International Journal of Engineering & Technology, 8 (1.7) (2019) 274-281

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Green Cloud Computing: Perspective of Variety Coverage in Pre-Control

Mohd Badrulhisham Ismail[1], Yusnani Mohd Yusof[2], Habibah Hashim[3]

[1]Electrical Engineering Section, University Kuala Lumpur British Malaysia Institute, Malaysia
[2,3] Faculty of Electrical, University Technology MARA, Malaysia
**Corresponding author E-mail: badrulhisham.ismail@unikl.edu.my*

Abstract

In green computing, efficiency is required in consolidating virtual machines without degrading quality of service. This paper presents a study on dynamic VM Resource Allocation to produce lower power consumption and at the same time to optimize the stability. To achieve this objective, a new algorithm is used to calculate on the fly the Lower and Upper Threshold Limit using Statistical concept, and pre-control method is applied in order to optimize the stability of the process. The Pre-Control method sets the pre-control limits on upper and lower specification limits where process capability is based on meeting the conditions of a pre-control chart. The chart determines the type of variation the process is experiencing. Six sigma theories are then applied in order to get the desired range for the threshold limit. The results prove that dynamic VM Resource Allocation with a wider range of Green Region produce a more stable process.

Keywords: *Stability; Cloud Computing; Virtual Machine; Optimizing; Pre-Control Chart.*

1. Introduction

Evaluation of IT technology start back in early of 2000 where it grows rapidly and it begins with the improvement of speed for PC processor, digital photographic, digital visual system and the born of smart phone. It somehow creates a huge demand on keeping those personal important files into mobile storage which is Cloud Computing. Cloud Computing itself can be divided into three important layer which are Software as a service level (SaaS), Platform as a service level (PaaS) and Infrastructure as a service level (IaaS) [1]. Currently at each layer of Cloud Computing itself, there are plenty of famous application online, refer to Figure 1.1. This study will focus on PaaS level, where after Dynamics VM resource allocation take place, the optimization of the stability will execute by applying the Pre-Control concept. Pre-Control is one of the Statistical Process Control (SPC) tools to check the status of a process, and it can manage the variation of the whole process such as when to continue running, adjust a process, or stop and solve a process. By applying the correct setup of the pre-control, running rules and sufficient sampling, it is a powerful technique.
The drastically impact which can be seen on the huge demand for Cloud Computing is that Power Consumption at Data Centre increase tremendously and it is forecasting to increase 76% from 2007 till 2030 [3]. Figure 2 shows where the data taken at Google Data Centre proved that the Server itself contribute the most Power Consumption. Thus by applying the concept of virtualization during Dynamics VM resource allocation and optimize the stability via Pre-Control method is expecting to reduce the Power Consumption at Server level.
The industry is facing the issue on hosting a variety range from small and big, which makes the stability in term of performance is fluctuate and not predictable depending on time varying load. Thus this study proposal optimization on the stability of the dynamics VM resource allocation via pre-control method.

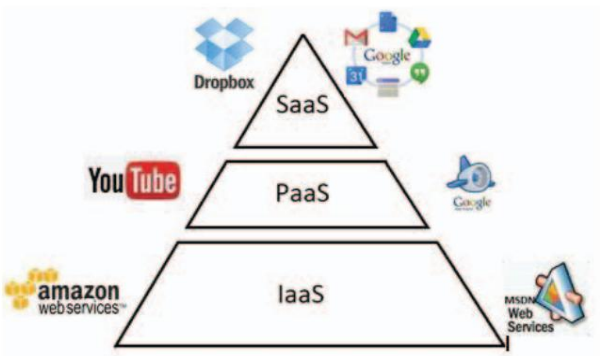

Figure 1: Cloud Computing Layer link to current famous user [2]

This paper presents a pre-control method where the double threshold is calculated based on the Six Sigma process, which defines that if one has six standard deviations between the process mean and the nearest specification limit then, no items should fail to meet specification [4]. This study has provided insights into how Pre Control strategies can help improve stability of the system. In this paper we compare the effect of four Pre Control setting on system stability.

2. Related Works

Figure 3 shows the evolution of research on Cloud Computing done since 2012 till 2015 are more on SLA, Cost, Bandwidth, Dynamics and Optimization. None research to do an improvement on stability for Cloud Computing being execute up to now, and this study is focusing on improving the stability of dynamics VM resource allocation existing system via pre-control concept. However, there are some study being carried out to optimization of single server.

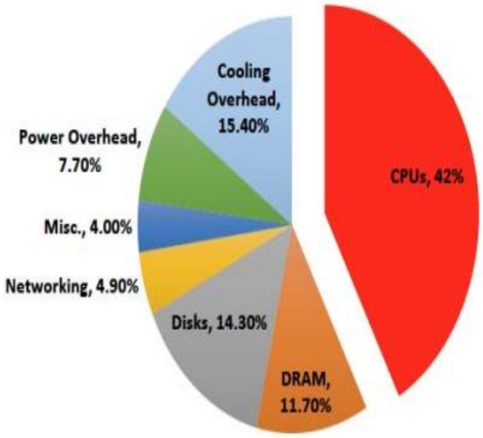

Figure 2: Power Break Down at Google Data Center [5]

Song et al. [6] proposed the optimizing the active server in used, they can achieve an application on demand and also support green computing. They applied bin packing resource allocation algorithm where it can avoid overload occurrence and intelligently adjust the resource available for virtual machine (VM) within and across physical server.
Rocha et al. [7] designed a hybrid optimization model which using VM placement strategies, and it able to optimized the network quality and also reduce energy consumption. According to reliability and quality of any product or system, tool performance consistency is very crucial and vital, in order to meet the standard requirement [8].
Chen et al. [9] developed a concept of double threshold where they define hot threshold as upper limit and cold threshold as their lower limit, and they use a fix value for both of that limit. And as for the thesis, it will apply both static and dynamics threshold limit. Initial the proposed algorithm will set a fix limit, later it will calculate the new threshold limit on the fly by use the concept of Six Sigma technique.
Hussein et al. [10] utilized either single threshold of CPU control limit (THR) or local regression (LR) for over utilizes host detection. They discover that by using single threshold limit, the power consumption is decreasing but it violation in SLA due to increasing the executing time.
Wang et al. discovered by applying double threshold can produce energy efficient, reduce Service Level Agreement[11] and also improve Quality of Service.
Patil et al. [12] presented the Double Threshold Energy Aware Load Balancing (DT-PALB) where the range of the threshold is fix between 25% to 75%. They are aiming to migrate any VM when CPU utilization is not within the range of 25% to 75%. By applying fix DT-PALB, they managed to reduce the energy consumption up to 26.4%.

3. Methodology

Figure 4 shows where this study is utilizing the private cloud data as the input data to the stability optimizer system. A raw data from CPU of single server from private cloud of manufacturing company is used as input data to the propose system.

3.1 Dynamics Resource VM Allocation

This first part of the study will emphasize on creating a dynamics resource VM allocation algorithm where the it uses double threshold concept and those double threshold value will be assign on the fly depending the existing load of the physical server.

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - u)^2} \text{ where } u = \frac{1}{N}\sum_{i=1}^{N} x_i \quad (1)$$

$$\bar{X} = \frac{\sum X}{n} \quad (2)$$

Upper Control Limit: $UCL = \bar{X} + 3\sigma$ (3)

Lower Control Limit: $LCL = \bar{X} + 3\sigma$ (4)

Where N is represents the number of samples used in this study and σ is indicates the standard deviation value. The above equation (1) to (4) show how the double threshold is calculated in the fly using those formula, and it is applying the six sigma method.

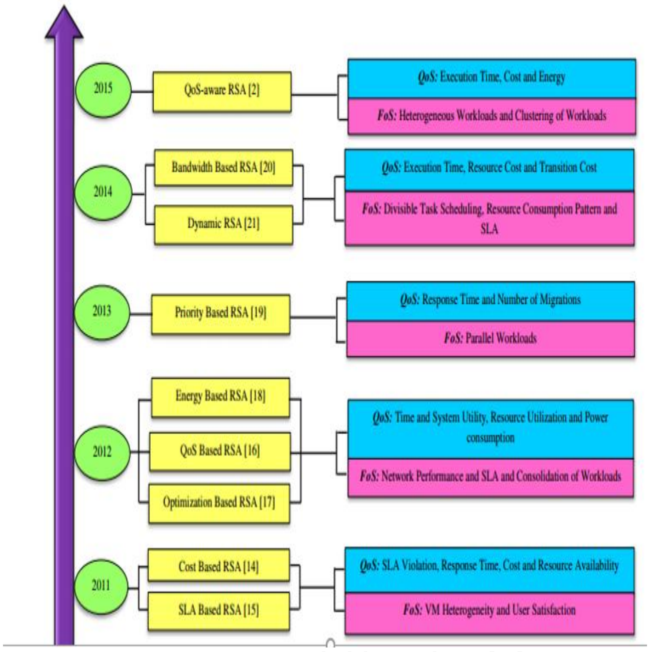

Figure 3: Resource Scheduling evolution [13]

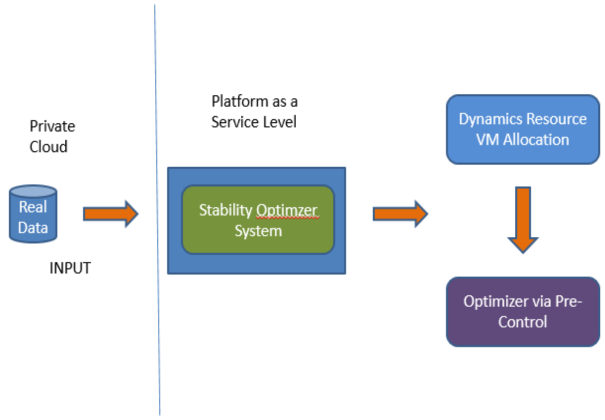

Figure 4: Proposed diagram for Stability Optimizer System

The definition of stable with relate to the power consumption in this study mean that the data of power consumption will sit inside the Green Region, refer to Figure 7. Figure 5 shows the full coverage of Six Sigma will cover nearly 100%. As for the load balancing part, this study considers 4 Modes which applies to sixteen different setting combinations for VM selection and VM Placement as laid out in Table 1.

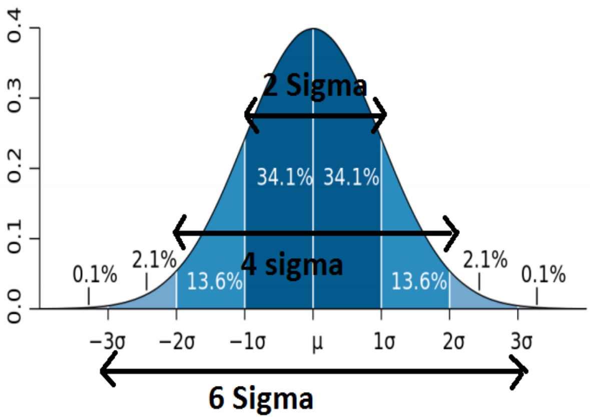

Figure 5: Coverage of Six Sigma

Table 1: Setting of Load Balancing

No	VM Selection	VM Placement
1	MMT	LR
2	RS	LRR
3	MU	MAD
4	MC	IQR

3.2. Optimizer via Pre-Control

The target of this study is to improve the stability of the whole system by utilizing the four different modes of pre-control settings, refer to Table 2 on the different range for each mode.

Table 2: Setting of Coverage for Pre-Control

Mode	Green Region	Yellow Region	Red Region
1	50	30	20
2	70	15	15
3	20	50	30
4	15	70	15

Figure 6 shows in detail how the Stability Optimize operates, and prior to it execution, the dynamics VM resource allocation will take place with the output of achieving final stability data. Then during the pre-control process, the study will select four types of mode in order to get the best stable output.

3.3 Setting of Cloud Sim Environment

In this study, the experimental was done via simulation called cloud sim, thus the setting of Virtual Machine and Data Center is required prior to the testing, refer to Table 3 and 4 for detail setup of the testing.

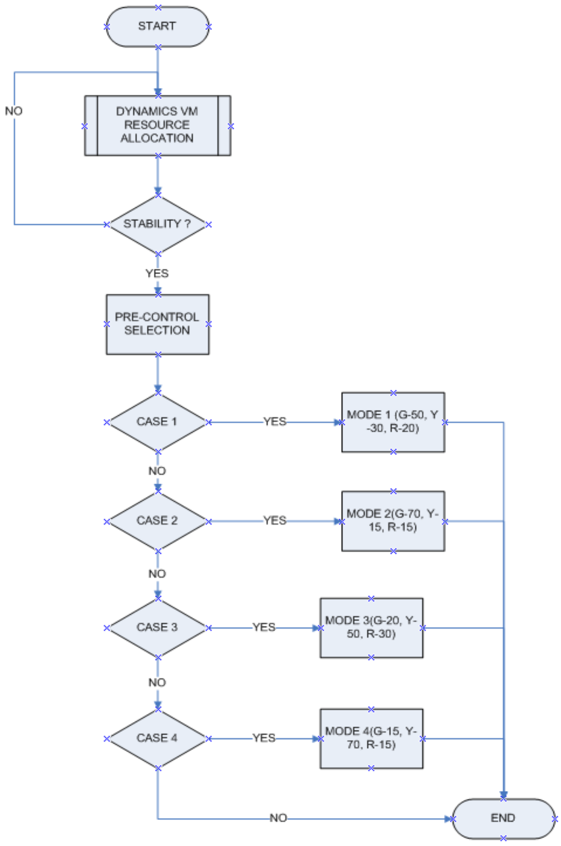

Figure 6: Flow Chart of Stability Optimizer System

Table 3: Setting of Virtual Machine

No	Items	Setting
1	Million Instruction Per Second (MIPS)	250, 500, 750, 1000
2	Number of CPU	1
3	RAM	128 (MB)
4	Bandwidth	2500
5	Image Size	2500 (MB)
6	Name	XEN

Table 4: Setting of Data Center

No	Items	Setting
1	System Architecture	X86
2	Operating System	Linux
3	Name	XEN
4	Million Instruction Per Second (MIPS)	1000, 2000, 3000
5	RAM	10G
6	Bandwidth	100000
7	Storage	1T
8	Max Power	250W

4. Results

Table 5 indicates that data on case of Mode 1 (Green – 50, Yellow – 30, Red – 20), 100% of the Power Consumption resides on the left side or lower part green region. 1 out of 11 combinations (9%) that is MMT/LRR, the power consumption locates in the center, refer to Figure 7. It indicates MMT/LRR produce most stable data of power consumption. On the top of that, 3 out of 11 combinations (27%) which are RS/IQR, MU/MAD, RS/MAD, the power consumption data are located close to the center (Median). Majority of the data which is 7 out 11 combinations (63%) situated at the weak low end of left side, refer to Figure 7.
Result of data for Mode 2 (Green – 70, Yellow – 15, Red – 15), can be seen at Table 6. It shows that 11 out 11 combinations (100%) locates inside green region. 8 out of 11 combinations (72.7%) can be seen at left side of green region and the balance of 3 out of 11 combinations (MMT/MAD, MMT/IQR & MU/LR) locates in the middle which is around (27 %). 5 out of 8 combinations (62.5%) that locates on left side are very close to the middle (Median data), and they are RS/IQR, MU/MAD, RS/MAD, RS/LR & MU/IQR.

Table 5: Range Coverage relation to Power Consumption on Mode 1 (Green – 50, Yellow – 30, Red – 20)

Mode	Low Green	High Green	Status	Power Consumption
MC/LRR	0.44	0.59	Green	0.46
MMT/LRR	0.42	0.59	Green	0.50
MMT/MAD	0.44	0.58	Green	0.47
MMT/IQR	0.43	0.55	Green	0.44
RS/IQR	0.42	0.59	Green	0.48
MU/MAD	0.45	0.57	Green	0.49
MU/IQR	0.41	0.62	Green	0.46
RS/MAD	0.45	0.57	Green	0.48
RS/LR	0.40	0.63	Green	0.46
MC/IQR	0.43	0.63	Green	0.44
MU/LR	0.43	0.58	Green	0.43

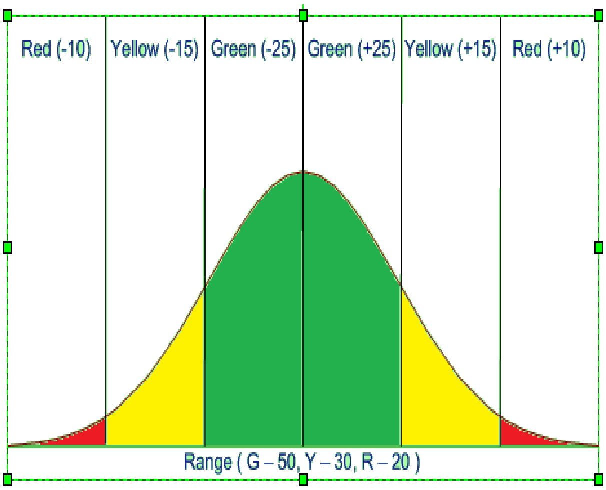

Figure 7: Pre-Control coverage for Mode 1

Table 6: Range Coverage relation to Power Consumption on Mode 2 (Green – 70, Yellow – 15, Red – 15)

Mode	Low Green	High Green	Status	Power Consumption
MC/LRR	0.40	0.67	Green	0.42
MMT/LRR	0.39	0.63	Green	0.43
MMT/MAD	0.44	0.61	Green	0.51
MMT/IQR	0.43	0.60	Green	0.51
RS/IQR	0.42	0.60	Green	0.48
MU/MAD	0.42	0.65	Green	0.46
MU/IQR	0.40	0.63	Green	0.49
RS/MAD	0.40	0.63	Green	0.49
RS/LR	0.40	0.63	Green	0.49
MC/IQR	0.41	0.61	Green	0.46
MU/LR	0.40	0.59	Green	0.50

Table 7 shows the result for Mode 3, (Green – 20, Yellow – 50, Red – 30) where 9 out 11 combinations (81.8%) locates in green region, 1 out of 11 combinations (9%) in the yellow region. 3 out of 10 combinations (30%), which is the median data of power consumption, and they are MC/LRR, MU/MAD and RS/MAD. 6 out of 10 combinations (60%) are a strong negative data which mean the data sit very close to the middle and 1 out of 10 combinations (10%) is a weak negative power consumption data.

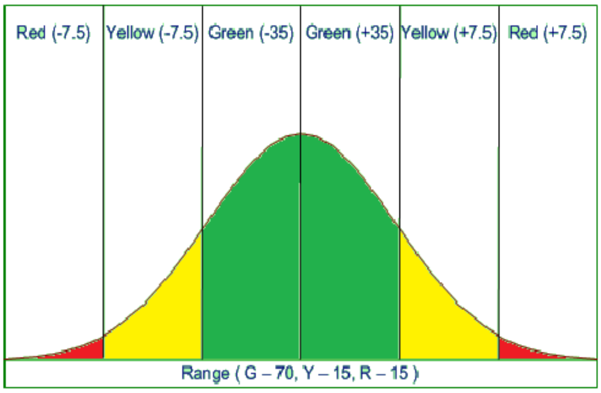

Figure 8: Pre-Control coverage for Mode 2

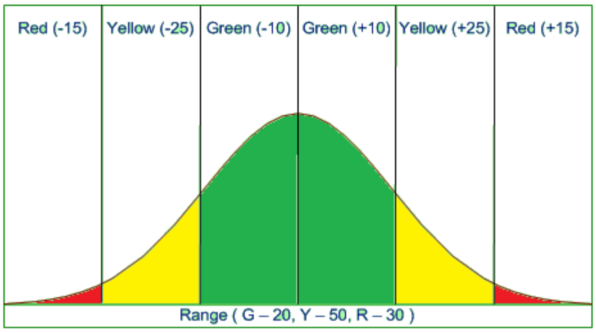

Figure 9: Pre-Control coverage for Mode 3

Table 7: Range Coverage relation to Power Consumption on Mode 3 (Green – 20, Yellow – 50, Red – 30)

Mode	Low Green	High Green	Status	Power Consumption
MC/LRR	0.49	0.53	Green	0.52
MMT/LRR	0.50	0.61	Yellow	0.47
MMT/MAD	NA	NA	NA	NA
MMT/IQR	0.49	0.55	Green	0.5
RS/IQR	0.49	0.55	Green	0.5
MU/MAD	0.36	0.59	Green	0.47
MU/IQR	0.50	0.59	Green	0.51
RS/MAD	0.48	0.54	Green	0.5
RS/LR	0.48	0.53	Green	0.49
MC/IQR	0.48	0.53	Green	0.48
MU/LR	0.48	0.53	Yellow	0.47

As for Mode 4, (Green – 15, Yellow – 70, Red – 15), the result can be observed in Table 8, and it seems that 4 out of 11 combinations (36.3%) is in the green region and 6 out of 11 combinations (54.5%) is in the yellow region. 1 out of 4 combinations (25%) is sits on the positive side of green which is on the right side, and the other three is located on the left side or negative side of the green. As for the data in the yellow region, 2 out of 6 combinations (33.33%) is located in the positive side of the yellow region and the other 67.67 % is located in the negative side of the yellow region.

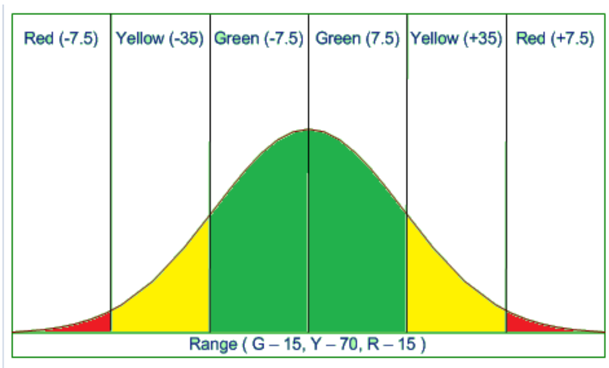

Figure 10: Pre-Control coverage for Mode 4

Table 8: Range Coverage relation to Power Consumption on Mode 4 (Green – 15, Yellow – 70, Red – 15)

Mode	Low Green	High Green	Status	Power Consumption
MC/LRR	0.48	0.53	Green	0.49
MMT/LRR	0.47	0.51	Green	0.5
MMT/MAD	NA	NA	NA	NA
MMT/IQR	0.49	0.52	Green	0.49
RS/IQR	0.49	0.52	Green	0.49
MU/MAD	0.49	0.53	Yellow	0.54
MU/IQR	0.49	0.53	Yellow	0.54
RS/MAD	0.51	0.56	Yellow	0.50
RS/LR	0.50	0.56	Yellow	0.48
MC/IQR	0.54	0.60	Yellow	0.5
MU/LR	0.50	0.57	Yellow	0.46

Figure 11 shows summary of result of this study, and it encompasses mode 1(Green-50), mode 2 (Green-70), mode 3 (Green-20) and mode 4(Green-15). The data shows the distribution of the data which sits inside the Green Region that is a stable region. Thus in case of center data, the results are 40% for mode 1, 70% for mode 2, 30% for mode 3 and 0% for mode 4, and as for the stability region, 100% is seen on mode 1 and mode 2, 81.3% for mode 3, 36.3% for mode 4. In summary whenever the range of Green region can be expanded, the impact is that the system will become more stable.

5. Conclusion

The main aim of this study is to produce a system which is producing low power consumption and with a stable process. Four Pre-Control strategies have been applied to the process, whereby different ranges for Green, Yellow and Red regions have been specified for the four Pre-Control modes. Double threshold values were calculated based on the Six Sigma Method and 16 different VM resource allocation strategies were considered.

Results show that Mode 1 and Mode 2 has the best strategy in achieving stable and low power process at the same time, while the combination that achieved the most optimum result is MU/LR at Mode 2. However, it seems that the stable process is not producing the lowest power process. The stable process definitely produce a high quality performance of the system itself [15]. This paper concludes pre control methods have an advantage in that by expanding the range of Green region in the pre-control, the process become more stable.

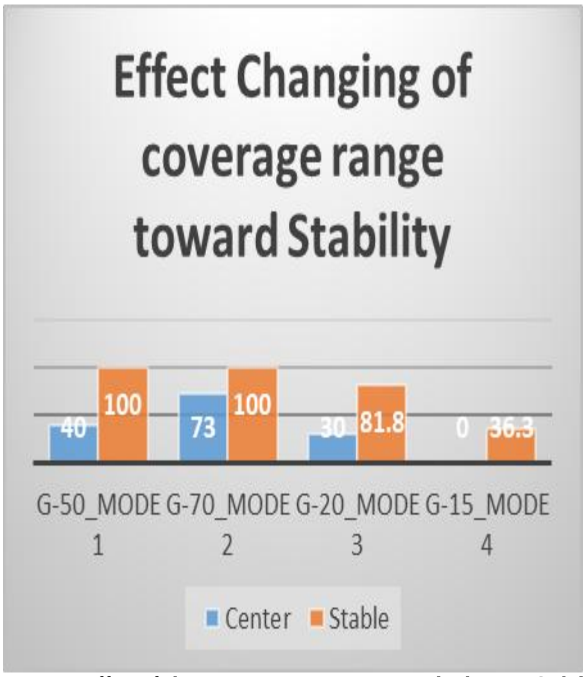

Figure 11: Effect of changing coverage range toward achieving Stability

Acknowledgement

The authors would like to express many thanks to the Ministry of Higher Education Malaysia and the Faculty of Electrical Engineering, Universiti Teknologi MARA (UiTM), for providing the support to carry out this research.

References

[1] R. Suchithra, "Heuristic Based Resource Allocation Using Virtual Machine Migration : A Cloud Computing Perspective," vol. 2, no. 5, pp. 40–45, 2013.

[2] C. Technology, S. K. Saroj, G. Noida, S. K. Chauhan, A. K. Sharma, and S. Vats, "Threshold Cryptography Based Data Security in Cloud Computing," IEEE Int. Conf. Comput. Intell. Commun. Technol., pp. 202–207, 2015.

[3] B. Wadhwa, “Carbon Efficient VM Placement and Migration Technique for Green Federated Cloud Datacenters,” pp. 2297–2302, 2014.
[4] Tennant, Geoff “SIX SIGMA: SPC and TQM in Manufacturing and Services,” Gower Publishing, Ltd.p25. ISBN 0-566-08374-4, 2001.
[5] D. Zhan, “Optimizing Cloud Data Center Energy Efficiency via Dynamic Prediction of CPU Idle Intervals,” pp. 985–988, 2015.
[6] W. Song, Z. Xiao, Q. Chen, and H. Luo, “Adaptive resource provisioning for the cloud using online bin packing,” vol. X, no. X, pp. 1–14, 2013.
[7] L. A. Rocha, “A Hybrid Optimization Model for Green Cloud Computing,” 2014.
[8] M. Aslam, “Statistical Monitoring of Process Capability Index Having One Sided Specification Under Repetitive Sampling Using an Exact Distribution,” vol. 6, 2018.
[9] Z. Xiao, W. Song, and Q. Chen, “Dynamic Resource Allocation using Virtual Machines for Cloud Computing Environment,” IEEE Trans. Parallel Distrib. Syst., pp. 1–1, 2012.
[10] S. R. Hussein, Y. Alkabani, and H. K. Mohamed, “Green cloud computing : Datacenters power management policies and algorithms,” pp. 0–5, 2014.
[11] J. Wang, C. Huang, K. He, X. Wang, X. Chen, and K. Qin, “An energy-aware resource allocation heuristics for VM scheduling in cloud,” Proc. - 2013 IEEE Int. Conf. High Perform. Comput. Commun. HPCC 2013 2013 IEEE Int. Conf. Embed. Ubiquitous Comput. EUC 2013, pp. 587–594, 2014.
[12] J. Adhikari and P. S. Patil, “Double Threshold Energy Aware Load Balancing In Cloud Computing,” 2013.
[13] S. Singh, “A Survey on Resource Scheduling in Cloud Computing :,” pp. 217–264, 2016.
[14] G. S. Poulami Dalapati, “Green Solution for Cloud Computing with Load Balancing and Power Consumption Management,” Int. J. Emerg. Technol. Adv. Eng., vol. 3, no. 3.
[15] B. Wadhwa, “Carbon Efficient VM Placement and Migration Technique for Green Federated Cloud Datacenters,” pp. 2297–2302, 2014.