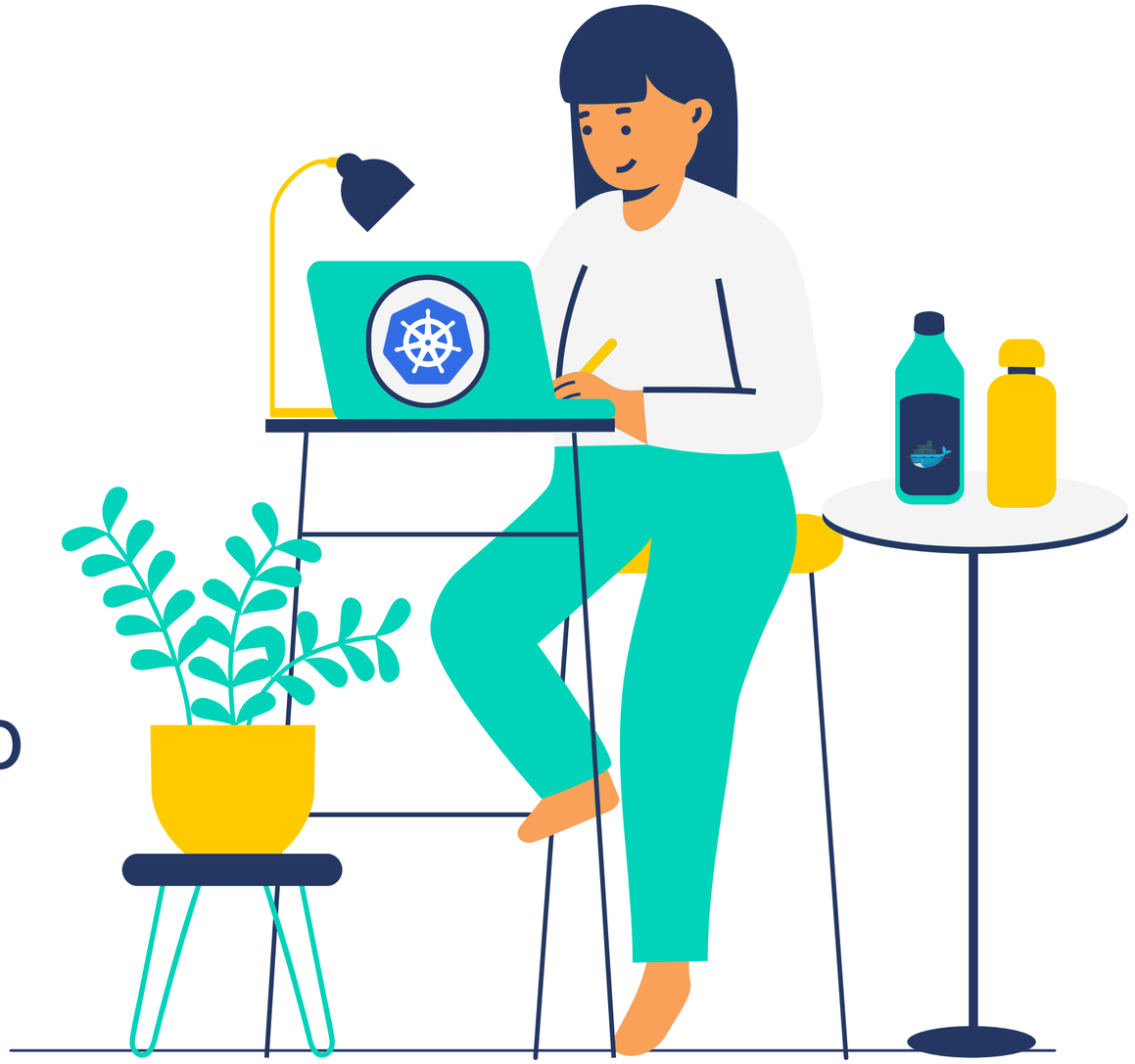
Containers & Kubernetes

A Beginner's Workshop

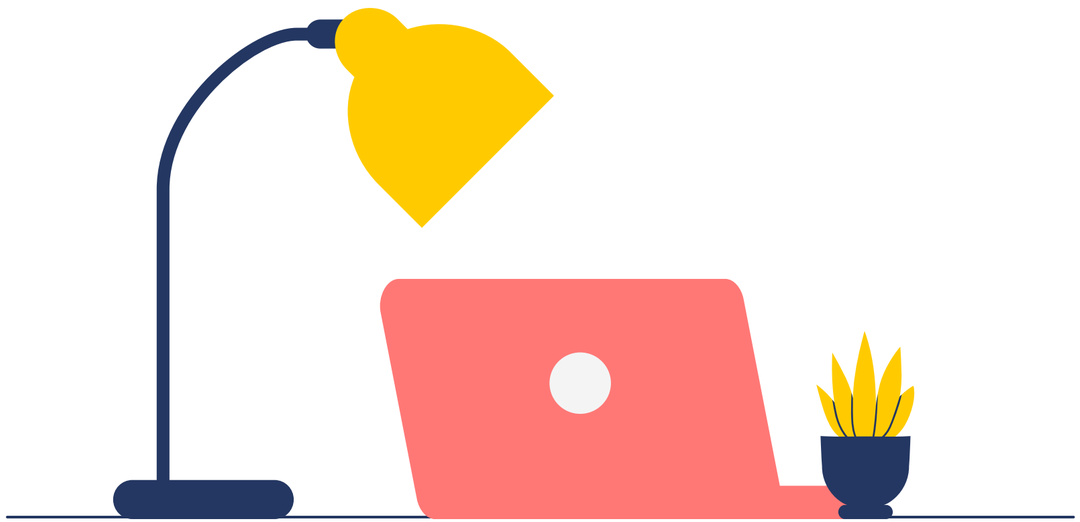
Rigerta Demiri & Katharina Sick

#theNewITGirls | November 17, 2023



About today

Let’s do a step-by-step journey into the world of containers and Kubernetes.



Containers & Docker

What are containers? Why are they cool? How to create & use them?

Kubernetes

What is Kubernetes? Why do so many companies need it? How to get started?

Troubleshooting and Questions

Feel free to ask any time! :)

Hello, I'm Rigerta 👋

Data Engineer @GitLab

Vienna Data Engineering Meetup

linkedin.com/in/rigerta/

VIENNA DATA ENGINEERING MEETUP

So, what is Docker?

An open-source tool used to turn your **application** into a **container** that can easily be deployed in any other system.

First things first, what is an Application?

Any piece of **Software** that performs a specific function either for an end user or for another application.

An **Application** is written in a specific **Programming language** and typically has one or more **Dependencies.**

Cool, so what is a Container?

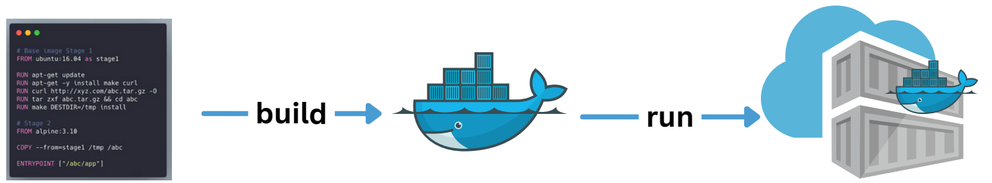
A **self-contained**, **runnable** software application or service.

And how do we do this with Docker?

We write a **Dockerfile**, which is “a recipe” defining how to build a **Docker Image** and when we run the image so we can reach the application, we are in a **Container**

Key Concepts

- **Application**
  - Any piece of software you write, to fulfil a goal for end users or other applications
- **Dependencies**
  - All software libraries an application needs to be able to run successfully
- **Dockerfile**
  - A text file containing a set of instructions
- **Docker image**
  - A read-only blueprint that includes container-creation instructions
  - An **executable** application artifact



- **Docker container**
  - A running instance of a Docker **image** that gets created when the **$ docker run** command is implemented
  - Multiple containers can run from the same Docker image
- **Docker registry**
  - A storage and distribution system for container images (can be **private** or **public**)
  - Docker Hub (hub.docker.com) is the **official public** Docker registry

OK, let's take a step back

Why do we even **need** Docker?
How were applications deployed before it?

Traditional Application Deployment

Developer

Pushes code for 3 applications into their own Git repositories

Web Application 1

Web Application 2

Web Application 3

Application Deployment Process

Artifact

Deployment instructions

Production Server

Install & config all necessary libraries / databases / services for **Appplication 1 directly on the server**

Same for **Application 2**

Same for **Application 3**

User

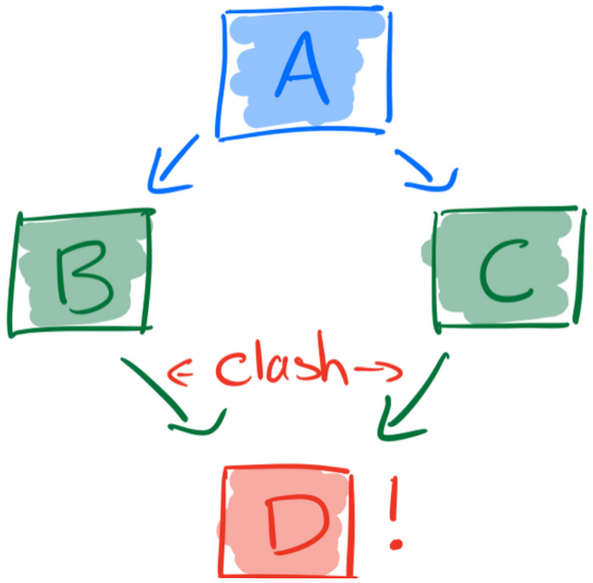
Consumes the web application via a web browser

What is the problem with that?

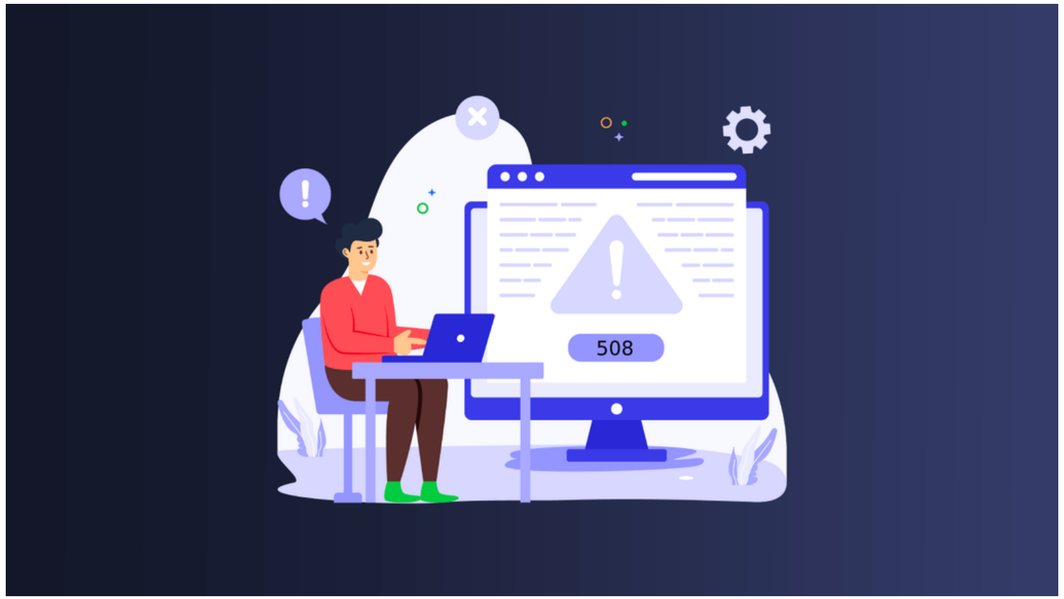
The same production server is usually used for **multiple** applications, for efficiency, **but**:

- Error prone process
- Different applications might need different
  - **software & software versions**
  - **libraries & library versions**

- This causes:
  - dependency issues
  - a painful **deployment process**



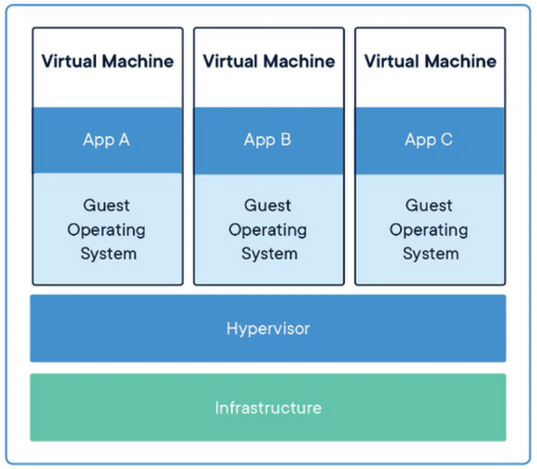
What is the problem with that?



Memory and **processing power** of the production server are **limited**

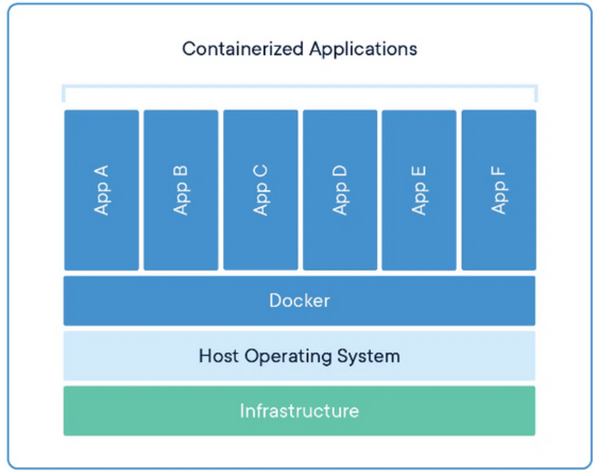
This is where Kubernetes & Docker play very well together and you will hear all about it in Part 2 of this workshop by Katharina

Enter Docker



VM Virtualization

OS Kernel & the application layer of the OS

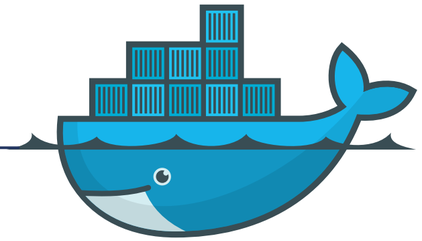


Docker Virtualization

Only the application layer of the OS

Benefits

- **Isolation**
  - No conflicting with the host system
- **Packaged application and all its dependencies** (code, libraries, system binaries etc)
  - No more “it works on my machine” issues
- **Reliable deployment**
  - A **self-contained** image is used to deploy, making the deployment independent of the OS or other details of the host system
  - Docker runtime is **the only** necessary installation

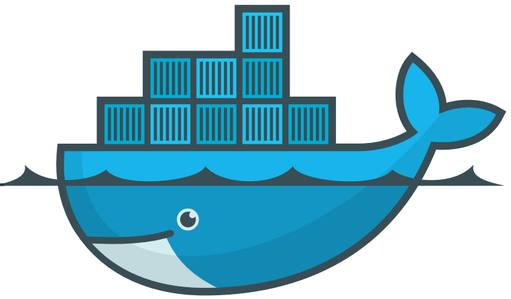


Enter Docker

More benefits

- **Better resource consumption management**
  - Configurable memory & cpu a container can use (docs on resource constraints)

- **Efficiency**
  - A side effect of the lightweight, efficient isolation model of containers
  - **Many** Docker containers can run on a single production server



Demo Time

- Step by step Docker introduction
- Docker Registry
- Use existing Docker Images
- Create your own Docker Image

First steps

- **Docker running locally**
  - Instructions to download and install Docker
  - I run/prefer **Rancher Desktop**
    - An open-source application that provides all the essentials to work with containers and Kubernetes on the desktop

- **An IDE or text editor to use for editing files.**
  - I prefer VSCode - Download link

- **Free Docker Account**
  - You can sign-up for a free Docker account (https://hub.docker.com) and access free unlimited public repositories
  - **Not mandatory**, images are available to unauthenticated users too

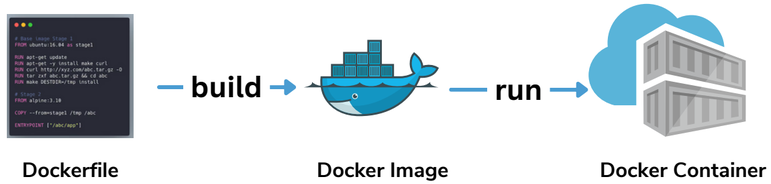
Demo Part 1

- **Where to find Docker Images?**
  - Docker Registries
    - Public (Docker Hub)
    - Private (AWS ECR, Google Container Registry, etc)
- **How to create a Container?**
- **How to access a containerised application**
  - Port Binding
- **How to stop Containers**
- **How to remove Docker Images and Containers**

Demo Part 2

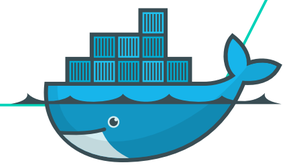
Creating your own Docker Image

- **Creating a Streamlit Application**
- **Running it locally with** streamlit run
- **Building a Docker Image for this Application**



Main Takeaways

- Docker is an open source virtualization technology
- With Docker you can package your application into a single runnable artifact - Docker Image
- Docker Images will run everywhere, independent of the platform you deploy it to



Where to go from here?

Explore the official documentation

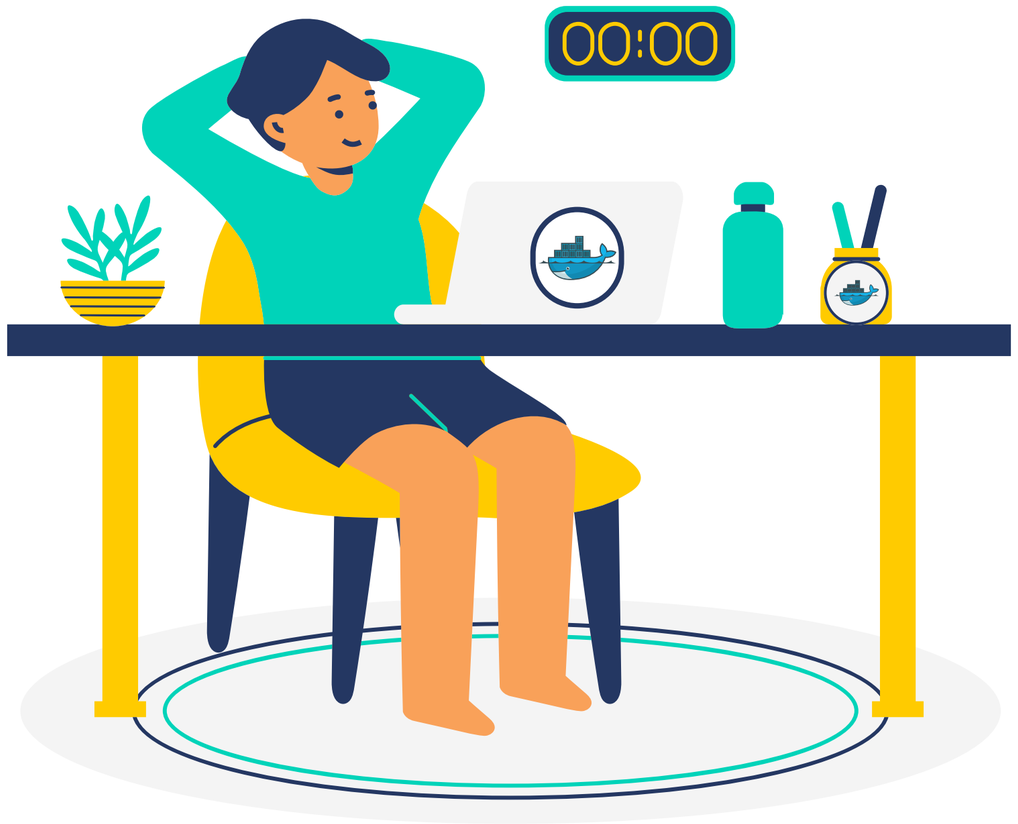
- https://docs.docker.com/get-started/
- https://www.docker.com/resources/what-container/
- https://docker-curriculum.com/#docker-compose
- https://rancherdesktop.io/
- https://docs.streamlit.io/

Watch YouTube videos

- Techworld with Nana

Experiment with side projects

- Build a simple application in any language of your choice and containerise it
- Play around and experiment with Docker
- Have fun!



Thank you!

Happy to take any questions.

Kubernetes

What is Kubernetes? Why do so many companies need it? How to get started?

What is Kubernetes?

Container Orchestration System

- Takes care of all the containers you want to run

Automates Deployment, Scaling and Management

- Deploys your applications based on your description (declarative configuration)
- Scale on demand
- Self-healing capabilities

Open Source

- Open-sourced by Google in 2014
- Part of the Cloud Native ecosystem

Kubernetes = Helmsman/Pilot = k8s

Why is it so useful?

It helps to organize and manage a huge amount of containers

It can scale your applications in busy times

It makes communication between various components easier

It allows you to update your applications without downtime

It has a very big and supportive community

When to use it?

If you have a huge amount of applications and services running

- Basically, it makes the most sense in enterprise environments

It can be an overkill in many situations and there are good alternatives for smaller projects

- Hosting your own server
- Serverless functions (Google Cloud Run, AWS Lambda,...)

Core Components

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Node

- A worker machine (physical or virtual)
- A Kubernetes cluster runs on one or multiple nodes

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Service

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Pod

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Deployment

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Service

- Exposes pods to other pods and services in the cluster

Namespace

- Isolates resources in a cluster

Let’s go!

Install kind

- We’ll use kind to locally run a Kubernetes cluster
- https://kind.sigs.k8s.io/docs/user/quick-start/#installation
- Verify if kind is working:
  - `kind version`

Install kubectl

- We’ll use kubectl to interact with the Kubernetes cluster
- https://kubernetes.io/docs/tasks/tools/#kubectl
- Verify if kubectl is working:
  - `kubectl version --client`

Let’s really go!

Create a local Kubernetes cluster

- `kind create cluster --name kubernetes-playground`

Execute first commands in the cluster

- `kubectl cluster-info`
- `kubectl explain pod`

Take a look at kubeconfig

- `cat ~/.kube/config`

Explore the newly created cluster

- `kubectl get namespaces`
- `kubectl get nodes -o wide`
- `kubectl get pods`

Let’s deploy something I

Create a file called deployment.yaml

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: hello-kubernetes
spec:
  template:
    metadata:
      labels:
        app: hello-kubernetes
     spec:
       containers:
       - image: paulbouwer/hello-kubernetes:1
         name: hello-kubernetes
         ports:
         - containerPort: 8080
           name: http
   selector:
     matchLabels:
       app: hello-kubernetes
```

Let’s deploy something II

Create a namespace

- `kubectl create namespace hello-kubernetes`

Create a deployment

- `kubectl apply -n hello-kubernetes -f deployment.yaml`

Take a look at the created resources

- `kubectl -n hello-kubernetes get deployments`
- `kubectl -n hello-kubernetes get pods`
- `kubectl port-forward -n hello-kubernetes deployment/hello-kubernetes 8080:8080`

Let’s set environment variables

Add an environment variable

- `spec.template.spec.containers[0].env:`
  - `- name: MESSAGE`
  - `  value: ‘Hello #theNewITGirls! :)’`

We can also read information from Kubernetes

- `spec.template.spec.containers[0].env:`
  - `- name: KUBERNETES_NAMESPACE`
  - `  valueFrom:`
  - `   fieldRef:`
  - `    fieldPath: metadata.namespace`
  - `- name: KUBERNETES_POD_NAME`
  - `  valueFrom:`
  - `   fieldRef:`
  - `    fieldPath: metadata.name`
  - `- name: KUBERNETES_NODE_NAME`
  - `  valueFrom:`
  - `   fieldRef:`
  - `    fieldPath: spec.nodeName`

Let’s use a configmap

Create a file called configmap.yaml

```
apiVersion: v1
kind: ConfigMap
metadata:
 name: hello-kubernetes-config
data:
 message: "Hello from the config map! :)"
```

Apply it

- `kubectl apply -n hello-kubernetes -f configmap.yaml.yaml`

Reference it

- `spec.template.spec.containers[0].env:`
  - `- name: MESSAGE`
  - `  valueFrom:`
  - `    configMapKeyRef:`
  - `      name: hello-kubernetes-config`
  - `      key: message`

Let’s use a secret

Create a file called secret.yaml

```
apiVersion: v1
kind: Secret
metadata:
 name: hello-kubernetes-secrets
stringData:
 message: "I am a secret value!"
```

Apply it

- `kubectl apply -n hello-kubernetes -f secret.yaml`

Reference it

- `spec.template.spec.containers[0].env:`
  - `- name: MESSAGE`
  - `  valueFrom:`
  - `    secretKeyRef:`
  - `      name: hello-kubernetes-secrets`
  - `      key: message`

Let’s scale it

Set replicas

- `spec.replicas: 3`

Take a look at the created resources

- `kubectl -n hello-kubernetes get deployments`
- `kubectl -n hello-kubernetes get pods`
- `kubectl port-forward -n hello-kubernetes deployment/hello-kubernetes 8080:8080`

Let’s update without downtime

Change the update strategy

- `spec.strategy.type: RollingUpdate`

Take a look at the created resources

- `kubectl -n hello-kubernetes get deployments`
- `kubectl -n hello-kubernetes get pods`
- `kubectl port-forward -n hello-kubernetes deployment/hello-kubernetes 8080:8080`

Let’s create a service

Create a file called service.yaml

```
apiVersion: v1
kind: Service
metadata:
  name: hello-kubernetes
spec:
  selector:
  app: hello-kubernetes
  ports:
  - protocol: TCP
    port: 8080
    targetPort: 8080
```

Create a service

- `kubectl apply -n hello-kubernetes -f service.yaml`

Let’s clean up

Delete the Kubernetes cluster

- `kind delete cluster --name kubernetes-playground`

Where to go from here?

Explore the official documentation

- https://kubernetes.io/docs/home/

Watch YouTube videos

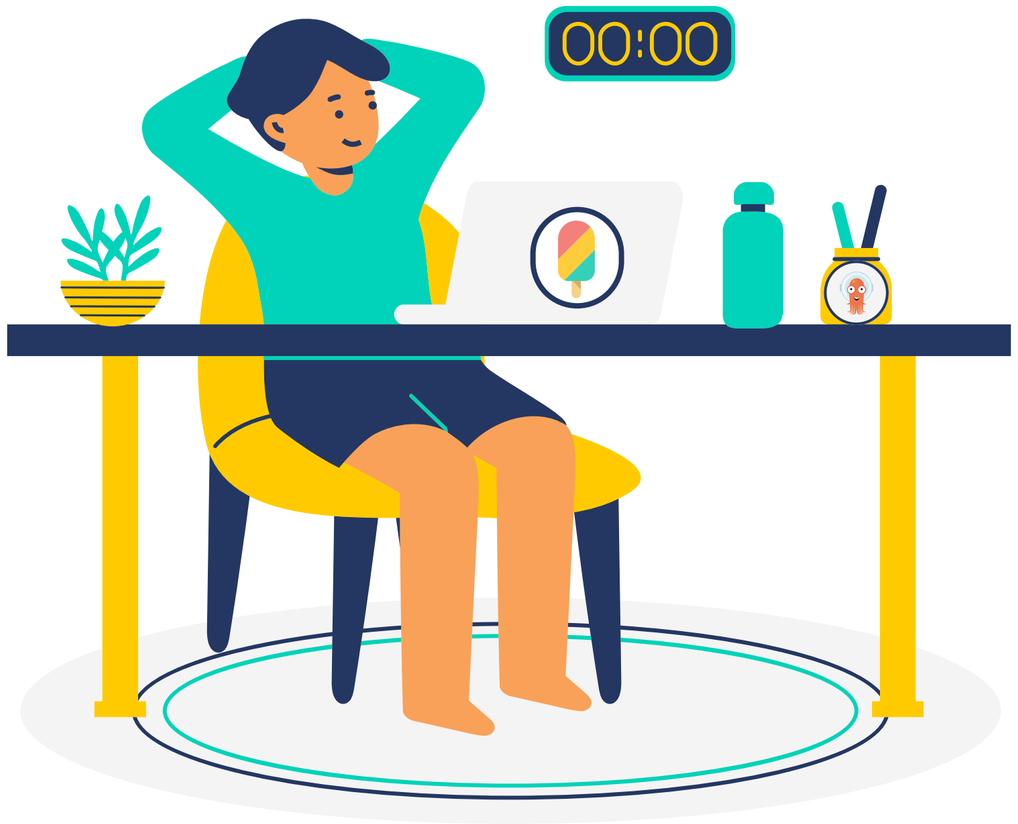
- Techworld with Nana
- 100 Days of Kubernetes

Experiment with side projects

- Trying examples is a great way of learning
- Just play around and experiment with workloads
- Celebrate small successes

Join Kubernetes communities

- Kubernetes Slack
- Cloud Native Linz
- Cloud Native Austria (Graz, Innsbruck, Salzburg & Vienna)



Thank you! :)

Happy to take any questions.