Frankfurt University of Applied Sciences

Master's Thesis

Containerized multi-level deployment for a distributed adaptive microservice application

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Declaration of Authorship

I, Tim Wißmann, declare that this thesis titled, 'Containerized multi-level deployment for a distributed adaptive microservice application' and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
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"Thanks to my solid academic training, today I can write hundreds of words on virtually any topic without possessing a shred of information, which is how I got a good job in journalism."

Dave Barry

FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Abstract

Faculty 2 - Computer Science and Engineering
Allgemeine Informatik Master

Master of Science

Containerized multi-level deployment for a distributed adaptive microservice application

by Tim Wißmann

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too...

Acknowledgements

The acknowledgements and the people to thank go here, don't forget to include your project advisor…

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Abbreviations

LAH **L**ist **A**bbreviations **H**ere

Chapter 1

Introduction

1.1 Scope

1.2 Intended audience

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1.4 Outline

Chapter 2

Background and related work

2.1 Baseline architecture

The current system design consists of multiple levels.

2.2 Problem statement

The existing application is clearly based on a microservice architecture. However, it is not able to run on a distributed system yet. It consists of multiple processes that have to run on the same system and need a full working operating system as baseline. Containerization of the system has never been tested (erprobt) and needs to be introduced. Additionally, the automatic service extension requires communication between the cluster orchestration management and the applications running on the nodes.

Regarding logging, while the frontend application does, the microservices currently do not produce log files. Instead, all sub processes write the information on its standard output stream.

2.3 Related Work

Chapter 3

System design

3.1 Target architecture

3.2 Applied technologies

Various applications for realizing the architecture have been compared. In the following sections the different options are that were taken into account are presented.

3.2.1 Cluster management

For managing the cluster several technologies were compared. - Hyper-V Replication controller - docker swarm - Kubernetes - open Shift

3.2.2 Cluster networking

flannel - noch nicht vollständig ausgereift

calico -> bevorzugt?

3.2.3 Container environment

As container environment `containerd` is used. Containerd is.. In comparison to other container environments this is ...

docker

containerd - container runtime which is used in docker -> Only tech with support for Windows - equal tech stack everywhere

LXC container linux containers

Chapter 4

Implementation

4.1 Cluster Setup

The following section describes the setup of different machines in the cluster, so called nodes. While the master node refers to the Kubernetes Control-Plane node which is responsible for distribution of the workers, the worker nodes are the actual machines that are executing the applications. During development the cluster was set up on virtual machines completely, due to the lack of physical hardware.

4.1.1 Creating the master node

For setting up the master node on Linux a system based on Debian Bullseye 11.5 has been used. After installing and setting up the operating system, the swap mechanism needs to be permanently turned off. This is done by editing the file system table (fstab) in file `/etc/fstab` respectively by commenting out the swap partitions and masking the systemd swap units.

After installing the pre-requisite packages, a containerd config file needs to be created. For this, the command from Listing 4.1 is applied.

```
sudo sysctl net.bridge.bridge-nf-call-iptables=1
echo 1 > /proc/sys/net/ipv4/ip_forward
sudo containerd config default | sudo tee /etc/containerd/config.toml &>/dev/null
```

Listing 4.1: Bash command for setting up containerd config

Afterwards the systemd control group (cgroup) is added to the runtime options of containerd and the its service is restarted. After setting up the prerequisites, the cluster can be initialized by running the command line tool as shown in Listing 4.2 with the appropriate configuration as parameter.

```
sudo kubeadm init --config config.yaml
```

LISTING 4.2: Bash command for setting up the cluster

Installing a Container Network Interface After successfully running the initialization, the cluster overlay network `flannel` needs to be setup. This is required for working with Windows worker nodes. To setup `flannel` the respective pod description can be directly downloaded from the vendor[1]. In the configuration the VNI (4096) and port (4789) for Flannel on Windows were set. Afterwards the configuration has been applied on the cluster. After linking kubectl to the local control plane node, the successful setup of the cluster can be checked with the `kubectl` command.

Adding the proxy daemonsets For using Windows worker nodes in a Kubernetes cluster, additional configmaps and daemonsets need to be applied on the cluster. Those are used for setting up a proxy for `flannel`.

```
curl -L https://github.com/kubernetes-sigs/sig-windows-tools/releases/latest/download/kube-proxy.yml |
kubectl apply -f https://github.com/kubernetes-sigs/sig-windows-tools/releases/latest/download/flannel
```

4.1.2 Creating the worker node

On the Windows worker node, the prerequisites were installed first. While installing the prerequisite `crictl` it was added to the PATH environment variable. After the setup, the node preparation scripts of the Kubernetes Special Interest Group (SIG) were retrieved. Before running the scripts, the **CNI!** (**CNI!**) version needs to be aligned to the same version written on the master node. Therefore the appearances of v0.2.0 have been replaced with v0.3.0 respectively. Afterwards the installation script was executed. It sets up the **NAT!** (**NAT!**) configuration on the worker node and registers containerd as a service. For having a valid image at a later point in time, the value sandbox_image in cri in containerd's configuration file (config.toml) needs to be replaced with a newer version.

[1] https://raw.githubusercontent.com/flannel-io/flannel/master/Documentation/kube-flannel.yml

After sucessfully setting up the **NAT!** and installing containerd as a service, the node will be finally prepared to host tasks. For this, another powershell script ”PrepareNode”[2] from the Kubernetes **SIG!** (**SIG!**) was run. After running the script the resulting ”StartKubelet” file needs to be changed to drop invalid arguments.

Furthermore, the following lines were added to the Kubelet configuration:

```
enforceNodeAllocatable: []
cgroupsPerQOS: false
enableDebuggingHandlers: true
```

Since the configuration changes needs to be served only to Windows machines (config value are valid for Windows only) we (‼WE‼) need to manually change the configuration on the nodes locally. This

After successful run of the preparation script the node was ready to join the cluster. For this, the

[2] https://github.com/kubernetes-sigs/sig-windows-tools/releases/download/v0.1.5/PrepareNode.ps1

Chapter 5

Discussion

5.1 Analysis

5.2 Dunno whata write yet...

Chapter 6

Conclusion and future work

6.1 Future work

- Linux port and cluster based on linux

6.2 Conclusion

Appendix A

Appendix Title Here

Write your Appendix content here.

cgroup control group

SIG Special Interest Group

Bibliography