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# CSCI 5410: Assignment 1

## Part A

### Performance Comparison between Container-based and VM-based Services [1]

The authors of this paper have compared the performance of the Container-based and the VM-based services. As per the current scenario, it is a widely known fact the container-based services give better performance than VM-based services [1]. So, to clear the air, the authors have studied and quantified the performance difference in terms of throughput, response time, and CPU utilization considering different deployment scenarios [1].

The introduction of the paper talks about various topics and covers their main contributions to the study. The authors talk about the concept and primary aim of microservices architecture. The use of microservice architecture is widely accepted as it eases the development and deployment of the services in constantly changing algorithms used in real-time services. The most popular and widely used container-based service is the Docker containers. So, theoretically, it is stated that the container-based services consistently outperform the VM-based services in various factors like execution time, latency, throughput, power consumption, CPU utilization, and memory usage [1]. Initially, the authors were going to consider Docker containers against the AWS EC2. However, as per the Amazon AWS documentation, the Docker containers sit on the EC2 VMs instead of bare-metal hardware. As this defeats the purpose of the study, so authors decided to go with AWS EC2 Container Service (ECS) against AWS EC2 for VM-based deployment as both are deployed on the same Amazon cloud. The paper provides the following things, a methodology and an experimental setup to assess the performance, a comparative performance based on different deployment scenarios, and showcase the final result of the comparison.

The authors then briefly describe the background of microservices architecture, service-oriented architecture (SOA), docker containers, virtual machines, and hypervisors. The main difference between the microservices architecture and the SOA is that the services are loosely coupled, reusable and dynamically used. On the other hand, talking about virtualization, the authors state that hypervisors in virtual machines increase the overhead lowering the performance as the hypervisor is responsible for managing physical resources and virtualization. So, to overcome these drawbacks, containers came into the picture, making it easy to deploy containers on any infrastructure. The paper shows differences between the virtual machines and docker containers using images, also stating that apart from the performance, the docker containers consumed less power than virtual machines. The paper states a considerable overhead caused due to the deployment of docker containers on top of the EC2 virtual machine adopted by Amazon cloud. The reason behind using such an approach is to utilize the existing infrastructure. Another reason for this approach is that the customers get the freedom to manage their containers hosted on the ECS, providing all the EC2 VMs' features.

The authors perform various experiments on the EC2 Container Service (ECS) and EC2 VMs by deploying Docker containers on the ECS. The purpose of the experiments is to evaluate the performance difference between the VM-based and Container-based services. Three vital steps are performed in the AWS Environment Setup, Performance Metrics, and the Measurement Tool experiments. So, in the AWS Environment Setup, the authors configure the ECS service cluster in the Tokyo region. After setting up the environment, three different scenarios are considered for evaluating the performance. In scenario 1, they considered only one web service running on one container instance. In scenario 2, ECS scaling is tested by running two web service tasks on one container running on different ports [1]. Finally, in scenario 3, the container instance is hosting multiple services all running simultaneously. Now, under the Performance Metrics, the authors have outlined some key aspects based on which performance comparison is made, like the Server Throughput (requests/sec), Response Time (millisecond), and CPU Utilization (percent). In the paper, the authors have used JMeter as a Measurement Tool which acts as a generation and testing tool. The experiment performed launched all instances in the Tokyo region, and the requests sent by JMeter were made at midnight to avoid any network fluctuations and overheads. Each performance metric computed for each user was repeated five times and averaged [1].

The experiment results for the first scenario showed that the throughput increased with an increase in the number of threads but then after a certain point started saturating at a thread count of 10 for both ECS and EC2. The CPU utilization reaches 100% for both ECS and EC2 when handling requests of 10 users and above. The response time is better of EC2 as compared to ECS. For the second scenario, the throughput flattened slightly less than scenario 1, whereas the response time also degraded. Comparing the performance measure of scenarios 1 and 2 shows that the performance degraded as more services get deployed.

In this paper, the authors have experimented with comparing the performance of cloud-based services deployed using docker containers and virtual machines on the Amazon cloud environment. So, in conclusion, the result in general and under three deployment scenarios is that the VM-based services easily outperformed the container-based web services for all three performance metrics. So, through this paper, the authors suggest that EC2 in the AWS cloud is the recommended choice over the ECS service for stringent performance requirements. As for future work, the authors plan to perform the same experiment for GCP and Microsoft Azure platforms.

## References

[1] T. Salah, M. J. Zemerly, Y. C. Yeun, M. Al-Qutayri, and Y. Al-Hammadi, "Performance Comparison between Container-based and VM-based Services," in *20th Conference on Innovations in Clouds, Internet, and Networks (ICIN)*, Abu Dhabi, 2017.