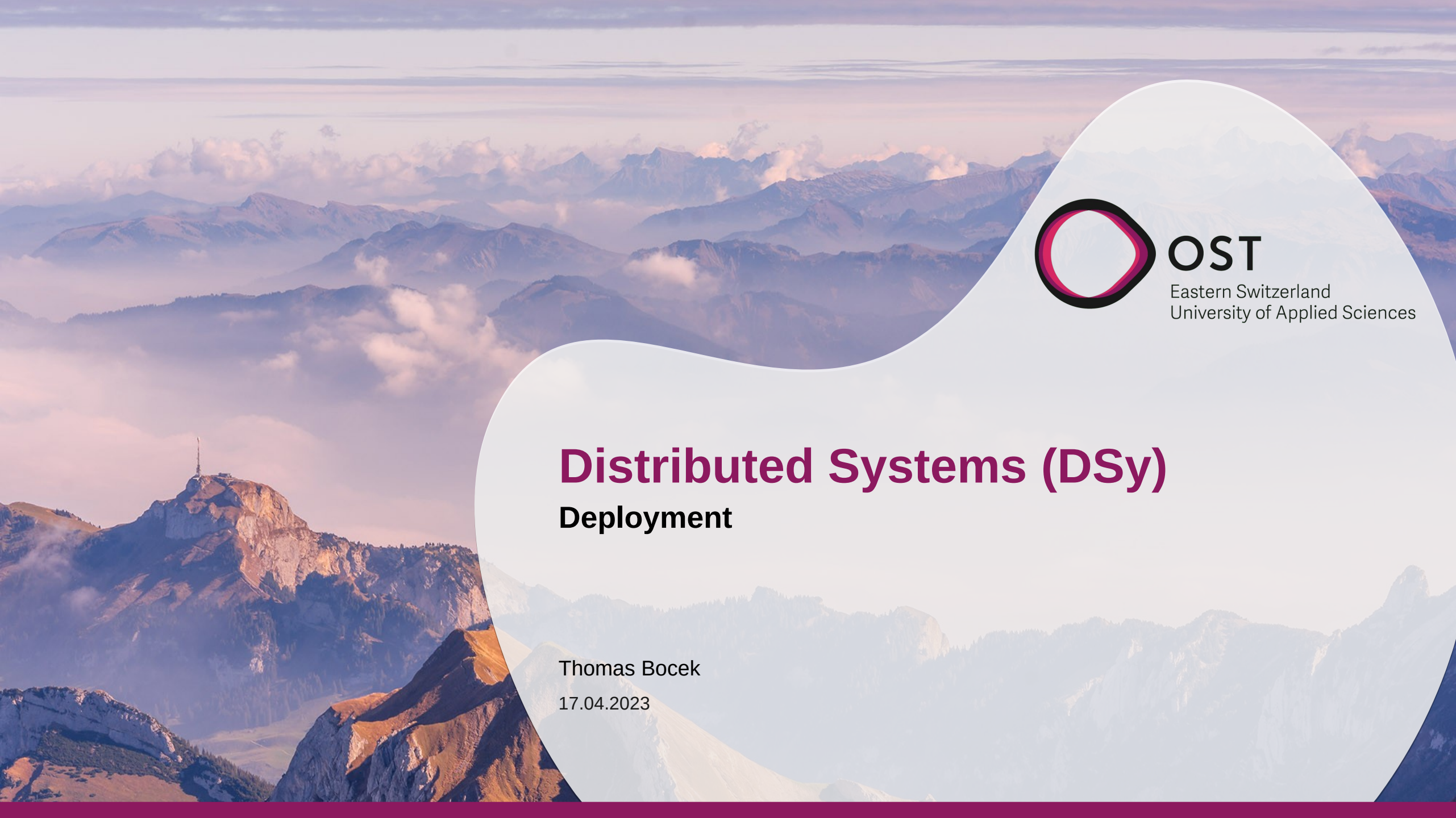

OST
Eastern Switzerland
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Distributed Systems (DSy)

Deployment

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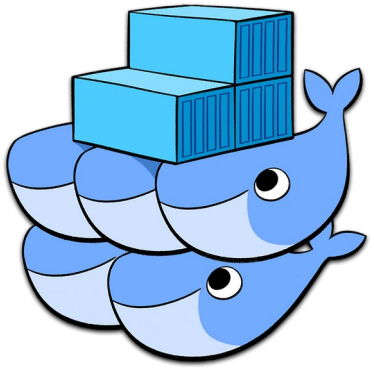
Learning Goals

- Lecture 8 (Deployment)
  - Different ways to deploy your service
    - High-level overview
  - Cloud Infrastructure [link], Cloud Operations [link] - Laurent Metzger
  - Cloud Solutions [link] - Mirko Stocker

Back in the old days…

- OTS: apt-get / yum / pacman install package, e.g., Apache – configure – run
- Custom SW: Java: war, provide custom /etc/init.d script with binary or script
- Problem:
  - It runs on my machine, who installs Java in the right version?
  - What happens on crashes?
  - Scaling?
  - HW defect?
  - Misconfiguration - access to complete PC?
- VMs / Containers help a lot
  - No access to complete PC, can scale, move to another machine, pre-install the right Java version
- So, how to deploy your app?
  - Ansible (Progress Chef, Puppet) - and more
    - Playbooks with ssh host list – your host needs to run the same OS (apt/yum)
  - Docker Swarm
    - Works with docker-compose.yml – with docker you package your application the same way on any platform - simple
      - Which to use? [link]
  - Kubernetes
    - Widespread

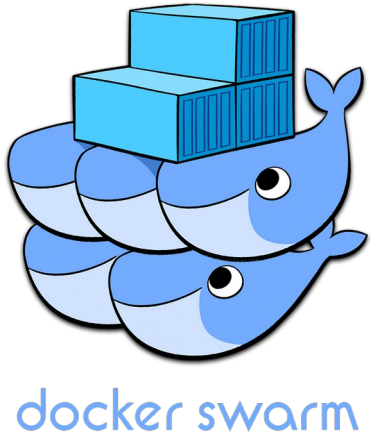
Docker Swarm



- Use docker --context to run/maintain containers on other machines
- Docker Swarm
  - Deploy with docker-compose.yml (deploy)
  - Built into docker
    - docker swarm – manage swarm
    - docker node – manage nodes
  - Scheduler is responsible for placement of containers to nodes
  - Can use the same files, easy to setup?
    - Azure, Google cloud, Amazon

- Kubernetes vs. Docker Swarm
- “Docker Swarm has already lost the battle against Kubernetes for supremacy in the container orchestration space” [link]
- “Kubernetes supports higher demands with more complexity while Docker Swarm offers a simple solution that is quick to get started with.” [link]

Docker Swarm



- 3 “Machines”
  - KVM instances, alpine running
    - Workers: 192.168.1.238, 192.168.1.103, 192.168.1.173
    - Manager: 192.168.1.166
- Run on manager
  - docker swarm init --advertise-addr 192.168.1.166
- To add a worker to this swarm, run the following command:
  - docker swarm join --token .. 192.168.1.166
  - docker info
  - docker node ls
- Manager are setup
- Join nodes
  - Run the docker swarm join command
  - docker node ls
- Workers are setup

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Docker Swarm

- Create service
  - docker service create --name registry --publish 5000:5000 registry:2
  - Where to find the docker image
- Check service
  - docker service ls
- Many options in docker-compose
  - docker stack deploy --compose-file docker-compose.yml

```
worker:
  image: gaiadocker/example-voting-app-worker:latest
  networks:
    voteapp:
      aliases:
        - workers
  depends_on:
    - db
    - redis
  # service deployment
  deploy:
    mode: replicated
    replicas: 2
    labels: [APP=VOTING]
    # service resource management
    resources:
      # Hard limit - Docker does not allow to allocate more
      limits:
        cpus: '0.25'
        memory: 512M
      # Soft limit - Docker makes best effort to return to it
      reservations:
        cpus: '0.25'
        memory: 256M
    # service restart policy
    restart_policy:
      condition: on-failure
      delay: 5s
      max_attempts: 3
      window: 120s
    # service update configuration
    update_config:
      parallelism: 1
      delay: 10s
      failure_action: continue
      monitor: 60s
      max_failure_ratio: 0.3
    # placement constraint - in this case on 'worker' nodes only
    placement:
      constraints: [node.role == worker]
```


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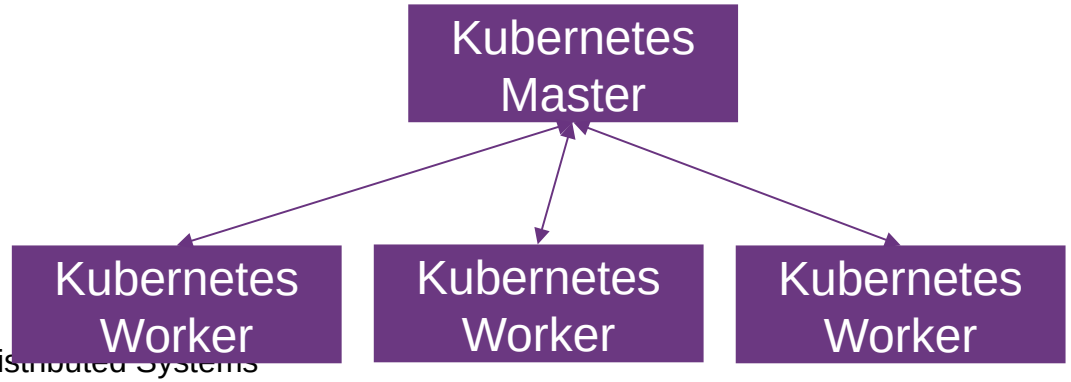
Kubernetes

- What is Kubernetes (K8s)
  - Container orchestration
    - Automates deployment, scaling, and management of containerized applications
  - Started by Google in 2014, now with CNCF
    - Widely adopted in the industry for managing complex applications
- Kubernetes-based PaaS
  - Google, Amazon, Azure (book), Digital Ocean, …
    - Difficult pricing schemes
- Why Kubernetes?
  - Simplifies application deployment and management
    - Development: run on one machine, deployment how and where to distribute?
  - Ensures high availability and fault tolerance
    - Containers can crash, machine that runs container can crash (e.g., out of memory)
  - Supports auto-scaling based on demand
  - Facilitates rolling updates and rollbacks
    - Rollbacks are hard, especially with state, stateless rollback is easier
  - Provides a powerful ecosystem of tools and services
    - Package manager Helm released in 2016 (convert docker-compose)

Kubernetes

- Design principles
  - Configuration is declarative – declare state with YAML/JSON
  - Immutable containers
    - Don’t store state in a container. If a health check fails, Kubernetes removes the container and starts a new one
    - Rollback applications, use older version of container – may need to change schema



- Architecture
  - Master Node: Controls the overall state of the cluster
    - API Server: Manages communication within the cluster
    - etcd: Stores configuration data for the cluster
    - Controller Manager: Ensures the desired state of the cluster
    - Scheduler: Assigns workloads to worker nodes
  - Worker Node: Runs application containers
    - kubelet: Communicates with the master node and manages containers
    - kube-proxy: Handles network routing and load balancing
    - Container runtime: Executes containers (Docker, containerd, etc.)

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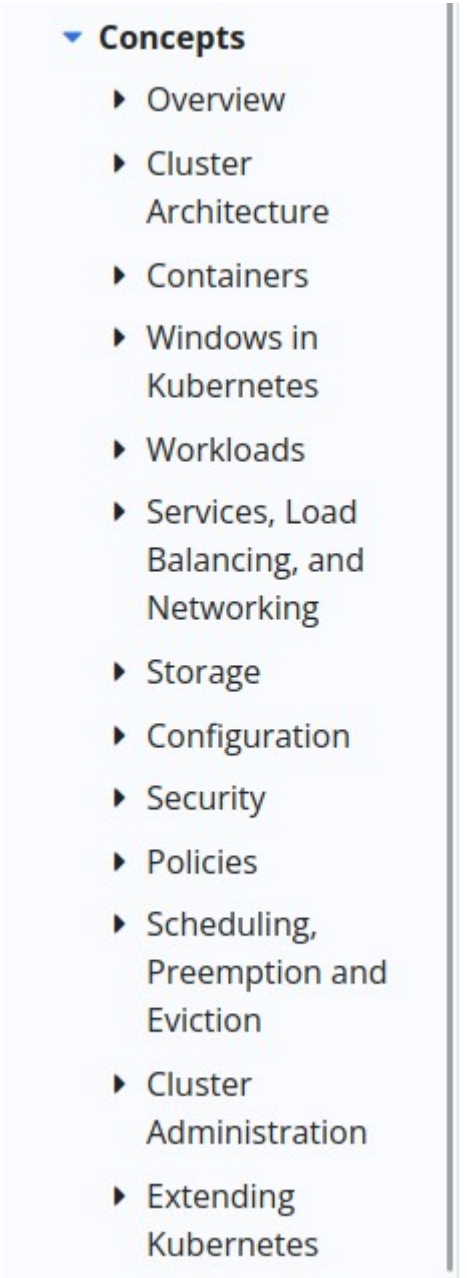
Kubernetes

- Key Concepts [link]
  - Pod: Smallest deployable unit, contains one or more containers
  - Service: Stable network endpoint to expose a set of Pods
  - Deployment: Manages the desired state of an application, define scale, HW limits
  - ConfigMap: Stores non-sensitive configuration data for an application
  - Secret: Stores sensitive configuration data, like passwords and API keys
  - Volume: Persistent storage for data generated by a container
  - Namespaces – run multiple projects on one cluster, separate with namespaces



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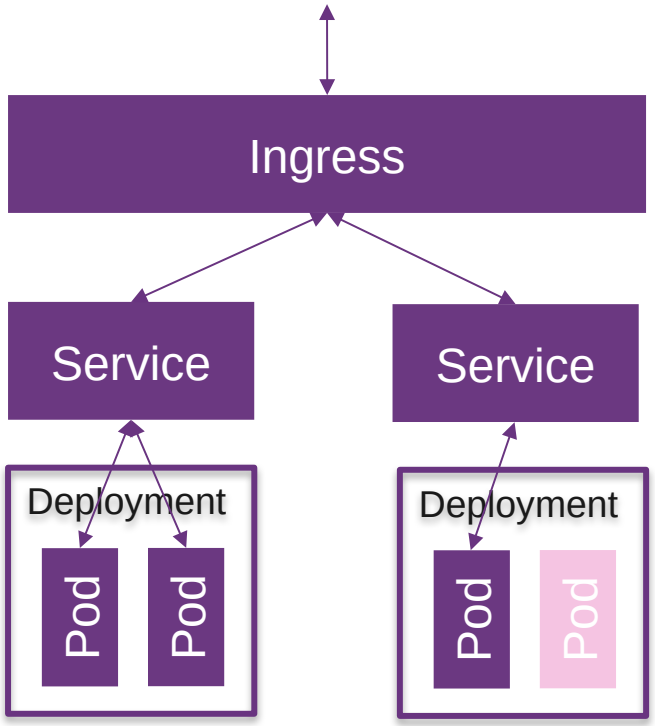
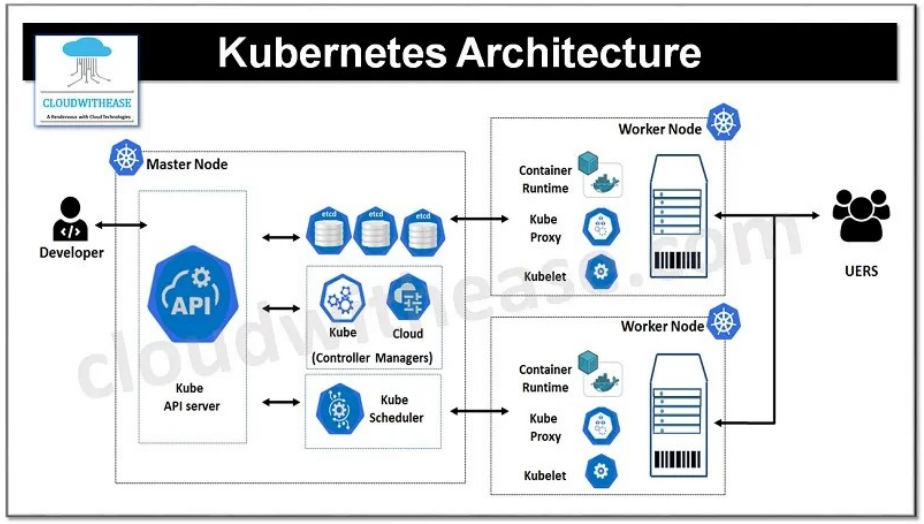
Kubernetes

- Getting Started with Kubernetes: Minikube, k3s
  - Minikube: Run a single-node Kubernetes cluster locally
  - kubectl: Command-line tool for managing a Kubernetes cluster
  - Kubernetes Dashboard: Web-based user interface for managing a cluster
- Deploy any containerized application
  - Use health endpoints
    - Liveness/Readiness
- Official documentation: https://kubernetes.io/docs
- Kubernetes tutorials: https://kubernetes.io/training
- Youtube course





Source: https://cloudwithease.com/what-is-kubernetes/

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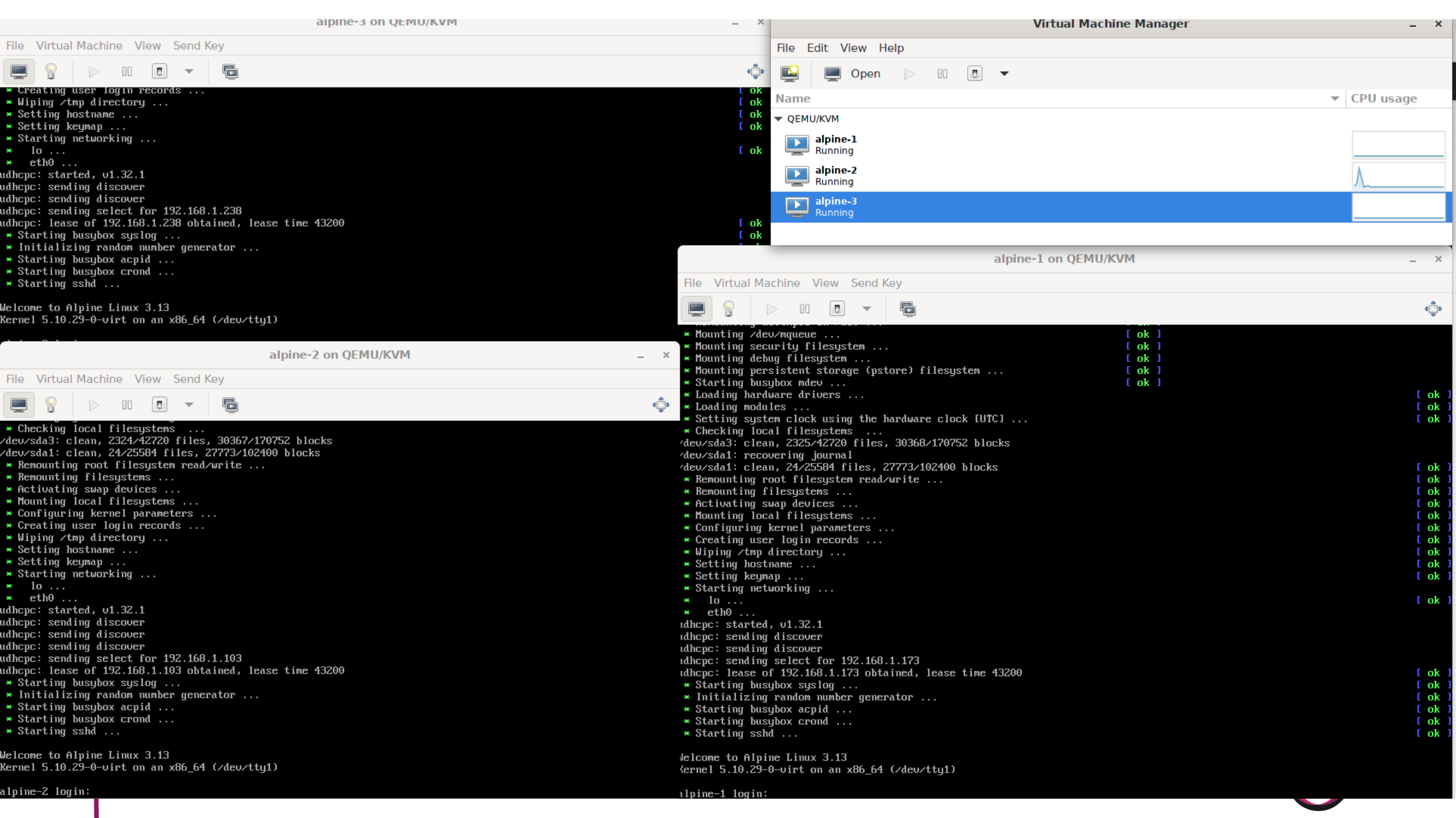
alpine-3 on QEMU/KVM
File Virtual Machine View Send Key
* Creating user login records ... [ok
* Wiping /tmp directory ... [ok
* Setting hostname ... [ok
* Setting keymap ... [ok
* Starting networking ... [ok
* lo ...
* eth0 ...
udhcpc: started, v1.32.1
udhcpc: sending discover
udhcpc: sending discover
udhcpc: sending select for 192.168.1.238
udhcpc: lease of 192.168.1.238 obtained, lease time 43200 [ok
* Starting busybox syslog ... [ok
* Initializing random number generator ...
* Starting busybox acpid ...
* Starting busybox crond ...
* Starting sshd ...
Welcome to Alpine Linux 3.13
Kernel 5.10.29-0-virt on an x86_64 (/dev/tty1)
Virtual Machine Manager
File Edit View Help
Open
Name
CPU usage
QEMU/KVM
alpine-1
Running
alpine-2
Running
alpine-3
Running
alpine-2 on QEMU/KVM
File Virtual Machine View Send Key
* Checking local filesystems ...
/dev/sda3: clean, 2324/42720 files, 30367/170752 blocks
/dev/sda1: clean, 24/25584 files, 27773/102400 blocks
* Remounting root filesystem read/write ...
* Remounting filesystems ...
* Activating swap devices ...
* Mounting local filesystems ...
* Configuring kernel parameters ...
* Creating user login records ...
* Wiping /tmp directory ...
* Setting hostname ...
* Setting keymap ...
* Starting networking ...
* lo ...
* eth0 ...
udhcpc: started, v1.32.1
udhcpc: sending discover
udhcpc: sending discover
udhcpc: sending discover
udhcpc: sending select for 192.168.1.103
udhcpc: lease of 192.168.1.103 obtained, lease time 43200
* Starting busybox syslog ...
* Initializing random number generator ...
* Starting busybox acpid ...
* Starting busybox crond ...
* Starting sshd ...
Welcome to Alpine Linux 3.13
Kernel 5.10.29-0-virt on an x86_64 (/dev/tty1)
alpine-2 login:
alpine-1 on QEMU/KVM
File Virtual Machine View Send Key
* Mounting /dev/mqueue ... [ok]
* Mounting security filesystem ... [ok]
* Mounting debug filesystem ... [ok]
* Mounting persistent storage (pstore) filesystem ... [ok]
* Starting busybox mdev ... [ok]
* Loading hardware drivers ... [ok]
* Loading modules ... [ok]
* Setting system clock using the hardware clock [UTC] ... [ok]
* Checking local filesystems ...
/dev/sda3: clean, 2325/42720 files, 30368/170752 blocks
/dev/sda1: recovering journal
/dev/sda1: clean, 24/25584 files, 27773/102400 blocks [ok]
* Remounting root filesystem read/write ... [ok]
* Remounting filesystems ... [ok]
* Activating swap devices ... [ok]
* Mounting local filesystems ... [ok]
* Configuring kernel parameters ... [ok]
* Creating user login records ... [ok]
* Wiping /tmp directory ... [ok]
* Setting hostname ... [ok]
* Setting keymap ... [ok]
* Starting networking ...
* lo ... [ok]
* eth0 ...
udhcpc: started, v1.32.1
udhcpc: sending discover
udhcpc: sending discover
udhcpc: sending select for 192.168.1.173
udhcpc: lease of 192.168.1.173 obtained, lease time 43200 [ok]
* Starting busybox syslog ... [ok]
* Initializing random number generator ... [ok]
* Starting busybox acpid ... [ok]
* Starting busybox crond ... [ok]
* Starting sshd ... [ok]
Welcome to Alpine Linux 3.13
Kernel 5.10.29-0-virt on an x86_64 (/dev/tty1)
alpine-1 login: