CSCI 5410

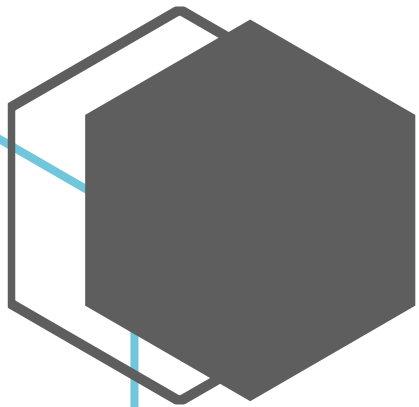### Assignment 1 – Part A

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Research Paper Critique

The article - "Performance Comparison between Container-based and VM-based Services" seeks to assess the execution metrics corresponding to Container technology and Virtual Machine (VM)-based services. Microservice architecture, which is popular for large-scale processes, is commonly deployed using Docker Containers, or virtual machines [1]. The paper contradicts the common notion, that services that are executed with containers perform better than those over virtual machines and provides substantial evidence to support its claim. With advancements in Cloud computing, dockers have emerged as the popular choice for deployment of services since they compress all associated objects and dependencies in a single image. Reports have shown that containers tend to outperform virtual machines due to relatively lesser execution time and higher throughput. The paper also points out that unlike common practices, Containers in Amazon are deployed over a Virtual Machine rather than a physical hardware and compares Amazons Elastic Container Service (ECS) and Elastic Cloud Compute (EC2), which're Amazon Web Services for Containers and Virtual Machines, respectively, eventually proving that the performance of a Virtual Machine is far superior to that of a Container.

The article introduces the domain of Microservices and Service Oriented Architecture (SOA), elaborating how SOA supports reusability and loose coupling between dynamic components. It then proceeds to contrast how Virtual Machines and Containers are hosted and elaborates how the Hypervisors in Virtual Machines cause large overheads as opposed to portable and scalable Docker images. Various studies have shown that Services deployed using containers result in less latency over virtual machines and introduced lower power consumption. Amazon might have adopted the practice of deploying containers over VMs to optimize costs through reuse of existing resources, ease of maintenance of containers and increase speed but the performance of containerized services has not been a major concern. The authors therefore quantified the difference in performance through experimental work by comparing the performance of containers-based services with VM-based services when both are deployed on a same virtual environment.

The authors chose a ECS service from the Tokyo region, JMeter to generate and test requests and a webpage to which HTTP requests were generated, in order to perform their experiment. Three performance metrics, namely, Throughput, Response Time and CPU Utilization were computed, in three different scenarios for varying number of users, repeated five times and averaged. The first scenario consisted of a single web service executing on one Container instance and a similar VM instance. In each subsequent scenarios, the number of web services running on the Container and VM was incremented by one.

In the first scenario, the throughput recorded for the ECS and EC2 instances was 8000 and 10,000 requests per second (req/s), respectively [2]. In the subsequent scenario these figures were reduced to 6000 and 9000 req/s before flattening off at 5500 and 7000 req/s for the third scenario. The EC2 instance also exhibited lesser response time and lesser CPU Utilization than the ECS instance. The ECS instance displayed a significant extra execution time by 125% for a workload of 20 users for two web

services. In addition, the ECS instance was observed to reach peak CPU utilization way ahead of the EC2 instance.

The article highlights that the major cause of the performance degradation in container-based services was attributed to deployment mechanism adopted by Amazon. The domain of the paper corresponds to Cloud Computing and performance of Virtual machines. The paper briefly describes Multiservice architectures, Containers and Virtual Machines. Subsequently, it compares the performance of Amazons Container Technology against its Virtual Machines and concluded that the performance of Virtual Machines was observed to be significantly better than the Containers. In conclusion, the paper conjectures that VM-based web services outperform container-based web services with respect to all performance metrics and recommends the use of EC2 in AWS cloud for deploying applications with stringent performance requirements with ample evidence and results.

Citations

[1]   J. Zhang, X. Lu and D. K. Panda, "Performance Characterization of Hypervisor-and Container-Based Virtualization for HPC on SR-IOV Enabled InfiniBand Clusters," *2016 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, Chicago, IL, 2016, pp. 1777-1784.

[2]   T. Salah, M. J. Zemerly, C. Y. Yeun, M. Al-Qutayri and Y. Al-Hammadi, "Performance comparison between container-based and VM-based services," *2017 20th Conference on Innovations in Clouds, Internet and Networks (ICIN)*, 2017, pp. 185-190, doi: 10.1109/ICIN.2017.7899408.