Inception-of-Things
(IoT)

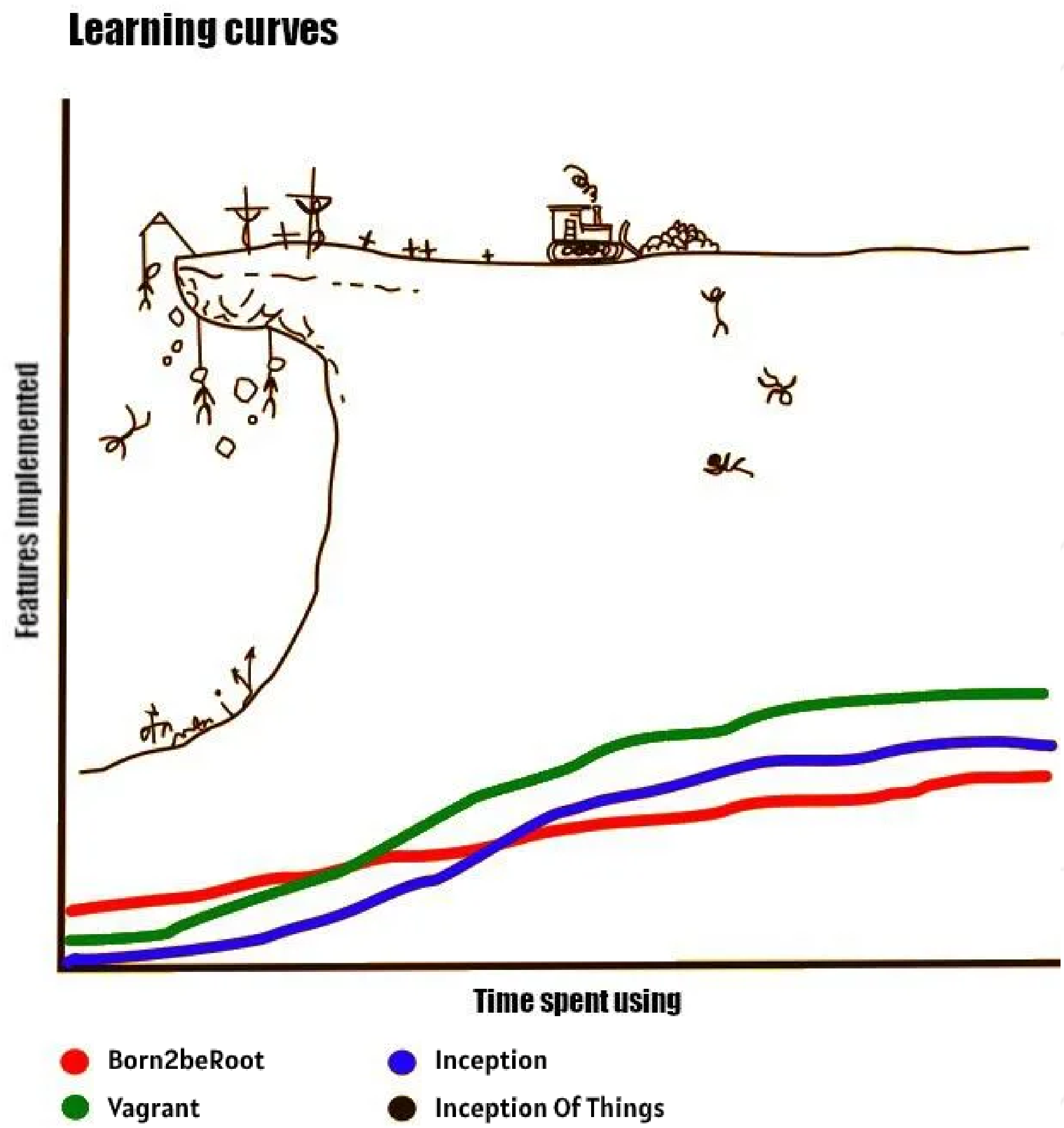
Summary: This document is a System Administration related exercise.

Version: 3.1

Contents

Chapter I

Preamble



Chapter II

Introduction

This project aims to deepen your knowledge by making you use `K3d` and `K3s` with `Vagrant`.

You will learn how to set up a personal virtual machine with `Vagrant` and `the distribution of your choice`. Then, you will learn how to use `K3s` and its `Ingress`. Last but not least, you will discover `K3d` that will simplify your life.

These steps will get you started with `Kubernetes`.

> This project is a minimal introduction to Kubernetes. Indeed, this tool is too complex to be mastered in a single subject.

Chapter III

General guidelines

- The whole project has to be done in a **virtual machine**.
- You have to put all the configuration files of your project in folders located at the root of your repository (go to Submission and peer-evaluation for more information). The folders of the mandatory part will be named: `p1`, `p2` and `p3`, and the bonus one: `bonus`.
- This topic requires you to apply concepts that, depending on your background, you may not have covered yet. We therefore advise you not to be afraid to read a lot of documentation to learn how to use `K8s` with `K3s`, as well as `K3d`.

You can use any tools you want to set up your host **virtual machine** as well as the provider used in Vagrant.

Chapter IV

Mandatory part

This project will consist of setting up several environments under specific rules.

It is divided into three parts you have to do in the following order:

- Part 1: K3s and Vagrant
- Part 2: K3s and three simple applications
- Part 3: K3d and Argo CD

IV.1 Part 1: K3s and Vagrant

To begin, you have to set up 2 **machines**.

Write your first `Vagrantfile` using the **latest stable version** of `the distribution of your choice` as your operating system. It is STRONGLY advised to allow only the bare minimum in terms of resources: 1 CPU and 512 MB of RAM (or 1024). The machines must be run using `Vagrant`.

Here are the expected specifications:

- The machine names must be the login of someone from your team. The hostname of the first machine must be followed by the capital letter S (like *Server*). The hostname of the second machine must be followed by SW (like *ServerWorker*).
- Have a dedicated IP on the primary network interface. The IP of the first machine (*Server*) will be `192.168.56.110`, and the IP of the second machine (*ServerWorker*) will be `192.168.56.111`.
- Be able to connect with SSH on both machines with no password.

⚠ You will set up your Vagrantfile according to modern practices.

You must install `K3s` on both machines:

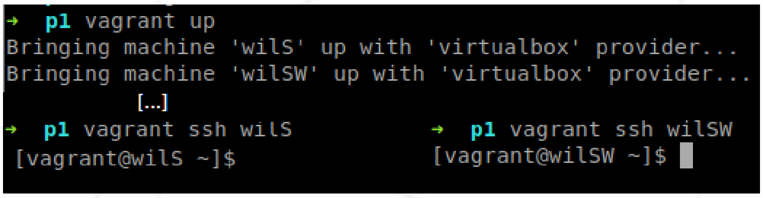
- In the first one (*Server*), it will be installed in controller mode.
- In the second one (*ServerWorker*), in agent mode.

💡 You will have to use **kubectl** (and therefore install it as well).

Here is a **basic example** of a `Vagrantfile`:

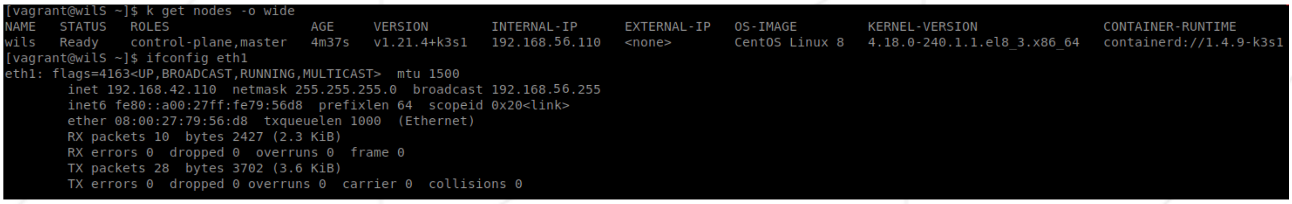
```
$> cat Vagrantfile
Vagrant.configure(2) do |config|
    [...]
    config.vm.box = REDACTED
    config.vm.box_url = REDACTED

    config.vm.define "wilS" do |control|
            control.vm.hostname = "wilS"
            control.vm.network REDACTED, ip: "192.168.56.110"
            control.vm.provider REDACTED do |v|
                v.customize ["modifyvm", :id, "--name", "wilS"]
                [...]
        end
        config.vm.provision :shell, :inline => SHELL
            [...]
        SHELL
            control.vm.provision "shell", path: REDACTED
    end
    config.vm.define "wilSW" do |control|
            control.vm.hostname = "wilSW"
            control.vm.network REDACTED, ip: "192.168.56.111"
            control.vm.provider REDACTED do |v|
                v.customize ["modifyvm", :id, "--name", "wilSW"]
                [...]
            end
            config.vm.provision "shell", inline: <<-SHELL
                  [..]
            SHELL
            control.vm.provision "shell", path: REDACTED
    end
end
```

Here is an example when the virtual machines are launched:



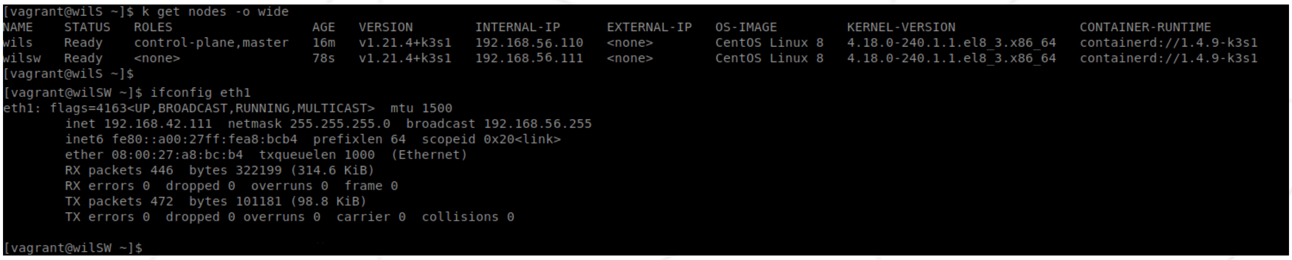
```
➜  p1 vagrant up
Bringing machine 'wilS' up with 'virtualbox' provider...
Bringing machine 'wilSW' up with 'virtualbox' provider...
          [...]
➜  p1 vagrant ssh wilS            ➜  p1 vagrant ssh wilSW
 [vagrant@wilS ~]$                [vagrant@wilSW ~]$
```

Here is an example when the configuration is not complete:



```
[vagrant@wilS ~]$ k get nodes -o wide
NAME   STATUS   ROLES                  AGE     VERSION        INTERNAL-IP      EXTERNAL-IP   OS-IMAGE         KERNEL-VERSION                CONTAINER-RUNTIME
wils   Ready    control-plane,master   4m37s   v1.21.4+k3s1   192.168.56.110   <none>        CentOS Linux 8   4.18.0-240.1.1.el8_3.x86_64   containerd://1.4.9-k3s1
[vagrant@wilS ~]$ ifconfig eth1
eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.42.110  netmask 255.255.255.0  broadcast 192.168.56.255
        inet6 fe80::a00:27ff:fe79:56d8  prefixlen 64  scopeid 0x20<link>
        ether 08:00:27:79:56:d8  txqueuelen 1000  (Ethernet)
        RX packets 10  bytes 2427 (2.3 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 28  bytes 3702 (3.6 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

Here is an example when the machines are correctly configured:



```
[vagrant@wilS ~]$ k get nodes -o wide
NAME    STATUS   ROLES                  AGE   VERSION        INTERNAL-IP      EXTERNAL-IP   OS-IMAGE         KERNEL-VERSION                CONTAINER-RUNTIME
wils    Ready    control-plane,master   16m   v1.21.4+k3s1   192.168.56.110   <none>        CentOS Linux 8   4.18.0-240.1.1.el8_3.x86_64   containerd://1.4.9-k3s1
wilsw   Ready    <none>                 78s   v1.21.4+k3s1   192.168.56.111   <none>        CentOS Linux 8   4.18.0-240.1.1.el8_3.x86_64   containerd://1.4.9-k3s1
[vagrant@wilS ~]$
[vagrant@wilSW ~]$ ifconfig eth1
eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.42.111  netmask 255.255.255.0  broadcast 192.168.56.255
        inet6 fe80::a00:27ff:fea8:bcb4  prefixlen 64  scopeid 0x20<link>
        ether 08:00:27:a8:bc:b4  txqueuelen 1000  (Ethernet)
        RX packets 446  bytes 322199 (314.6 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 472  bytes 101181 (98.8 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

[vagrant@wilSW ~]$
```

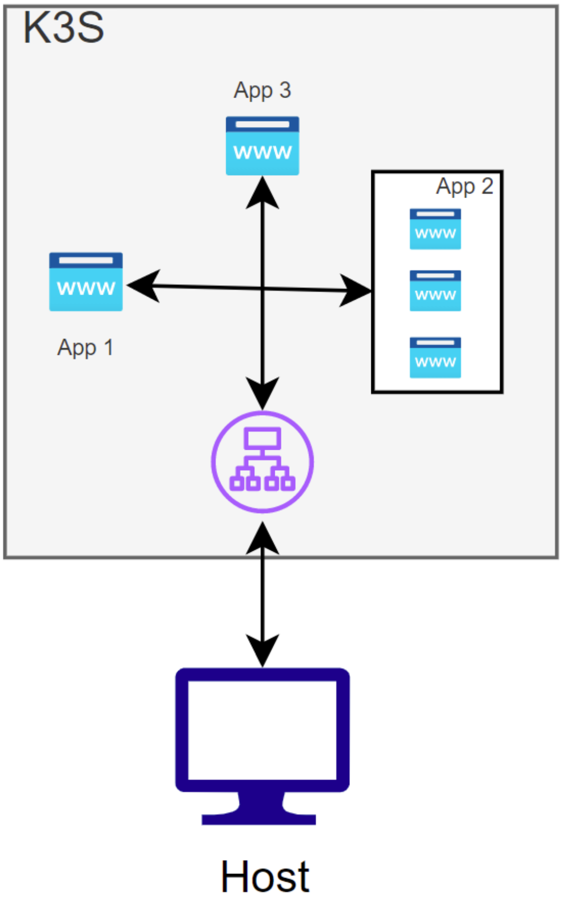
On the example above the use of ifconfig eth1 is done under macOS, if you are under the latest version of linux the command is: ip a show eth1

IV.2 Part 2: K3s and three simple applications

You now understand the basics of K3s. Time to go further! To complete this part, you will need only one virtual machine with **the distribution of your choice** (**latest stable version**) and K3s in server mode installed.

You will set up 3 web applications of your choice that will run in your K3s instance. You will have to be able to access them depending on the HOST used when making a request to the IP address 192.168.56.110. The name of this machine will be your login followed by S (e.g., *wilS* if your login is *wil*).

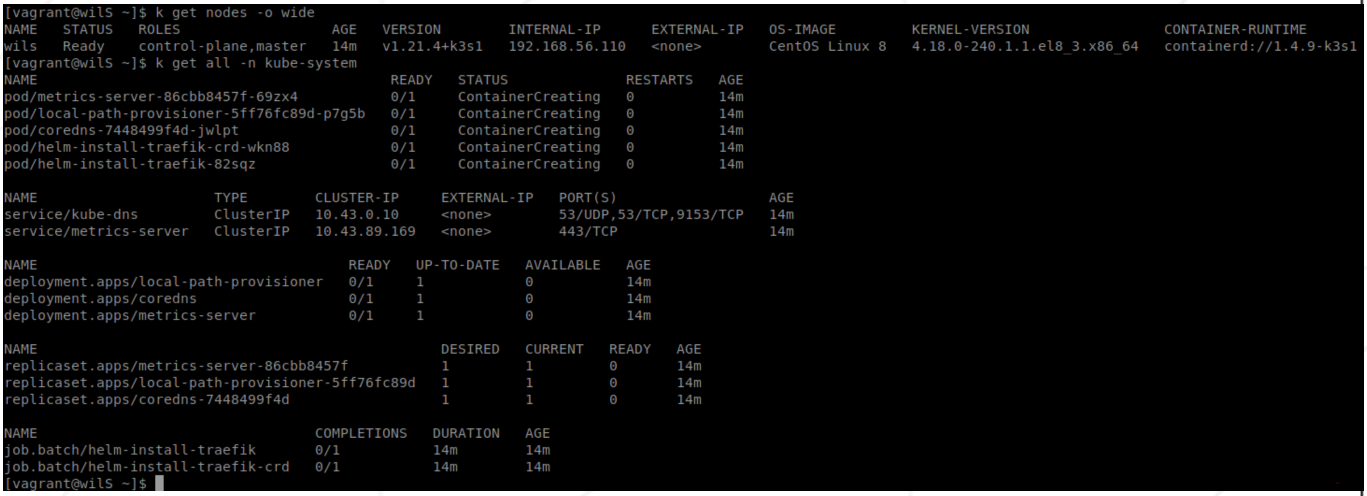
Here is a simple example diagram:



When a client inputs the IP address 192.168.56.110 in their web browser with the HOST *app1.com*, the server must display app1. When the HOST *app2.com* is used, the server must display app2. Otherwise, app3 will be selected by default.

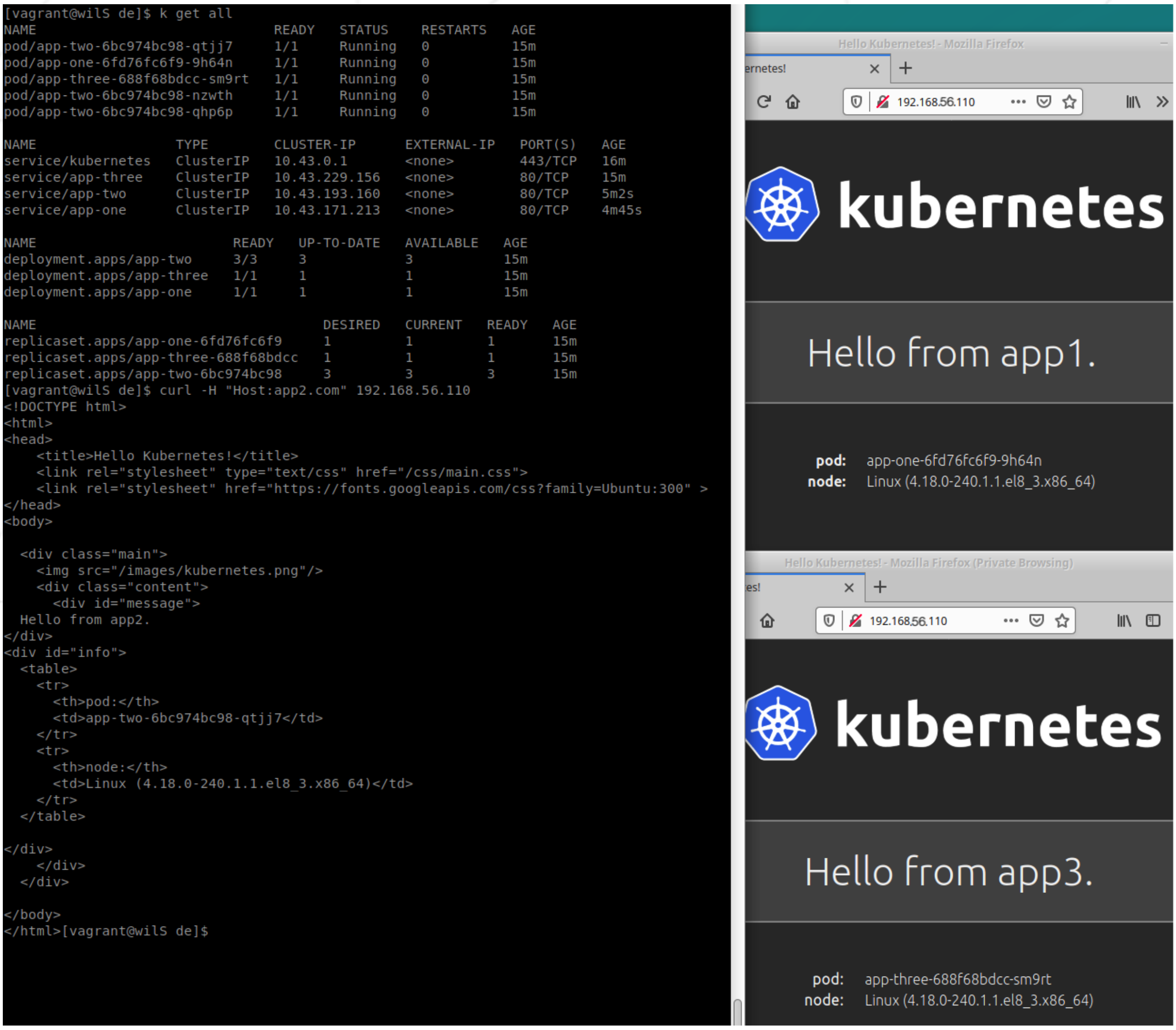
As you can see, application number 2 has 3 replicas. Adapt your configuration to create the replicas.

First, here is an expected result when the virtual machine is not configured:



```
[vagrant@wilS ~]$ k get nodes -o wide
NAME   STATUS   ROLES                  AGE   VERSION        INTERNAL-IP      EXTERNAL-IP   OS-IMAGE         KERNEL-VERSION                CONTAINER-RUNTIME
wils   Ready    control-plane,master   14m   v1.21.4+k3s1   192.168.56.110   <none>        CentOS Linux 8   4.18.0-240.1.1.el8_3.x86_64   containerd://1.4.9-k3s1
[vagrant@wilS ~]$ k get all -n kube-system
NAME                                          READY   STATUS              RESTARTS   AGE
pod/metrics-server-86cbb8457f-69zx4           0/1     ContainerCreating   0          14m
pod/local-path-provisioner-5ff76fc89d-p7g5b   0/1     ContainerCreating   0          14m
pod/coredns-7448499f4d-jwlpt                  0/1     ContainerCreating   0          14m
pod/helm-install-traefik-crd-wkn88            0/1     ContainerCreating   0          14m
pod/helm-install-traefik-82sqz                0/1     ContainerCreating   0          14m

NAME                     TYPE        CLUSTER-IP     EXTERNAL-IP   PORT(S)                  AGE
service/kube-dns         ClusterIP   10.43.0.10     <none>        53/UDP,53/TCP,9153/TCP   14m
service/metrics-server   ClusterIP   10.43.89.169   <none>        443/TCP                  14m

NAME                                     READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/local-path-provisioner   0/1     1            0           14m
deployment.apps/coredns                  0/1     1            0           14m
deployment.apps/metrics-server           0/1     1            0           14m

NAME                                                DESIRED   CURRENT   READY   AGE
replicaset.apps/metrics-server-86cbb8457f           1         1         0       14m
replicaset.apps/local-path-provisioner-5ff76fc89d   1         1         0       14m
replicaset.apps/coredns-7448499f4d                  1         1         0       14m

NAME                                 COMPLETIONS   DURATION   AGE
job.batch/helm-install-traefik       0/1           14m        14m
job.batch/helm-install-traefik-crd   0/1           14m        14m
[vagrant@wilS ~]$ 
```

Here is an expected result when the virtual machine is correctly configured:



```
[vagrant@wilS de]$ k get all
NAME                              READY   STATUS    RESTARTS   AGE
pod/app-two-6bc974bc98-qtjj7      1/1     Running   0          15m
pod/app-one-6fd76fc6f9-9h64n      1/1     Running   0          15m
pod/app-three-688f68bdcc-sm9rt    1/1     Running   0          15m
pod/app-two-6bc974bc98-nzwth      1/1     Running   0          15m
pod/app-two-6bc974bc98-qhp6p      1/1     Running   0          15m

NAME                   TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)   AGE
service/kubernetes     ClusterIP   10.43.0.1       <none>        443/TCP   16m
service/app-three      ClusterIP   10.43.229.156   <none>        80/TCP    15m
service/app-two        ClusterIP   10.43.193.160   <none>        80/TCP    5m2s
service/app-one        ClusterIP   10.43.171.213   <none>        80/TCP    4m45s

NAME                        READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/app-two     3/3     3            3           15m
deployment.apps/app-three   1/1     1            1           15m
deployment.apps/app-one     1/1     1            1           15m

NAME                                   DESIRED   CURRENT   READY   AGE
replicaset.apps/app-one-6fd76fc6f9     1         1         1       15m
replicaset.apps/app-three-688f68bdcc   1         1         1       15m
replicaset.apps/app-two-6bc974bc98     3         3         3       15m
[vagrant@wilS de]$ curl -H "Host:app2.com" 192.168.56.110
<!DOCTYPE html>
<html>
<head>
    <title>Hello Kubernetes!</title>
    <link rel="stylesheet" type="text/css" href="/css/main.css">
    <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Ubuntu:300" >
</head>
<body>

  <div class="main">
    <img src="/images/kubernetes.png"/>
    <div class="content">
      <div id="message">
  Hello from app2.
</div>
<div id="info">
  <table>
    <tr>
      <th>pod:</th>
      <td>app-two-6bc974bc98-qtjj7</td>
    </tr>
    <tr>
      <th>node:</th>
      <td>Linux (4.18.0-240.1.1.el8_3.x86_64)</td>
    </tr>
  </table>

</div>
    </div>
  </div>

</body>
</html>[vagrant@wilS de]$
```

Hello Kubernetes! - Mozilla Firefox

ernetes!

192.168.56.110

kubernetes

Hello from app1.

pod: app-one-6fd76fc6f9-9h64n
node: Linux (4.18.0-240.1.1.el8_3.x86_64)

Hello Kubernetes! - Mozilla Firefox (Private Browsing)

es!

192.168.56.110

kubernetes

Hello from app3.

pod: app-three-688f68bdcc-sm9rt
node: Linux (4.18.0-240.1.1.el8_3.x86_64)

`The Ingress is not displayed here on purpose. You will have to show it to your evaluators during your defense.`

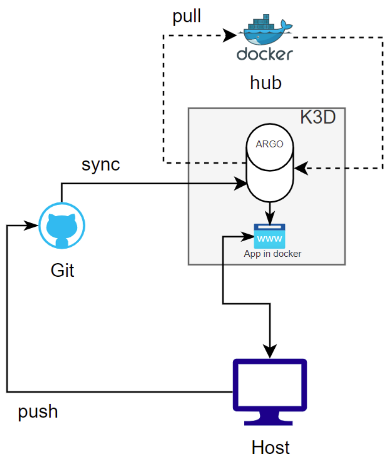
IV.3 Part 3: K3d and Argo CD

You now master a minimalist version of K3S! Time to set up everything you have just learnt (and much more!) but without Vagrant this time. To begin, install K3D on your virtual machine.

You will need Docker for K3d to work, and probably some other software as well. Therefore, you must write a **script** to install all the necessary packages and tools during your defense.

First of all, you must understand the difference between K3S and K3D.

Once your configuration works as expected, you can start to create your first **continuous integration**! To do so, you have to set up a small infrastructure following the logic illustrated by the diagram below:



You have to create two namespaces:

- The first one will be dedicated to Argo CD.
- The second one will be named *dev* and will contain an application. This application will be automatically deployed by Argo CD using your online Github repository.

Yes, indeed. You will have to create a public repository on Github where you will push your configuration files.
You are free to organize it the way you like. The only mandatory requirement is to put the login of a member of the group in the name of your repository.

The application to be deployed must have **two different versions** (read about tagging if you are unfamiliar with it).

You have two options:

- You can use the pre-made application created by Wil, which is available on Dockerhub.
- Or you can code and use your own application. Create a public Dockerhub repository to push a Docker image of your application. Also, tag its two versions this way: **v1** and **v2**.

You can find Wil's application on Dockerhub here:
https://hub.docker.com/r/wil42/playground.
The application uses port 8888.
Find the two versions in the *TAG* section.

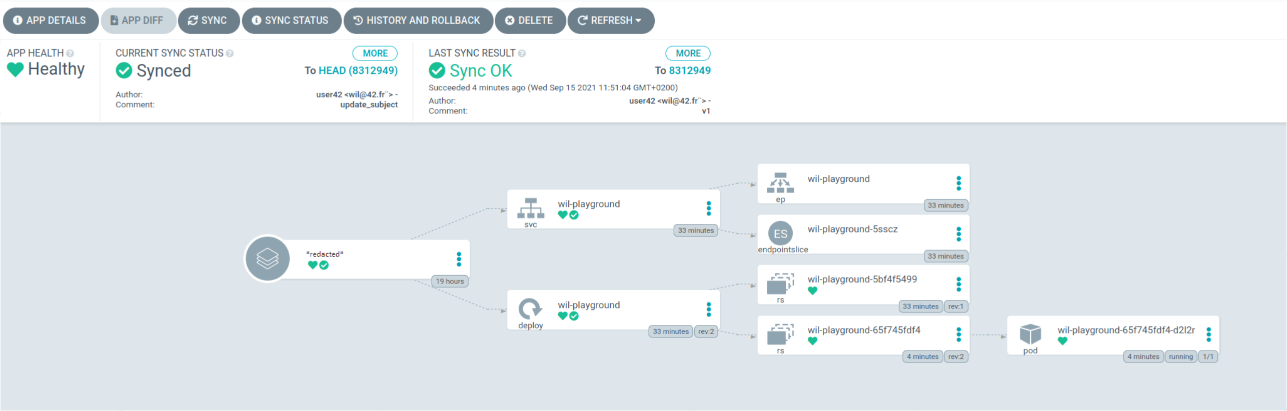
If you decide to create your own application, it must be made available thanks to a public Docker image pushed into a Dockerhub repository. The two versions of your application must also have a few differences.

You must be able to change the version from your public Github repository, then check that the application has been correctly updated.

Here is an example showing the two `namespaces` and the *POD* located in the *dev* `namespace`:

```
$> k get ns
NAME            STATUS  AGE
[..]
argocd          Active  19h
dev             Active  19h
$> k get pods -n dev
NAME                           READY  STATUS   RESTARTS  AGE
wil-playground-65f745fdf4-d2l2r 1/1   Running  0         8m9s
$>
```

Here is an example of launching `Argo CD` that was configured:



APP HEALTH
Healthy

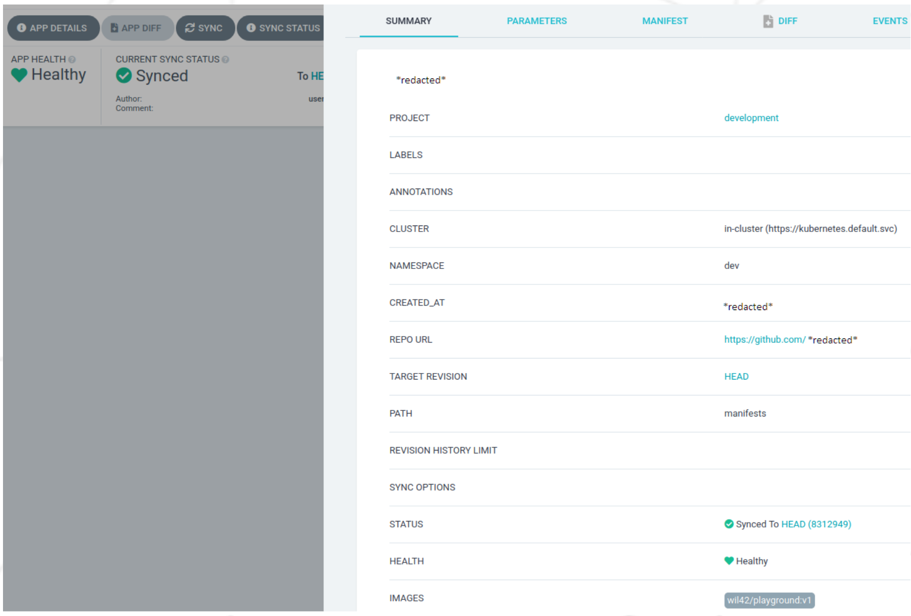
CURRENT SYNC STATUS
Synced
To HEAD (8312949)
Author: user42 <wil@42.fr¨> -
Comment: update_subject

LAST SYNC RESULT
Sync OK
To 8312949
Succeeded 4 minutes ago (Wed Sep 15 2021 11:51:04 GMT+0200)
Author: user42 <wil@42.fr¨> -
Comment: v1

We can check that our application uses the version we expect (in this case, the **v1**):

```
$> cat deployment.yaml | grep v1
     - image: wil42/playground:v1
$> curl http://localhost:8888/
{"status":"ok", "message": "v1"}
```

Here is a screenshot of `Argo CD` with our **`v1`** application using Github:



APP HEALTH
Healthy

CURRENT SYNC STATUS
Synced
To HE
Author: user
Comment:

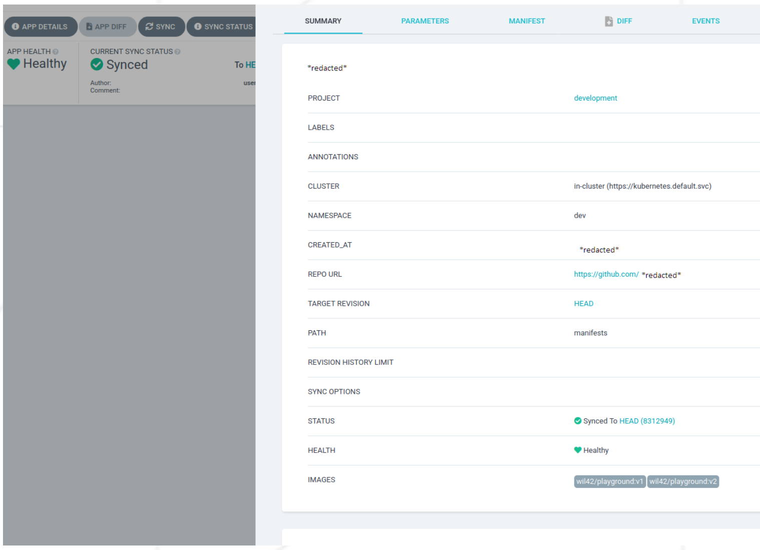
redacted

PROJECT	development
LABELS	
ANNOTATIONS	
CLUSTER	in-cluster (https://kubernetes.default.svc)
NAMESPACE	dev
CREATED_AT	*redacted*
REPO URL	https://github.com/ *redacted*
TARGET REVISION	HEAD
PATH	manifests
REVISION HISTORY LIMIT	
SYNC OPTIONS	
STATUS	Synced To HEAD (8312949)
HEALTH	Healthy
IMAGES	wil42/playground:v1

Below, we update our Github repository by changing the version of our application:

```
$>sed -i 's/wil42\/playground\:v1/wil42\/playground\:v2/g' deployment.yaml
$>g up "v2" # git add+commit+push
[..]
   a773f39..999b9fe master -> master
$> cat deployment.yaml | grep v2
  - image: wil42/playground:v2
```

You can see thanks to `Argo CD` that the application is synchronized:



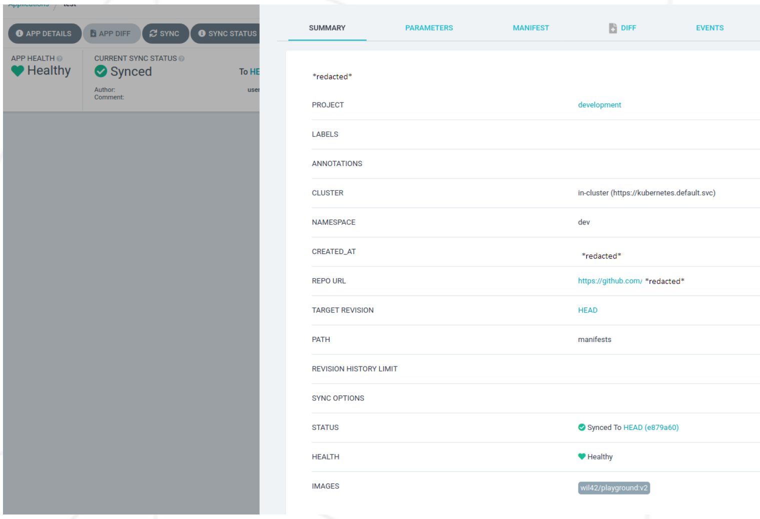
APP HEALTH
♥ Healthy

CURRENT SYNC STATUS
✓ Synced
To HE
Author:
Comment:
user

redacted

PROJECT	development
LABELS	
ANNOTATIONS	
CLUSTER	in-cluster (https://kubernetes.default.svc)
NAMESPACE	dev
CREATED_AT	*redacted*
REPO URL	https://github.com/ *redacted*
TARGET REVISION	HEAD
PATH	manifests
REVISION HISTORY LIMIT	
SYNC OPTIONS	
STATUS	✓ Synced To HEAD (8312949)
HEALTH	♥ Healthy
IMAGES	wil42/playground:v1 wil42/playground:v2

The application was successfully updated:



APP HEALTH
♥ Healthy

CURRENT SYNC STATUS
✓ Synced
To HE
Author:
Comment:
user

redacted

PROJECT	development
LABELS	
ANNOTATIONS	
CLUSTER	in-cluster (https://kubernetes.default.svc)
NAMESPACE	dev
CREATED_AT	*redacted*
REPO URL	https://github.com/ *redacted*
TARGET REVISION	HEAD
PATH	manifests
REVISION HISTORY LIMIT	
SYNC OPTIONS	
STATUS	✓ Synced To HEAD (e879a60)
HEALTH	♥ Healthy
IMAGES	wil42/playground:v2

We check that the new version is available:

```
$> curl http://localhost:8888/
{"status":"ok", "message": "v2"}
```

During the evaluation process, you will have to do this operation with the app you chose: Wil's or yours.

Chapter V

Bonus part

The following bonus task is intended to be useful: add **Gitlab** to the lab you completed in Part 3.

> `Beware this bonus is complex. The latest version available of Gitlab from the official website is expected.`

You are allowed to use whatever you need to achieve this extra. For example, `helm` could be useful here.

- Your Gitlab instance must run locally.
- Configure Gitlab to make it work with your cluster.
- Create a dedicated `namespace` named *gitlab*.
- Everything you did in Part 3 must work with your local Gitlab.

Turn this extra work in a new folder named `bonus` and located at the root of your repository. You can add everything needed so your entire cluster works.

> `The bonus part will only be assessed if the mandatory part is flawless. Flawless means the mandatory part has been fully completed and functions without issues. If you have not passed ALL the mandatory requirements, your bonus part will not be evaluated at all.`

Chapter VI

Submission and peer-evaluation

Turn in your assignment in your `Git` repository as usual. Only the work inside your repository will be evaluated during the defense. Don't hesitate to double check the names of your folders and files to ensure they are correct.

Reminder:

- Turn the mandatory part in three folders located at the root of your repository: `p1`, `p2` and `p3`.
- Optional: Turn the bonus part in a located at the root of your repository: `bonus`.

Below is an example of the expected directory structure:

```
 $> find -maxdepth 2 -ls
424242     4 drwxr-xr-x  6 wandre  wil42      4096 sept. 17 23:42 .
424242     4 drwxr-xr-x  3 wandre  wil42      4096 sept. 17 23:42 ./p1
424242     4 -rw-r--r--  1 wandre  wil42      XXXX sept. 17 23:42 ./p1/Vagrantfile
424242     4 drwxr-xr-x  2 wandre  wil42      4096 sept. 17 23:42 ./p1/scripts
424242     4 drwxr-xr-x  2 wandre  wil42      4096 sept. 17 23:42 ./p1/confs
424242     4 drwxr-xr-x  3 wandre  wil42      4096 sept. 17 23:42 ./p2
424242     4 -rw-r--r--  1 wandre  wil42      XXXX sept. 17 23:42 ./p2/Vagrantfile
424242     4 drwxr-xr-x  2 wandre  wil42      4096 sept. 17 23:42 ./p2/scripts
424242     4 drwxr-xr-x  2 wandre  wil42      4096 sept. 17 23:42 ./p1/confs
424242     4 drwxr-xr-x  3 wandre  wil42      4096 sept. 17 23:42 ./p3
424242     4 drwxr-xr-x  2 wandre  wil42      4096 sept. 17 23:42 ./p3/scripts
424242     4 drwxr-xr-x  2 wandre  wil42      4096 sept. 17 23:42 ./p3/confs
424242     4 drwxr-xr-x  3 wandre  wil42      4096 sept. 17 23:42 ./bonus
424242     4 -rw-r--r--  1 wandre  wil42      XXXX sept. 17 23:42 ./bonus/Vagrantfile
424242     4 drwxr-xr-x  2 wandre  wil42      4096 sept. 17 23:42 ./bonus/scripts
424242     4 drwxr-xr-x  2 wandre  wil42      4096 sept. 17 23:42 ./bonus/confs
```

`Any scripts you need will be added in a scripts folder. The configuration files will be in a confs folder.`

`The evaluation process will happen on the computer of the evaluated group.`