# Solution M3: Container Orchestration

This is one possible and fully automated solution for the tasks included in the homework

All steps that follow assume that we decided to base our solution on **Debian 12** box

Please note, that this solution is intentionally far from being an optimal one

Here, the emphasis is put on readability and not on optimization or speed

You must adjust some values like IP addresses, image (or box) names, repository names, credentials, etc. to match your use case

## The Environment

Prepare the environment by creating a **Vagrantfile** with the following content

# -\*- mode: ruby -\*-

# vi: set ft=ruby :

Vagrant.configure("2") do |config|

  config.ssh.insert\_key = false

  config.vm.define "docker1" do |docker1|

    docker1.vm.box="shekeriev/debian-12.11"

    docker1.vm.hostname = "docker1.do1.lab"

    docker1.vm.network "private\_network", ip: "192.168.99.100"

    docker1.vm.synced\_folder "vagrant/", "/vagrant"

    docker1.vm.provision "shell", path: "docker.sh"

    docker1.vm.provision "shell", path: "docker-master.sh"

  end

  config.vm.define "docker2" do |docker2|

    docker2.vm.box="shekeriev/debian-12.11"

    docker2.vm.hostname = "docker2.do1.lab"

    docker2.vm.network "private\_network", ip: "192.168.99.101"

    docker2.vm.synced\_folder "vagrant/", "/vagrant"

    docker2.vm.provision "shell", path: "docker.sh"

    docker2.vm.provision "shell", path: "docker-worker.sh"

  end

  config.vm.define "docker3" do |docker3|

    docker3.vm.box="shekeriev/debian-12.11"

    docker3.vm.hostname = "docker3.do1.lab"

    docker3.vm.network "private\_network", ip: "192.168.99.102"

    docker3.vm.synced\_folder "vagrant/", "/vagrant"

    docker3.vm.provision "shell", path: "docker.sh"

    docker3.vm.provision "shell", path: "docker-worker.sh"

    docker3.vm.provision "shell", path: "docker-build-and-run.sh"

  end

end

We will need to create a **docker.sh** file to install and configure the necessary packages

#!/bin/bash

export DEBIAN\_FRONTEND=noninteractive

echo "\* Add hosts ..."

echo "192.168.99.100 docker1.do1.lab docker1" >> /etc/hosts

echo "192.168.99.101 docker2.do1.lab docker2" >> /etc/hosts

echo "192.168.99.102 docker3.do1.lab docker3" >> /etc/hosts

echo "\* Add any prerequisites ..."

apt-get update

apt-get install -y ca-certificates curl gnupg lsb-release git

echo "\* Add Docker repository and key ..."

curl -fsSL https://download.docker.com/linux/debian/gpg | gpg --dearmor -o /usr/share/keyrings/docker-archive-keyring.gpg

echo "deb [arch=$(dpkg --print-architecture) signed-by=/usr/share/keyrings/docker-archive-keyring.gpg] https://download.docker.com/linux/debian $(lsb\_release -cs) stable" | tee /etc/apt/sources.list.d/docker.list > /dev/null

echo "\* Install Docker ..."

apt-get update

apt-get install -y docker-ce docker-ce-cli containerd.io

echo "\* Add vagrant user to docker group ..."

usermod -aG docker vagrant

echo "\* Adjust Docker configuration ..."

sed -i 's@-H fd://@-H fd:// -H tcp://0.0.0.0@g' /lib/systemd/system/docker.service

echo "\* Restart Docker ..."

systemctl daemon-reload

systemctl restart docker

Next, we can create two separate files for the Swarm initialization and joining processes

First, we will create one for the master named **docker-master.sh** with the following content

#!/bin/bash

echo "\* Initialize swarm ..."

docker swarm init --advertise-addr 192.168.99.100

echo "\* Save the worker join token to a file ..."

docker swarm join-token -q worker > /vagrant/token.txt

Then, we will create a **docker-worker.sh** file for the nodes with the following content

#!/bin/bash

echo "\* Join the swarm ..."

docker swarm join --token $(cat /vagrant/token.txt) --advertise-addr $(hostname -I | cut -d ' ' -f 2) 192.168.99.100:2377

So far, we have the base infrastructure

We can stop here and do the steps related to the images and containers manually

Instead, we will continue our automation initiative

## The Web Component

In general, we should stick to the rule - one container, one process

This will lead us to a separation of the **PHP** and **NGINX** functionalities

Because the task requirements are asking us to combine **PHP** and **NGINX** in one container, let us see how this can be done

There are multiple ways to accomplish this

For this particular example the **Supervisor** utility was used

Once again, please note, that even though it is recommended every container to be responsible for one process (to have one process running), we can override this recommendation

We must create **application/Dockerfile.web** with the following or similar content

FROM php:fpm

# Install additional packages

RUN docker-php-ext-install pdo\_mysql

# Adds the NGINX and Supervisor packages

RUN apt-get update -y && apt-get install -y nginx supervisor

# Removes the /etc/nginx/sites-{available,enabled} folders

RUN rm -rf /etc/nginx/sites-\*

# Redirects the NGINX log (access and error) to stdout and stderr

RUN ln -sf /dev/stdout /var/log/nginx/access.log && ln -sf /dev/stderr /var/log/nginx/error.log

# Adds our specific configuration for NGINX

ADD ./support/nginx-php.conf /etc/nginx/conf.d/nginx-php.conf

# Adds configuration for Supervisor utility

ADD ./support/supervisor.conf /etc/supervisor.conf

# Copies our PHP application

ADD ./bgapp/web/ /var/www/html/

# Exposes port 80

EXPOSE 80

# Sets the routine to be executed when container is started

CMD ["supervisord", "-c", "/etc/supervisor.conf"]

As we can see a few other files are referenced here

One of the additional files is the **NGINX** configuration (**application/support/nginx-php.conf**) with the following content

server {

        listen 80  default\_server;

        root /var/www/html;

        index index.php index.html index.htm;

        location / {

            try\_files $uri index.php$is\_args$args;

        }

        location ~ \.php$ {

            include fastcgi\_params;

            fastcgi\_pass 127.0.0.1:9000;

            fastcgi\_index index.php;

            fastcgi\_param SCRIPT\_FILENAME $document\_root/$fastcgi\_script\_name;

        }

}

The other additional file is the **Supervisor** configuration (**application/support/supervisor.conf**) with the following content

[supervisord]

nodaemon=true

[program:nginx]

command=nginx -c /etc/nginx/nginx.conf  -g 'daemon off;'

process\_name=%(program\_name)s\_%(process\_num)02d

numprocs=1

autostart=true

autorestart=false

startsecs=0

redirect\_stderr=true

stdout\_logfile=/dev/stdout

stdout\_logfile\_maxbytes=0

[program:php-fpm]

command=php-fpm -R -F -c /usr/local/etc/php-fpm.conf

process\_name=%(program\_name)s\_%(process\_num)02d

numprocs=1

autostart=true

autorestart=false

startsecs=0

redirect\_stderr=true

stdout\_logfile=/dev/stdout

stdout\_logfile\_maxbytes=0

The **index.php** file and the rest of the application is the same as the used during the class practice, so nothing new here

## The Database Component

This component is simpler than the other one

Here we have just one process encapsulated in one container

The **application/Dockerfile.db** may look like this

FROM mariadb:10.7

ADD ./bgapp/db/db\_setup.sql /docker-entrypoint-initdb.d/init.sql

The **db\_setup.sql** file is the one used during the class practice, so nothing new here

## Other Infrastructure Files

In order to achieve as much automation as possible, we will need a few more files

The main supplementary file is the **docker-build-and-run.sh** executed on the third node. It should be like

#!/bin/bash

echo "\* Login to Docker Hub ..."

cat /vagrant/support/docker-hub-cred.txt | docker login --username shekeriev --password-stdin

echo "\* Clone the repository ..."

cd /vagrant/application && git clone https://github.com/shekeriev/bgapp

echo "\* Buld the web (php+nginx) image ..."

docker build -t shekeriev/hw3-web -f /vagrant/application/Dockerfile.web /vagrant/application/.

echo "\* Build the db image ..."

docker build -t shekeriev/hw3-db -f /vagrant/application/Dockerfile.db /vagrant/application/.

echo "\* Push the web image ..."

docker image push shekeriev/hw3-web

echo "\* Push the db image ..."

docker image push shekeriev/hw3-db

echo "\* Start the stack ..."

docker -H 192.168.99.100 stack up -c /vagrant/docker-compose.yaml hw3

echo "\* Show services in the stack ..."

docker -H 192.168.99.100 stack ps hw3

We should create a file (**support/docker-hub-cred.txt**) that contains our credentials (password) for **Docker Hub**

YOUR DOCKER HUB PASSWORD

Substitute the string with your password

Do not forget to change **shekeriev** to match your **Docker Hub** account name

The rest of the instructions in the above file are building the two images and pushing them to Docker **Hub**

Then they can be referred in our **docker-compose.yml** file and used to spin up our application stack

## The Compose File

Finally, we reached the point to check the **docker-compose.yaml** file

It should have the following content

services:

    web:

        image: shekeriev/hw3-web

        deploy:

            replicas: 3

        ports:

            - 8080:80

        networks:

            - appnet

        depends\_on:

            - db

    db:

        image: shekeriev/hw3-db

        networks:

            - appnet

        environment:

            MYSQL\_ROOT\_PASSWORD: "12345"

networks:

    appnet:

Do not forget to change **shekeriev** to match your **Docker Hub** account name

## Automatic Execution

This is all we need

The solution can be brought to life with the usual command

**vagrant up**

Sit back, relax, and watch the process

Once, everything is up and running, give it additional 30 seconds

Then open a browser tab on the host and navigate to one of the IP address of one of the nodes, for example

<http://192.168.99.100:8080>

There you should see the web application used for the class practice