IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Volume-6, Issue-4 E-ISSN: 2347-2693

Performance analysis of Fuzzy VM Management techniques for Task scheduling on Cloud systems

R.A. Kulkarni[1*], S.B. Patil[2], N. Balaji[3]

[1] Comp. Dept, PICT, Pune University ,Pune, India
[2]CSE Dept, BVCOE, BV University, PUNE, India
[3]Dept, JNTU Kakinada University, COE, VIZIANAGARAM, INDIA

Corresponding Author: Kulkarni_rekha@live.com , Tel.: 9970411550

Available online at: www.ijcseonline.org

Received: 10/Mar/2018, Revised: 17/Mar/2018, Accepted: 29/Mar/2018, Published: 30/Apr/2018

Abstract— Cloud Computing has been widely adopted by many industries as a platform to support distributed applications. Cloud provides the advantages of reduced operation costs, flexible system configuration and elastic resource provisioning. Even though cloud has been rapidly getting adopted there are various open challenges in areas such as management of virtual resources, security and organizational issues. One of the prominent technologies used by cloud computing is the virtualization. The virtualization technology faces tremendous challenges in supporting real-time applications on cloud as these applications demand real-time performance in open, shared and virtualized computing environments. In this paper we are analyzing the usage of fuzzy logic in improving the performance of time constrained tasks. Our proposed system makes use of fuzzy logic in scheduling of tasks to Virtual machines and in identification of destination host in migrating the overloaded virtual machines which can give better performance than the traditional scheduling algorithms used on cloud systems.

Keywords: Cloud Computing, Fuzzy logic, VM management, Performance metrics.

I. INTRODUCTION

Cloud computing is a "model for enabling ubiquitous, on-demand network based access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction" [1]. Cloud computing being a model for distributed computing provides network based access to a shared collection of computing resources which are configurable, provided and released with little amount of management and service provider interaction. Cloud can be thought of as service model consisting of three layers as software service provider(SaaS), Platform Service Provider (PaaS) and Infrastructure service provider (IaaS).

IaaS is the base layer of any cloud computing system. IaaS cloud offers physical servers, virtual machines, storage and connectivity resources to run anyone's enterprise applications on a pay-as-use basis. In order to measure the quality of service provided by the cloud service provider and end user there exists a Service Level Agreement(SLA). Both cloud providers and consumers have their Service Level Agreement defined between them for specifying the [2] and in identifying the destination host for migrating a overloaded VM. These approaches together can bring in the performance improvement.

Rest of the paper is organized as follows. Section I provides the introduction, Section II briefs about the related work in the field of VM management, Section III contains the architectural details and methodology of the proposed system, Section IV discusses about the experimental setups and results analysis. We provide conclusion and the future work in section V.

II. RELATED WORK

While solving specific workflow problems on cloud systems it is important to consider relevant performance criteria and system distribution while providing services to end users. In the literature, the relationship between workflow schedule and execution cost have been discussed[5]. This paper has also discussed the various quality of services and the

challenges for performing tasks on cloud. In [7] the various rule based algorithms have been studied in the field of cloud computing. The study has been done to improve the overall performance not specific to time constrained tasks. Marisol G valls ,T Cucinotta and Chenyang Lu have studied [3] the challenges in real time virtualization and predicable cloud computing" and provided a survey on recent advancements in real time virtualization and cloud computing. Virtualization Technology introduces a number of challenging issues for real time processing of tasks. Running software in predictable ways becomes difficult because of resource sharing among multiple virtual machine. In the cloud environment performance of one VM depends on the amount of resources other VMs are consuming. The other issue is dynamic creation and movement of VMs introduces high and sudden work-loads that can interfere with the performance of VMs.

Mohammad Alaul Haque Monil1 and Rashedur M. Rahman [4] .have studied the "VM consodidation approach based on heuristic fuzzy logic, and migration control.". In their approach they have used Virtual Machine consolidation is one such technique to ensure energy-QoS balance. They have explored fuzzy logic and heuristic based virtual machine consolidation approach to achieve energy-QoS balance. Jyothi sahni,Deo Prakash Vidyarthihave [16] have done ," A cost effective deadline-constrained dynamic scheduling algorithm for scientific workflow in a cloud environment", They have proposed a technique to exploit the advantages offered by cloud computing while taking into account the virtual machine (VM) performance variability and instance acquisition delay to identify a just-in-time schedule of a deadline constrained of VM that is overloaded and a place to move the overloaded VM. The overloaded VM has to be moved to another host so that the deadline of the task and intern the workflow deadline is being met. VM Consolidation is one of the techniques which draw researchers' attention and is an active field of research in recent times. VMs have to be migrated from one host to the other may be to reduce the energy or to avoid Service Level Agreement violation. So the proposed algorithm tries to migrate the VM from overloaded Hosts to other under loaded hosts in order to meet the SLA.

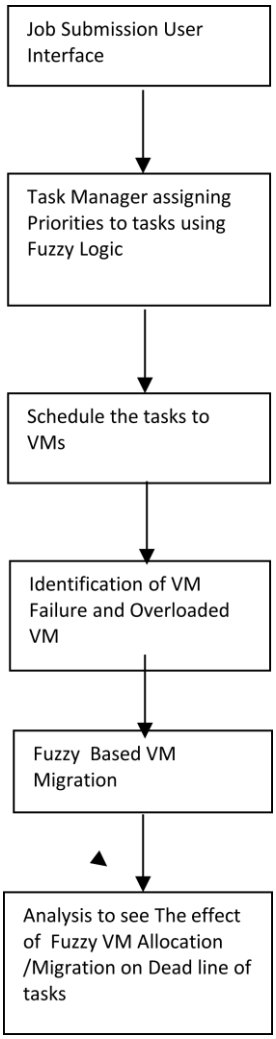

Figure 1 : Block diagram of proposed System

Following table shows an example tsk set and assigned fuzzy priorities to tasks. Based on the priorities VMs will be allocated to tasks to ensure that the deadline of the tasks is being met.

Task	Execution Time ET	External Priority EP	Deadline DL	Fuzzy Priority
T1	2	8	10	~9
T2	5	7	15	~12
T3	3	6	20	~15
T4	4	3	25	~16
T5	6	9	12	~10

Table 1 : Tasks with parameters

Algorithm for our proposed system :

1. Input the workflow consisting set of tasks along with parameters values.

2. Fuzzify the input parameters execution time(ET),External priority(EP) and deadline (DL).
3. Based on the inference rules caluculte the overall priority.
4. Defuzzyficate the output i.e overall priority .
5. Based on the priority map the tasks to different type of Vms.
6. Check for a situation of overloaded Host.
7. Based on the information available at various hosts and with the help of fuzzy logic with minimum migration time to identify the host to Live migrate the VMs.
8. Analyze is there any deadline misses of the workflow.

In our algorithm we are considering the minimum migration time as the policy for migrating the VM from an overloaded Host. In identifying the overload we are using the threshold such that CPU utilization of VM(a) is less than the CPU threshold as given in the equation 1

$$CPUu(a) \leq CPU_{threshold} \quad (1)$$

Minimum Migration Time (MMT) policy selects the VM which can be migrated within minimum time limit [4]. The migration time is limited by the memory the VM is using and the spare bandwidth. At any moment t, The MMT with Migration Control policy finds VM a that will be selected for migration by the equation 2. RAM(a) is the Radom Access Memory (RAM) utilization of VM a and RAM(b) is the RAM utilization of VM b. NET h means the available bandwidth for migration and Vh is the set of VMs of host h.

For performance analysis we have compared our proposed algorithm with weighed round robin (WRR) [6] where in weights can be assigned based on heuristics. Following figure shows the performance analysis related to number of migrations.

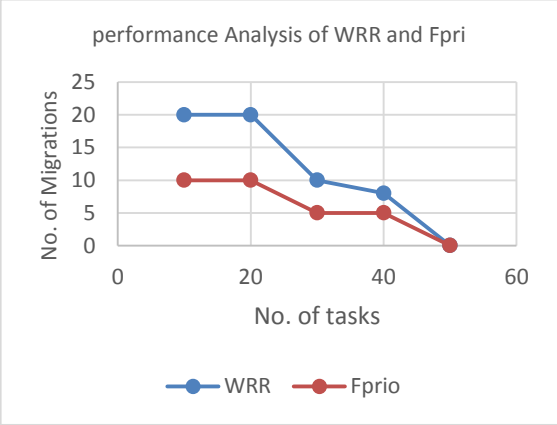

Figure 5 : No. of tasks (VMs) and Migrations

Following table shows the analysis of deadline being met with our algorithm and with weighted round robin.

No.of tasks in W	Deadline Of W	Fuzzy Algorithm for Meeting Deadline	WRR Algorithm
10	15	12	13
20	45	40	42
30	20	21	20
40	30	35	32
100	50	45	60
150	65	65	70

Table 2 : Tasks of workflow (W) with deadlines.

As observed with above table with more number of tasks our algorithm gives better results than WRR.

III. PROPOSED SYSTEM

Virtual machine provisioning and migration services are active part of the research which contribute in Self Adaptive and dynamic data center, data scaling in private and public clouds and high availability in clustered Vms through live migration. The performance improvement opportunities exists with regard to the migration of Vms with the help of VM Scheduling Algorithms and Accelerating VMs Live migration time.

Real time workloads require meeting of deadlines as QOS parameter and fuzzy logic can help us in deciding the way to schedule the tasks on Vms and migrating the overloaded VM so that meeting the workflow deadlines can be improved. In our proposed system we are analyzing the effect of using Fuzzy logic on task mapping and migration services. The architecture of proposed system is shown in figure 1.

In the first stage of proposed system fuzzy logic is being used to find the dynamic priority of the tasks. During the next stage as we will have to study the effect of VM migration on satisfying the deadline of workflow, the fuzzy logic will be used in identification

We are considering the task parameters as execution time(ET),External priority(EP) and deadline (D). Fuzzy logic is used to calculate the overall priority of the tasks. We are considering 3 types of Vms As VM small (Vs), large (V_l) and medium (V_m). Based on the priority, tasks will be

mapped to VMs. Fuzzification of various parameters is as shown in the following diagrams of Fig 2.Fig 3 and Fig 4.

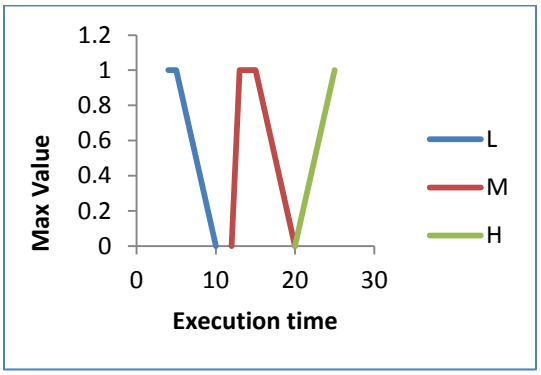

Figure 2 : Fuzzy membership of ET

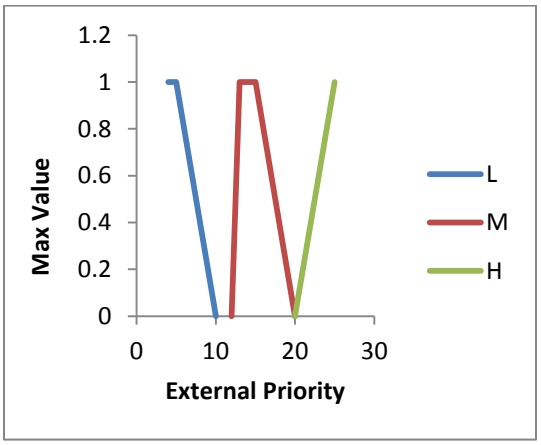

Figure 3 : Fuzzy membership of EP

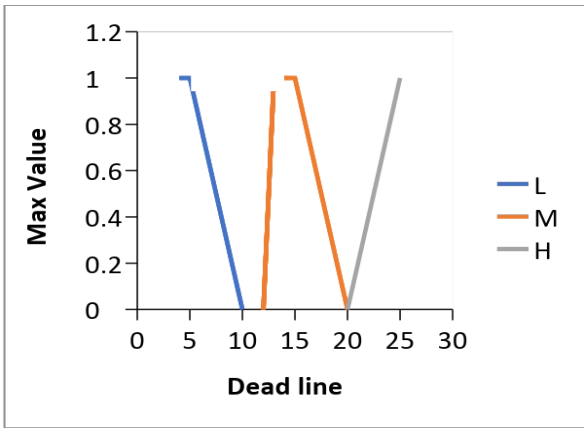

Figure 4 : Fuzzy membership of DL

So this method compares the migration time and selects the VM a with minimum migration time among all VMs residing in host h.

$$a \in V_h \mid \forall b \in V_h, \frac{RAM(a)}{NET_h} \leq \frac{RAM(b)}{NET_h} \qquad (2)$$

IV. EXPERIMENTAL RESULTS and PERFORMANCE ANALYSIS :

For experimental setup we have used CloudSim as simulation tool [9]. To integrate the fuzzy logic with basic CloudSim classes we have used jFuzzylogic language extension tool [10]. We have studies and analyzed our experiemt for workflows consisting of set of tasks. We have also considered the dependencies among the tasks with the help of directed acyclic graph (DAG).

Computational complexity of our algorithm with DAG :

Suppose the workflow W (T, E)to be scheduled consists of n tasks and e edges.

The maximum number of VM types offered by the Cloud provider be m.

Since W is a DAG, the maximum number of edges in W is $(n-1)(n-2)2 \cong O(n^2)$

Since each task may have atmost $(n-1)$ sucessors, the list of to_be_scheduled tasks is updated with time complexity(n).

Since a task may have a maximum of (n-1) children tasks,

Therefore, the complexity obtained while considering all the dependencies is ($\mathbf{N^3}$).

Performance metrics for IaaS cloud can be represented with 5 tuples as shown below[15].

(Infrastructure cloud) = {< IaaS >, <Compute,

Storage >, <Su, El , S >, < B >, < A, Co > }

Su: Speedup Speed gain of using more processing nodes over a single node

S: Scalability The ability to scale up resources for gain in system performance

El,: Elasticity Dynamic interval of auto-scaling resources with workload variation

B: Bandwidth Data transfer rate or I/O processing speed, (MB/s, Gbps)

A: Availability Percentage of time the system is up to deliver useful work. (%)

Cost : Service cost The price per cloud service (compute, storage, etc.) provided, ($/hour) constraints of tasks when we have less number of VMs. This approach can be improvised with other rule based techniques. In future we can apply VM migration to reduce the energy consumption and network bandwidth which has not been considered in this implementation.

V. V. CONCLUSION AND FUTURE WORK :

Cloud computing provides services to requester in a form of pay-as-you go utility service as per the Service Level Agreement to satisfy QOS. Here in this paper we have tried to analyze the effect of using fuzzy logic in managing the VMs which are essential part of any cloud service. We have employed minimum migration time as Migration policy. Usage of fuzzy logic it has been shown that it helps in meeting the deadline of real time technical performance requirements and both want to optimize the costs. So cloud providers tend to reduce downtime and increase availability in order to use their infrastructure more productively and efficiently. Services are utilized based on SLAs which define parameters of quality of service (QOS) in terms of pay-as-per-usage policy. There are various parameters of QOS like quality of results, consistency, throughput, availability, reliability, cost, deadline, trust, budget, etc.

For real time tasks the important parameter is meeting of the deadlines. In the real-time perspective one needs to provide actual execution mechanism that guarantee and enforce execution in isolation to meet the timing requirements of real-time applications. The cloud system often faces the difficulty in terms of processing fault or computational overload. The Faults may be because of longer execution periods than the expected time of the task or programming errors leading to the starvation of all low-priority tasks. One of the parameters which plays the major role in deadline constrained applications is to identify the priority assigned to the tasks so that overall workflow can meet the deadline. Overloading of VMs is a very common scenario in cloud which may in tern affect the QOS of time constrained tasks. So in our proposed system we are analyzing the effect of using fuzzy logic to improvise the priorities assigned to tasks

scientific workflow at lesser costs. They have not considered the VM failures or overloaded VM situation.

In [18] M.A Rodriguez and RajKumar Buyya have proposed a resource provisioning and scheduling strategy for scientific workflows on Infrastructure as a Service (IaaS) clouds. They have presented an algorithm based on the meta-heuristic optimization technique, particle swarm optimization (PSO), which aims to minimize the overall workflow execution cost while meeting deadline constraints. They have made the assumption that quite accurate estimation of execution time of the tasks is available. In [19] Rodrigo, R. Buyya have discussed about an algorithm that uses idle time of provisioned resources and budget surplus to replicate tasks to mitigate effects of performance variation of resources on soft deadlines of workflow applications. In cloud two resources with the same characteristics may have different performance in a given time, what results in variation in the execution time of tasks that may lead to delays in the workflow execution.

Tom Springer has [8] proposed "Fuzzy Logic Based Adaptive Hierarchical Scheduling for Periodic Real-Time Tasks". His work is on real time processing of tasks on embedded systems. In [15] Kai Hwang , X Bai , Yue Shi , M Li, W Chen , Y Wu have discussed about 'Cloud Performance Modeling with Benchmark Evaluation of Elastic Scaling Strategies". They have given the various performance metrics for analysis of various cloud models.

REFERENCES

[1] P. Mell and T. Grance, "The NIST Definition of Cloud Computing," US Nat'l Inst. of Science and Technology, 2011; http://csrc.nist.gov/publications/nist pubs/800-145/SP800145.pdf.

[2] Ehab NabielAlkhanak, Sai Peck Lee, Saif Ur Rehman Khan,"Cost-aware challenges for workflow scheduling approaches in cloud computing environments: Taxonomy and opportunities",Future Generation Computer Systems,ElseVier 50 (2015) 3–21

[3] Marisol García-Valls, Tommaso Cucinotta, Chenyang Lu"Challenges in real-time virtualization and predictable cloud computing".

[4] Mohammad A H, Monil and Rashedur M. R,"VM consolidation approach based on heuristics, fuzzy logic, and migration control" Journal of Cloud Computing: Advances, Systems and Applications (2016) 5:8DOI 10.1186/s13677-016-0059-7

[5] Ehab NabielAlkhanak, Sai Peck Lee, Saif Ur Rehman Khan,"Cost-aware challenges for workflow scheduling approaches in Cloud computing environments: Taxonomy and opportunities",Future Generation Computer Systems,ElseVier 50 (2015) 3–21

[6] D. Chitra Devi and V. RhymendUthariaraj "Load Balancing in Cloud Computing Environment Using Improved Weighted Round Robin Algorithm for Nonpreemptive Dependent

Tasks",The Scientific World Journal Volume 2016, Article ID 3896065, 14 pages
[7] Chun-Wei Tsai,Wei-chang Huang, M-S Chieng,Ming-chao Chiang and Chu-Sing Yang," A Hyper-heuristic Scheduling Algorithm for Cloud" ,IEEE transactions on cloud computing Vol-2 No2 April -June 2014.
[8] M.M.M. Fahmy, "A fuzzy algorithm for scheduling non-periodic job on soft real-time single processor system" ,Ain Shams Engineering Journal (2010) 1, 31–38
[9] Rodrigo N. Calheiros, Rajiv Ranjan, Anton Beloglazov, César A. F. De Rose, and R Buyy," CloudSim: A Toolkit for Modeling and Simulation of Cloud Computing Environments and Evaluation of Resource Provisioning", Algorithms Software: Practice and Experience (SPE), Volume 41, Number 1, Pages: 23-50, ISSN: 0038-0644, Wiley Press, New York, USA, January, 2011.
[10] JawwadShamsi,• Muhammad Ali Khojaye • Mohammad Ali Qasmi"Data-Intensive Cloud Computing: Requirements, Expectations, Challenges, and Solutions ", J Grid Computing (2013) 11:281–310 DOI 10.1007/s10723-013-9255-6
[11] Brendan Jennings Rolf Stadler " Resource Management in Clouds: Survey and Research Challenges " J NetwSyst Manage DOI 10.1007/s10922-014-9307-7
[12] Fei Teng, Frédéric Magoulès • Lei Yu • Tianrui Li " A novel real-time scheduling algorithm and performance analysis of a MapReduce-based cloud ",J Supercomput (2014) 69:739–765 DOI 10.1007/s11227-014-1115-z
[13] Avtar Singh and Kamlesh Dutta " A novel real-time scheduling algorithm. and performance analysis of a MapReduce-based cloud" IEEK Transactions on Smart Processing and Computing, vol. 2, no. 6,December 2013.
[14] Tom Springer, Steffen Peter Tony Givargis "Fuzzy Logic Based Adaptive HierarchicalScheduling for Periodic Real-Time Tasks", EWiLi'15, October 8th, 2015, Amsterdam, The Netherlands
[15] Kai Hwang , Xiaoying Bai , Yue Shi , Muyang Li, Wen-Guang Chen ,Yongwei Wu "Cloud Performance Modeling with Benchmark Evaluation of Elastic Scaling Strategies", IEEE transactions on parallel and distributed systems, vol. 27, no. 1, january 2016.
[16] Jyothi sahni,Deo Prakash Vidyarthi," A cost effective deadline-constrained dynamic scheduling algorithm for scientific workflow in a cloud environment", IEEE transactions on cloud computing, vol. 6, no. 1, january-march 2018
[17] Cingolani, Pablo, and Jesus Alcala-Fdez "jFuzzyLogic: a robust and flexible Fuzzy-Logic inference system language implementation." Fuzzy Systems (FUZZ-IEEE), 2012 IEEE International Conference on. IEEE, 2012.
[18] M.A Rodriguez and RajKumar Buyya "Deadline Based Resource Provisioning and Scheduling Algorithm for Scientific Workflows on Clouds", IEEE transactions on cloud computing, vol. 2, no. 2, april-june 2014
[19] Rodrigo N. Calheiros, Rajkumar Buyya "Meeting deadlines of scientific workflows in public clouds with tasks replication" IEEE trasaction on parallel and distributed systems vol 25,No 7,July 2014

Author Profiles

Mrs R.A.Kulkarni is working as Asst.Prof in PICT,Pune. She is pursuing her PhD at JNTUH in the domain of Cloud Computing. Her main areas of Interest are Distributed Computing, Operating Systems and Soft computing.

Dr.Suhas H Patil is currently working as professor in BVCOE, He is working as Research Paper Evaluator for World Scientific Engineering and Academic Society WSEAS, SCIEI and IASER. His main areas of interest are operating systems, Web technologies, Information systems etc. He has more than 224 research papers to his credit in reputed national and international journals and conferences. Member of International Society of Computer Associations (ISCA). Senior Member of Science and Engineering Institute (SSEI), Member of Editorial Review Board of International Journal of Intelligence Science (IJIS), Life Member, Numismatic Society of Kolkata, India (NCK). Member of Teacher Training and Education (MTTE), Education Management Professionals (EMP) and IEEE computer Society Members on LinkedIn (IEEE),member of ASDF(Association of Scientists not-for-profit organization focusing on research and development.

Dr.N Balaji is currently working as Professor of ECE & Vice-Principal at JNTU Kakinada University, COE, Narasaraopet. His areas of interest are VLSI architecture and signal processing.

