A CONTAINER-BASED PLATFORM FOR MULTI-CLOUD APPLICATION ORCHESTRATION

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Degree of MSc in Computer Science specialising in Cloud Computing

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DECLARATION

I declare that this is my own work and this dissertation does not incorporate without acknowledgment any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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The above candidate has carried out research for the Master's dissertation under my supervision.

Name of the supervisor: Dr. H. M. N. Dilum Bandara

Signature of the Supervisor: .... Date: *17/03/2020*

ABSTRACT

Multi-cloud applications are becoming popular, as they can run across multiple public and private cloud platforms while overcoming vendor lock-in, reducing cost, and enhancing flexibility and reliability. Applications hosted on multiple cloud platforms use either libraries or service-based abstraction layers. Application orchestration platforms further simplify the deployment and management of multi-cloud applications by providing auto-scaling, service metering, health monitoring, and a rich set of operational tools. Containerization is particularly useful in multi-cloud applications, as it provides a consistent environment for an application regardless of where it is deployed. However, container orchestration platforms such as Docker Swarm lack support and operational tools to enable seamless application orchestration across multi-cloud resources.

In this research, we developed a container-based platform for application orchestration in a multi-cloud setup as a set of microservices and required operational tools addressing the above limitations. Docker was chosen to demonstrate the proof of concept solution, as it already provides features to orchestrate microservices. Containerized multi-cloud applications can use the proposed application orchestration platform to achieve resource elasticity across multiple cloud platforms. To trigger scale in and out decisions, we used a rule-based approach where we compared the container runtime metrics provided by Docker with preconfigured threshold values. We evaluated the utility of the proposed platform using three web applications that were compute-intensive, memory-intensive, and utilized a RESTful application programming interface integrated with an external cloud service. The proposed container-based application orchestration platform improved the throughput of the three web applications by 180%, 73%, and 46%, respectively, compared to the same web applications deployed in a private cloud. Whereas the response time was reduced by 36%,-232%, and 7%, respectively. Even for cases where latency is increased error rate was reduced.

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API	Application Programming Interface
ARaaS	Application Runtime as a Service
AWS	Amazon Web Services
CD	Continuous Deployment
CLI	Command Line Interface
CN	Container
CPU	Central Processing Unit
CRUD	Create, Read, Update and Delete
DB	Database
DoS	Denial of Service
EC2	Elastic Compute Cloud
HW	Hardware
IaaS	Infrastructure as a Service
IT	Information Technology
LXC	Linux Containers
NFS	Network File System
ODM	Object Document Mapper
OS	Operating System
PaaS	Platform as a Service
QoS	Quality of Service
REST	Representational State Transfer
SaaS	Software as a Service
SDK	Software Development Kit
SLA	Service Level Agreements
SOA	Service-Oriented Architecture
SW	Software
vCPU	Virtual Central Processing Unit
VM	Virtual Machine