will just use existing quantitative migration methods, which we do not define to determine VM migration for metric

3.2.2 Phase 2: Computation of relative weights of each QoS and service

The evaluated ranking is reflected by the rationality of ranking scale. A ranking scale is a scale of numbers that indicates how many times more important or dominant one element is over another with respect to the criterion or property with respect to which they are compared. We use the standard Saaty [8] 9 level scales as table 1 shows.

Journal of Theoretical and Applied Information Technology
28th February 2018. Vol.96. No 4

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

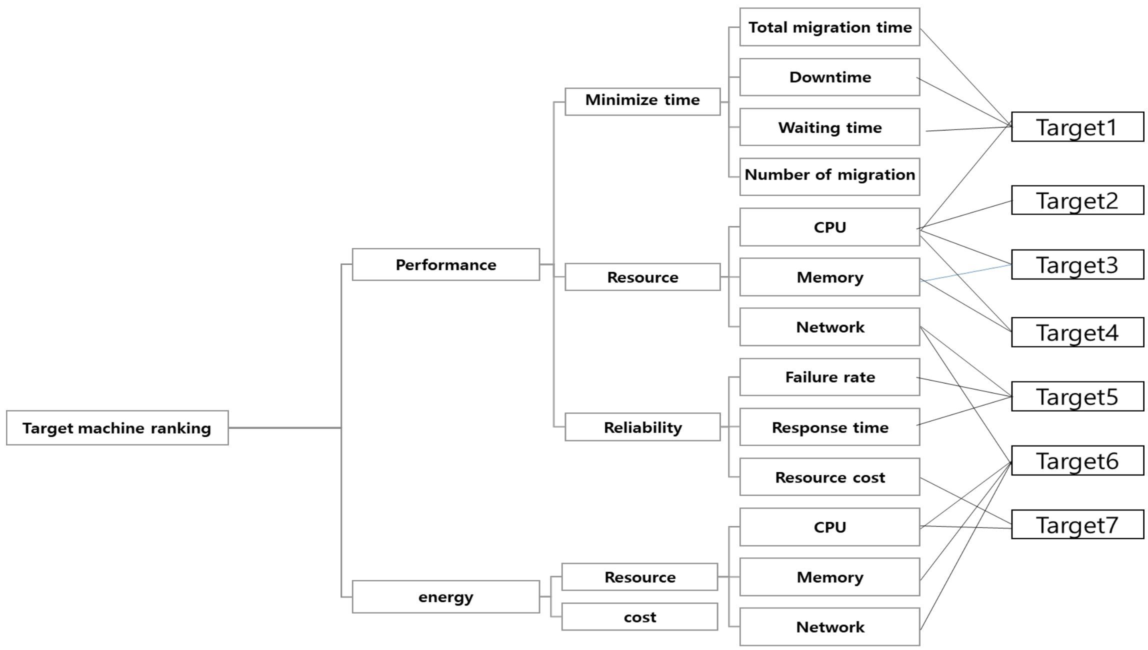

Figure 4 Target Machine ranking

Table 5 Relative value

Relative-importance	value
Equal importance/quality	1
Somewhat more important/better	3
Definitely more important/better	5
Much more important/better	7
Extremely more important/better	9

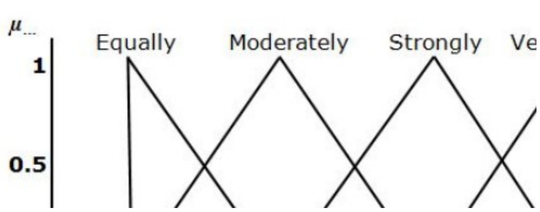

Figure 5 Membership Function of Fuzzy-AHP Relative value

3.2.3 Phase 3: Relative value-based weights for ranking target machine

As mentioned above, there are 5 Metric Energy efficiency: Power, Capacity , resource utilization, Number of VM. Waiting time.

(1) Power(M1): Power increase of allocating a VMs to a PM
(2) Capacity(M2) : Capacity of VM on pM:
(3) Resource utilization (M3), : Resource utilization of VM
(4) Number of VM (M4): Number of VM on PM
(5) Waiting time (M5): The delay incurred due to Migration of VMs to a PM

Here, we use V (value) as the example to show how the weights define. As show table 6, So we get following judgment matrix based equation (1~3)

Table 6 Notation in used paper

Notation	Descriptions
Wn	Sum of weight at Mn
Wm	Weight of Metric m
Mn	Metric n

$$W_m = \sum W_n \quad (1)$$

$$\mathrm{Wn} = \frac{V_{n-1}}{Vn} \quad (2)$$

$$\mathrm{s.t}\max \sum W_m \quad (3)$$

Table 7 defines relative value-based weight our set of policies based on table 5. As shown table 8, we calculate weight

Table 7 relative value –based weight

	M1	M2	…	Mn
M1	V1/V1	V1/V2	…	V1/Vn
M2	V2/V1	V2/V2	…	V2/Vn
,,,,	…	…	…	…
Mn	Vn/V1	V2/Vn	…	Vn/Vn

Table 8 Calculation of weight

Weights
0.254
0.090
0.456
0.047
0.153

4. EVALUATION

4.1 Evaluation Environment

In this section, we compare the energy consumption, execution time according to scenario. In order to avoid some random interference, every simulation is repeated 10 times. The CloudSim simulation toolkit is used for simulating and evaluating the proposed decision approach.
Table 9 defines our set of policies and its metric's importance order. Metrics weights based on each policy are shown in Fig 5.

Table 9 relative value-based weight for migration

	Power	Capacity	Resource utilization	Number of migration	Waiting time
Power	1.000	3.003	0.333	5.000	3.030
Capacity	0.333	1.000	0.200	3.030	0.333
Resource utilization	3.000	5.000	1.000	7.008	3.003
Number of migration	0.200	0.330	0.143	1.000	0.333
Waiting time	0.330	3.000	0.333	3.000	1.000

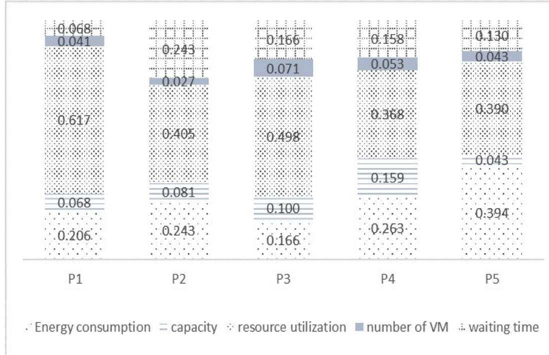

Figure 6 weight

4.2 Case scenario and Result of evaluation

Three different configurations have been chosen for testing loaded data centers:

1. 50 VMs allocated to 50 PMs.
2. Configuration 1.2: 100 VMs allocated to 100 PMs
3. Configuration 1.3: 150 VMs allocated to 150 PMs.

In this experiment, the number of VMs is the same as the number of PMs that they will be allocated to. Two experiments with three each were conducted to evaluate the proposed scheme.
The goal of the first experiment is to test the effectiveness of the solution on lightly loaded data centers while the second experiment tests the solution in more loaded cloud data centers.
These scenarios are considered relevant because we need to be confident that: (i) the opportunities that exist to save energy are exploited in lightly loaded settings, and (ii) adaptation costs and attempts at energy saving do not lead to more SLAs being missed in a heavily loaded setting.

Eventually, an experiment has been conducted to measure the execution time and compare

4.2.2 Execution time for scenario

The Execution time comparison result as the Figure 4 shows. ig. Shows proposed algorithm performs However, with a more complex configuration of 10 metrics and 1000 policies, our algorithm can make a decision over 500 services in less than a millisecond.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

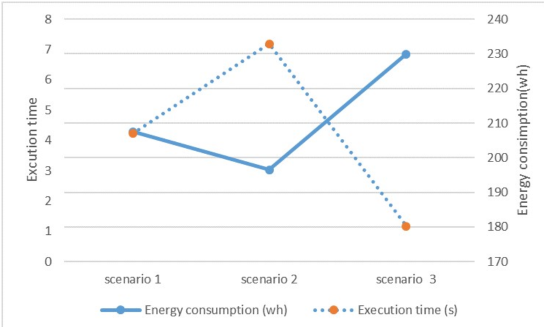

Figure 7 Execution time

4.2.1 Energy efficiency

In comparison to [15] approaches, where the selection is based on static method our proposal can be used with dynamic method.
In addition, unlike these approaches our algorithm allows to change the weight of each metric depending on perdition. [16] Proposes a rule-based service selection algorithm,

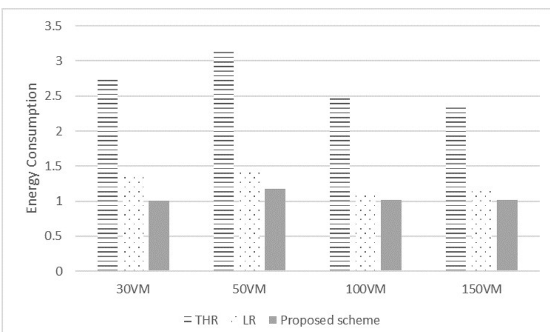

Figure 8 Energy consumption

Furthermore, we create a policy model based on metrics order, in contrast to [16], where the weight of each metric must be specified.
We can see proposed scheme has lower than the other policy. This demonstrates the weights of fitness function change
We try to improve proposed scheme by change the AHP weights.. Here we use the proportion of weight adjustment time in all execution time as the evaluation value to compare the efficiency of proposed scheme.

4.2.3 Predicion error

We defined time interval for resource prediction. And then we evaluated Prediction of error based Table 1. The proposed model is compared with existing works based on history, linear aggression.

Table 10 Time intervals for resource prediction

Time	Interval
T1	<3h
T2	2~6h
T3	7~12h
T4	13~24h
T5	1~3day

Our prediction model showed advantages over the traditional models Our research effort into migration will continue to address some of the issues raised in the dynamic service-provisioning environment. as MSE was several times smaller than those of traditional models. As the prediction step increases, the prediction errors of traditional models increased. Our model's prediction error remained acceptable, which indicates its effectiveness and stable performance

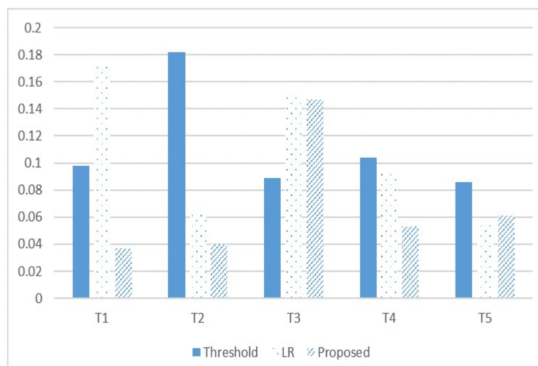

Figure 9 error

5. CONCLUSION & FUTURE WORK

5.1 Conclusion

Development of huge cloud data centers all around the world which has led to enormous energy consumption and In cloud computing [11] users move frequently, thus it is necessary for data centers to periodically resource scaling VMs to improve the resource efficiency of the system.
To meet user requirement and seamless service, we need to periodically resource scaling. This paper has concentrated on migration for resource scaling in CDCs as a solution to tackle with this problem. In order to evaluate the effect of each Policy considered in fuzzy policy separately on output targets.

we also verify that proposed method is the most effective learning strategy between source policy Proposed scheme contribution is as follows.

1) Decision of resource scaling based on multi-metric approach
2) Perform resource scaling through migration method

From the multi-metric, our proposed scheme takes into account how to effectively reduce the power consumption of the cloud data center.

5.2 Future work

According to evaluation result, our proposed scheme is able to efficiently manage the resource and reduce energy consumption in cloud datacenter. However, we need to more research and evaluation considering various environment.

Future work is as follow.

1) Improving resource scaling scheme
Future work is required to improvement of the resource-scaling scheme. In this paper, we considered two scenario based on VM migration scenario. Considering the other method such as consolidation and load balancing, furthermore, proposed scheme requires further study for finding optimal scaling scheme according to service type. For various service type, we will study advanced proposed scheme with various workloads and distributed Cloud data centers.

2) Considering memory and network usage during VM Migration
In this paper, we only considered CPU during VM VM migration. Although the CPU consumes most of the server's power, all other resource should involve.

ACKNOLWEDGEMENT

This research was supported by the MSIT(Ministry of Science and ICT), Korea, under the ITRC(Information Technology Research Center) support program (IITP-2017-2013-0-00717) supervised by the IITP(Institute for Information & communications Technology Promotion)) Corresponding Author is Eui-Nam Huh

REFRENCES:

[1]A. Anand, J. Lakshmi, and S. Nandy, "Virtual machine placement optimization supporting performance slas, " in Cloud Computing Technology and Science (CloudCom), 2013

[2]Carlo Mastroianni.al,"Probabilistic Consolidation of Virtual Machines in Self-Organizing Cloud Data Centers" IEEE TRANSACTIONS ON CLOUD COMPUTING, VOL. 1, NO. 2, JULY-DECEMBER 2013

[3] E. H. Choi, H. S. Hwang, and C. S. Kim, "Electron spectroscopy studies on magneto-optical media and plastic substrate interfaces," International Journal of Information and Communication Engineering, vol. 9, no. 4, pp. 358-362, 2011.

[4] J. L. Hennessy and D. A. Patterson, "Instruction-level parallelism and its exploitation," in Computer Architecture: A Quantitative Approach, 4th ed., San Francisco, CA: Morgan Kaufmann Pub., pp. 66-153, 2007.

[5] A. Hashmi, H. Berry, O. Temam, and M. Lipasti, "Automatic abstraction and fault tolerance in cortical microachitectures," in Proceeding of the 38th Annual International Symposium on Computer Architecture, New York: NY, pp. 1-10, 201

[6] B. Alavi, "Distance measurement error modeling for time-of-arrival based indoor geolocation," Ph.D. dissertation, Worcester Polytechnic Institute, Worcester MA, 2006.

[7] K. Shahzad, A. I. Umer, and B. Nazir, "Reduce VM migration in bandwidth oversubscribed cloud data centres," in 2015 IEEE 12th International Conference on Networking, Sensing and Control (ICNSC), 2015

[8]Z. Ayağ, R. Gürcan Özdemir, Evaluating machine tool alternatives through modified TOPSIS and alpha-cut based fuzzy ANP, Int. J. Prod. Econ. 140 ,2016

[9] S.-J, Chen S.-M, Fuzzy risk analysis based on similarity measures of generalized fuzzy numbers, IEEE Trans. Fuzzy Syst. ,2013

[10] L. Sun, H. Dong, F. Hussain, O. Hussain, J. Ma, Y. Zhang, A hybrid fuzzy framework for cloud service selection, in: IEEE International Conference on Web Services (ICWS), IEEE Computer Society, 2014

[11] Alfazi, T. Noor, Q. Sheng, Y. Xu, Towards ontology-enhanced cloud services discovery, in: X. Luo, J. Yu, Z. Li (Eds.), Advanced Data

Mining and Applications, in: Lecture Notes in Computer Science, vol. 8933, Springer International Publishing, 2014, pp. 616–629.

[12] K. Shahzad, A. I. Umer, and B. Nazir, “Reduce VM migration in bandwidth oversubscribed cloud data centres,” in 2015 IEEE 12th International Conference on Networking, Sensing and Control (ICNSC), 2015, pp. 140–145.

[13] Z. Ayağ, R. Gürcan Özdemir, Evaluating machine tool alternatives through modified TOPSIS and alpha-cut based fuzzy ANP, Int. J. Prod. Econ. 140 (2)(2012) 630–636.

[14] Chen S.-J, Chen S.-M, Fuzzy risk analysis based on similarity measures of generalized fuzzy numbers, IEEE Trans. Fuzzy Syst. 11 (1) (2003) 45–56.

[15] L. Sun, H. Dong, F. Hussain, O. Hussain, J. Ma, Y. Zhang, A hybrid fuzzy framework for cloud service selection, in: IEEE International Conference on Web Services (ICWS), IEEE Computer Society, 2014, pp. 313–320.

[16] J. Gao and G. Tang, “Virtual Machine Placement Strategy Research,” Intl. Conf. on Cyber-Enabled Dist. Computing and Knowledge Discovery,no. 2, pp. 294–297, 2013.

[17] S. E. Dashti and A. M. Rahmani, “Dynamic VMs placement for energy efficiency by PSO in cloud computing,” Journal of Experimental & Theoretical Artificial Intelligence, vol. 0, no. 0, pp. 1–16, 2015.

[18] A. Marotta and S. Avallone, “A simulated annealing based approach forpower efficient virtual machines consolidation,” in Cloud Computing,IEEE 8th Int. Conf. on, pp. 445–452, IEEE, 2015.

[19] E. Feller, L. Rilling, and C. Morin, “Energy-Aware Ant Colony Based Workload Placement in Clouds,” Grid Computing, 12th IEEE/ACM Intl. Conf. on, pp. 26–33, 2011.

[20] X.-F. Liu, Z.-H. Zhan, K.-J. Du, and W.-N. Chen, “Energy aware virtual machine placement scheduling in cloud computing based on ant colony optimization approach,” in Proc. of the conf. on Genetic and evolutionary computation, pp. 41–48, ACM, 2014.