Experimental Study on VM Allocation Algorithms in SDN-Cloud Environment

Amirah H. Alomari
Department of Computer Science, King Khalid University, Saudi Arabia
Email: aalamre@kku.edu.sa
Shamala K. Subramaniam
Department of Communication Technology and Networking, Faculty of Computer Science, University Putra, Malaysia
Email: shamala_ks@upm.edu.my
Normalia Samian
Department of Communication Technology and Networking, Faculty of Computer Science, University Putra, Malaysia
Email: normalia@upm.edu.my
Rohaya Latip
Department of Communication Technology and Networking, Faculty of Computer Science, University Putra, Malaysia
Email: rohayalt@upm.edu.my
Zuriati Zukarnain
Department of Communication Technology and Networking, Faculty of Computer Science, University Putra, Malaysia
Email: zuriati@upm.edu.my

ABSTRACT

Resource allocation in any distributed system is critical concern due to its involvement tasks that are linked to the success or failure of a system. On the other hand, Quality of Service and network performance are major concerns as it outlines the overall architecture of the system. In conjunction with new advancement in the highly networking based era, new resource allocation techniques are constantly developed to manage the changes and its implications. Software-Defined Network(SDN) shifts the traditional architecture of distributed systems to a new level. The main controlling element in SDN is located in a centralized unit where the controller unit is responsible on allocating incoming requests to available resource based on pre-defined conditions. Due to its ability of the controller to observe the entire network, the controller unit is capable of making decision based on network states. Relatively distributed networks such as Cloud and Fog are influenced by the concept of SDN. In this paper, we focus on SDN based Cloud to study the performance of different virtual machine (VM) allocation algorithms under different traffic load conditions. This study is conducted in a simulation environment using CloudSimSDN and real workloads. Results show that different VM allocation perform differently under various traffic load conditions. However, First Come First Served FCFS algorithms outperform in most scenarios.

Keywords - **Network Performance, Resource Allocation, Resource Management, Software-Defined Cloud, Virtual Machine Placement.**

1. INTRODUCTION

Software Defined Networks (SDN) shift traditional distributed systems to new level by introducing simplicity of management tasks. Compared with traditional networks where network devices such as routers in traditional networks are responsible on forwarding and routing decisions based on embedded hardware tables, performing prioritization and flirting of traffic rules. However, software- defined networks (SDN) transfer the controllability and management ability from network devices to a central unit where it has the advantage of observing the entire network and making related decisions based on current states [1][2].

Due to ease of management, relatively distributed systems are influenced by the idea of SDN, therefore, emerging architectures are developed such as SDN-based Cloud and SDN-based Fog/Edge. The process of employing SDN derived from the idea of reducing complexity and overcome existing issues in traditional distributed systems such as scalability and mobility [3]. Therefore, SDN is considered as the new future structure [4].

Resource management is associated to the system targeted performance and power consumption and resource allocation is the core function of any resource management.

Resource allocation is considered as critical issue due to systems' resource heterogeneity and dependency as well inconsistent workload [5]. Moreover, it is massive impact on multiple aspects such as performance, cost and functionality [6] since different resource allocation algorithms serve different objectives, therefore, predetermination of overall objective is crucial to the design of resource allocation strategy. In this paper, we analyze the performance of multiple virtual machine algorithms in SDN-based Cloud to study its performance under different traffic loads. The underlying algorithms allocate VMs differently and are distinguish from each other. We aim to observe the impact on overall performance of the system based on various network traffic and ability of controller to manage traffic accordingly.

Resource management mechanisms in traditional cloud differs to Software-defined network in terms of the location of those mechanisms are implemented. In traditional cloud architecture, devices are responsible on making controlling decisions while management is placed in a dedicated unit in SDN. As the emergence of the two structures brought features, it also introduces existing challenges such as power, scalability and security.

Even though many techniques contribute on resource allocation on both fields, however, rarely studies concentrate resource allocation in SDN-based Cloud environment. Therefore, in this experiment, we study the relationship between VM allocation algorithms performance and network traffic.

Extensive study was considering resource allocation in both SDN-based cloud and SDN-based fog [7]. Different algorithms deploy various techniques for resource allocation, such as, prioritization of VM requests is the main concern of resource allocation in [8] where critical requests have an advantage to be allocated prior normal ones. As well, dynamic ratio based on inconsistent workload is established as means for resource overbooking [9] in order to reduce violation of Service Level Agreement (SLA) and reduce power consumption. Both studies were conducted in simulation environment using CloudsimSDN. While resource utilization is considered as main criteria for allocating decision [10] by considering hosts CPU utilization as declaration of hosts loading condition such as overloaded/under loaded. Simulation results proves that proposed algorithms enhances overall network performance. The deployment of artificial intelligent is considered for more intelligent systems such as the deployment of genetic algorithms [11] and reinforcement learning [12].

2. METHODOLOGY

The main objective of this study is to analyze resource-based VM allocation in SDN- Cloud environment and study their performance under various network traffic loads. The following sections, we explain the conducted experiment in terms of underlying VM allocation algorithms, simulation tool, workload sets, measurement metrics, and obtained results with interpretation.

2.1. VM Allocation Algorithms

When VM requests enter the system, there are various ways to allocate dedicated hosts for the processing purpose. In this experiment, we observe the performance of various VM allocation algorithms in SDN-Cloud which are First Fit Decreasing order, First Come First Served, Random Allocation, Greedy Allocation and Anti-Affinity Allocation.

First Come First Served (FCFS) algorithm will allocate incoming VM requests in the basis of First Come First Served. This algorithm requires no information on resources availability nor requirements of both neither host nor VM.

First Fit Decreasing order FFD algorithm search hosts with enough resources to allocate VM requests. Some approaches use effective bandwidth as a resource determination of host selection [13], while others consider it as bandwidth requested by VM [8]. However, in this paper, we consider first host capable of accommodating VM request with no specification of host resources.

Random Allocation Allocate VM by selecting hosts randomly as long as the selected host has enough resources to be provided to the VM. There are no pre-conditions or any sort of intelligence in this method.

Anti-Affinity allocation is based on the idea of replicated VMs are allocated to different hosts in the case of any host failure. VMs are classified based on their IDs and allocation is performed based on VMs affinity.

Greedy algorithm, hosts are sorted based on their available processing power in order to place VMs accordingly. The VM will be placed to the dedicated host when the host processing matches processing requested by VM.

3. SIMULATION SETTINGS

We implemented the experimental study in SDN-based Cloud environment using simulation tool CloudSimSDN[14] and we study the performance impact of all allocation strategies using real workloads i.e. Wikipedia [15] which represent three-tier application model in order to reflect real world traffic. This study focus on the performance of different VM allocation strategies to analyze the controller capabilities employing various allocation algorithms under different traffic conditions. Our experiment consists of three scenarios. We observe the capability of the broker to manage resource in terms of allocating VMs to hosts based on different strategies where the network traffic increased in each scenario where scenario 1 represents the lowest traffic network while scenario 3 is the most loaded traffic. We evaluate each allocation algorithm based on number of successfully processed workloads, timeout workloads, total serve time, CPU serve time, and network serve time for each scenario.

4. RESULTS AND DISCUSSION

For evaluation purposes, we analyze FCFS, FFD, Random, Anti-Affinity and Greedy VM allocation algorithms based on number of processed workloads, number of timeout workloads, average serve time which is extended to average CPU time and average Network time required to execution.

Fig. 1 shows the results of successfully processed workloads performed by above mentioned VM allocation algorithms under different scenarios of network traffic. Comparing different scenarios, we find that all VM allocation algorithms perform better when the network is loaded with less traffic as shown in scenario 1 and 3 com- pared to scenario 3 which represents heavy loaded network. However, we observe that different

VM allocation algorithms performs differently under various traffic load condition. For example, in scenario 1 where traffic is light, FFD algorithm processed highest amount of workloads compared to the other algorithms which can be reasoned that FFD allocate VMs to the first host with enough resources which reduce the risk of causing workloads to timeout during the search of suitable host. While in scenario 2 when the traffic is moderate FCFS achieve the highest number of

Figure.1: number of processed workloads

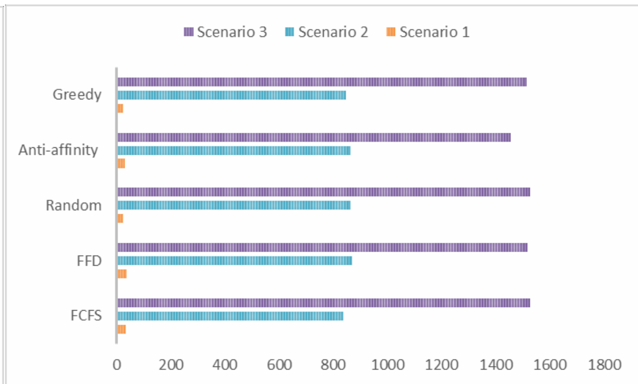

Figure.2: number of timeout workloads

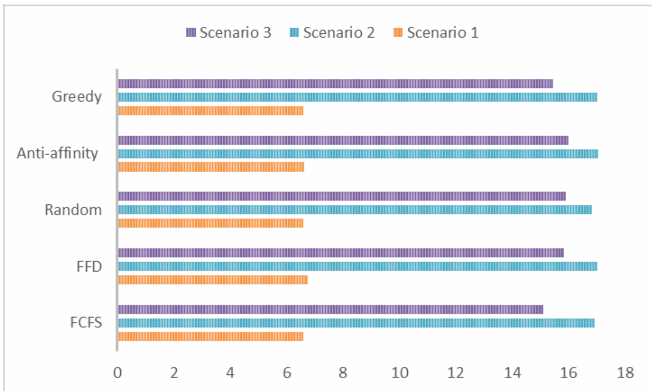

Figure.3: total serve time

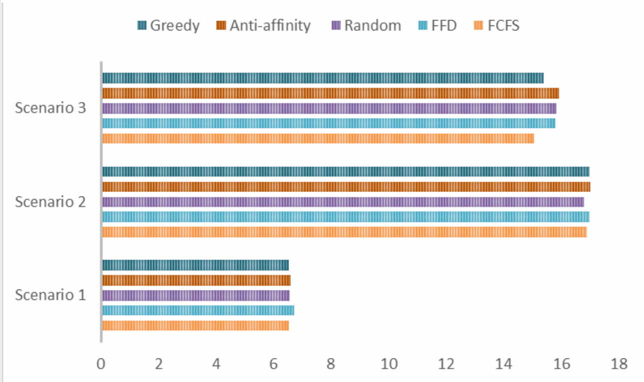

Figure.4: CPU serve time

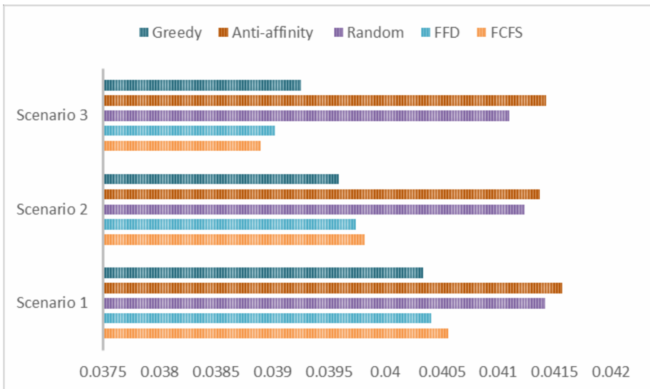

Figure.5: Network serve time

processed workloads compared to scenario 3 where anti-affinity algorithm processed highest number of workloads under heavy loaded networks.

Similarly, we find that there is direct relation between timeout workloads and network traffic, as shown in fig.2. Therefore, by concentrating on scenario 3, Anti-Affinity VM allocation manage to achieve lowest number of timeout work-loads. However, Random and Greedy still manage to achieve minimum number of timeout workloads when network traffic is the lowest. While, FCFS algorithm manage to achieve the lowest number of timeout workloads when traffic load is moderate.

In addition to that, in fig. 3, total serve time is the minimum in scenario 1 due to light network traffic. However, serve time is the highest in scenario 2 which is supposed to be less traffic than scenario 3. This is due to the problem of timeout workloads where highest number of workloads were timeout because of high network traffic in scenario 3. For this reason, the serve time is higher in scenario 2 than scenario 3 due to the high amount of workloads that were ready for processing. However, we find that FCFS algorithm maintain low serve time in all scenarios as the algorithm allocate requests based on arrival basis rather than VM or host resources specification which results speedy service for incoming requests.

Relatively, we precise the serve time to better understand each allocation strategy in terms of CPU and Network serving time, as shown in fig. 4 and fig. 5 respectively. Similarly, CPU serve time is the lowest when adopting FCFS allocation algorithm in all scenarios. While for network serve time, anti-affinity achieves the longest time in all cases while FFD algorithm achieves lowest network serve time when the network traffic is light and moderate. However, lowest network serve time is achieved by FCFS algorithm.

5. CONCLUSION

In this experiment we analyze the performance of most popular VM allocation in Software-Defined Network based Cloud which are First Fit Decreasing order, First Come First Serve, Random Allocation, Anti-Affinity, and Greedy VM Allocation Algorithms. We study the impact of traffic load on various VM allocation algorithms by considering three different scenarios where traffic is light, moderate, and heavy loaded respectively. The experiment is conducted using CloudSimSDN simulation tool which is an extension of CloudSim that is developed to assess contributions in the area of SDN-Cloud. As well, Real world work-loads were used for this experiment to reflect real world traffic and analyze controller ability to accommodate such traffic using different strategies. Simulation results show that there is tradeoff relationship between heavy loaded networks and successfully processed workloads. As well, direct relationship between heavy loaded networks and timeout workloads. However, the results show that different traffic changes the behavior of VM allocation which effect overall performance. Therefore, VM allocation act differently based on traffic load condition. In spite of this, our results prove that FCFS algorithm achieves better results compared to other VM allocation algorithms under different traffic conditions based on obtained measurement of processed workload, timeout workload, total serve time of both CPU and network serving time.

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BIOGRAPHIES

Amirah H. Alomari is a lecturer at King Khalid University, Saudi Arabia. She received bachelor of computer science degree from University Kebangsaan Malaysia (UKM), in 2014, and master degree in computer science from King Saud University (KSA) in Saudi Arabia in 2017.

Currently, she's pursuing her Ph.D degree in University Putra Malaysia (UPM) in the area of parallel and distributed systems. Her research interests include computer networks, artificial intelligent, and network management.

Shamala K. Subramaniam (Member, IEEE) received the bachelor's, master's, and Ph.D. degrees in computer science from Universiti Putra Malaysia (UPM), in 1996, 1999, and
2002, respectively. She is currently a Professor with the Department of Communication Technology and Network, Faculty of Computer Science and Information Technology, UPM. Her research interests include computer net-works, simulation and modeling, and scheduling and real-time systems.

Normalia Samian is an assistant professor at the Faculty of Computer Science and Information Technology, Universiti Putra Malaysia (UPM). She obtained her Diploma (Engineering), B.Sc (Computer Science) from UPM where she received Best UPM Student Award in 2006. In 2010, she received her M.Sc (Computer Science) from Universiti Teknologi Malaysia (UTM) in the area of Wireless Networks Security and was nominated for Best Academic Award candidate. She received her Ph.D degree in UPM in the area of cooperation in wireless multihop networks. Her research interests include ad hoc networks security, trust management in MANETs and game theoretical approaches for wireless multihop networks.

Rohaya Latip (Member, IEEE) received the Bachelor of Computer Science degree from Universiti Teknologi Malaysia, in 1999, and the M.Sc. degree in distributed systems and the Ph.D. degree in distributed database from Universiti Putra Malaysia. She was also the Head of the HPC Section at Universiti Putra Malaysia, from 2011 to 2012, and consulted the Campus Grid Project and also the Wireless for Hostel in Campus UPM Project. She is currently an Associate Professor with the Faculty of Computer Science and Information Technology, Universiti Putra Malaysia. She is also currently the Head of the Department of Communication Technology and Networks. She is a Co-Researcher at the Institute for Mathematic Research (INSPEM). Her research interests include big data, cloud and grid computing, network management, and distributed database.

Zuriati Ahmed Zukarnain (Member, IEEE) received the bachelor's and master's degrees in physics and education from Universiti Putra Malaysia (UPM), in 1997 and 2000, respectively, and the Ph.D. degree in quantum computing and communication from the University of Bradford, U.K., in 2005. At the faculty, she taught several courses for undergraduate students, such as data communication and networks, distributed systems, mobile and wireless, network security, computer architecture, and assembly language. For postgraduate students, she taught a few courses, such as the advanced distributed and research method. She has been an Academic Staff with the Faculty of Computer Science and Information Technology, UPM, since 2001. She was the Head of the Department of Communication Technology and Networks, from 2006 to 2011. She was also the Head of the Section of High-Performance Computing, Institute of Mathematical Research, UPM, from 2012 to 2015. Her areas of specialization include computer networks, distributed systems, mobile and wireless, network security, quantum computing, and quantum cryptography. She is member of the IEEE Computer Society.