Lecture 3: Kubernetes

AC295

Advanced Practical Data Science

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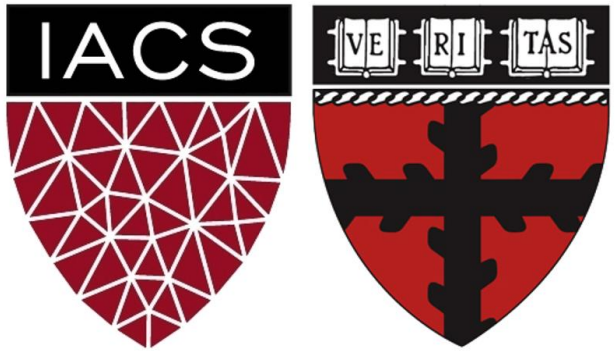

Outline

1: Communications

2: Recap

3: Introduction to Kubernetes

4: Creating and Running Containers | Review

5: Anatomy of a Kubernetes Cluster

6: Deploying a Kubernetes Cluster

7: Common kubectl Commands

Communications

Feedback from week 1 reading

A. More user cases

B. Difficulty: For some right for some needed searching many terms.

Exercise week 1 (DockerHub)

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Recap

Virtual Environment

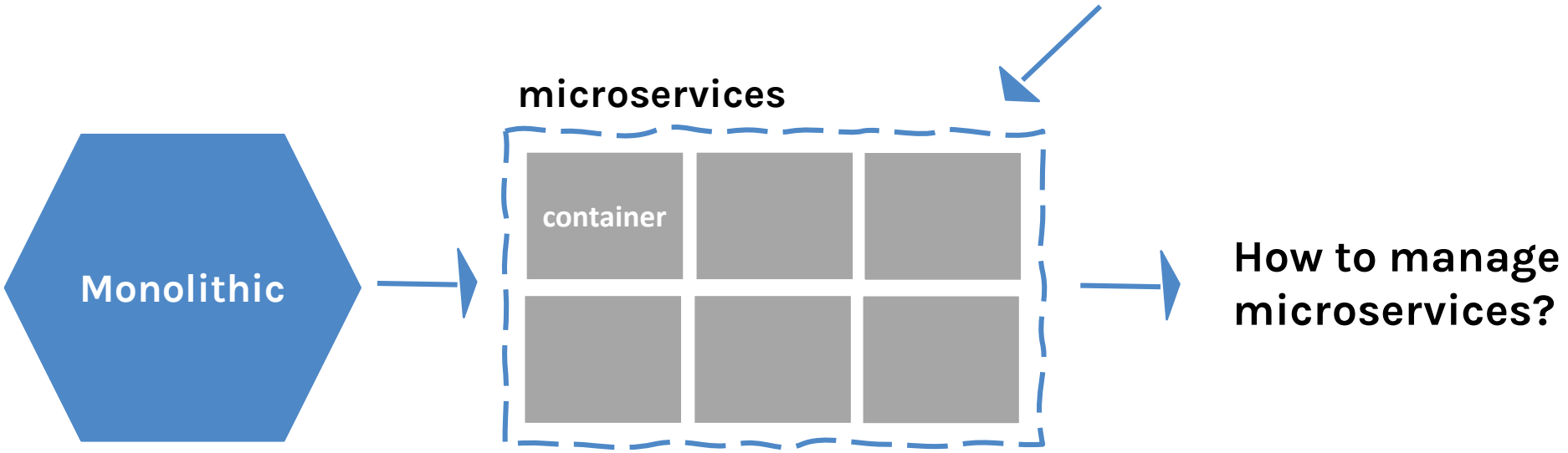
Pros: remove complexity
Cons: does not isolate from OS

Virtual Machines

Pros: isolate OS guest from host
Cons: intensive use hardware

Containers

Pros: lightweight
Cons: issues with security, scalability, and control



Recap

We talked about pros/cons of **environments** (removed complexity/does not isolate from OS), **virtual machines** (isolate OS guest from host/intensive use of the hardware), and **containers** (lightweight/issue with security, scalability, and control)

Goal: **find effective ways to deploy our apps** (more difficult than we might initially imagine) and to **break down a complex application** into smaller ones (*i.e. microservices*)

Issues we have fixed so far:

- conflicting/different operating system
- different dependencies
- "inexplicable" strange behavior

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Introduction to Kubernetes <K8s>

K8s manages containers

K8s is an open-source platform for container management developed by Google and introduced in 2014. It has become the standard API for building cloud-native applications, present in nearly every public cloud.

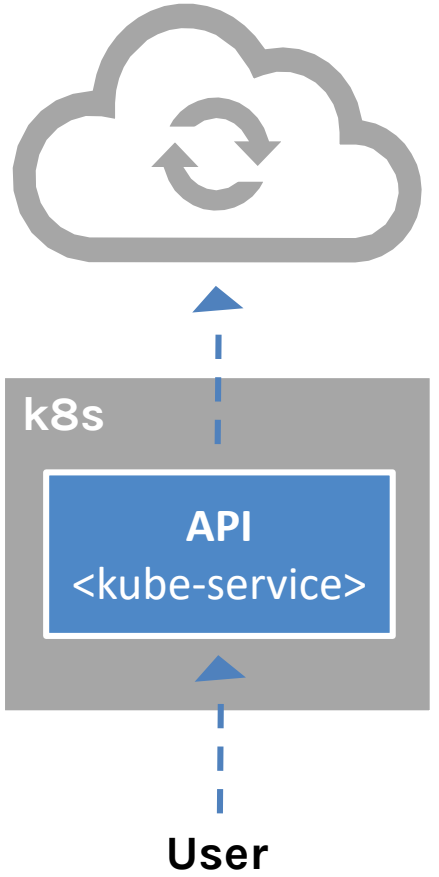
K8s users define rules for how container management should occur, and then K8s handles the rest!

> link to website <

Introduction to Kubernetes <cont>

There are many reasons why people come to use containers and container APIs like Kubernetes:

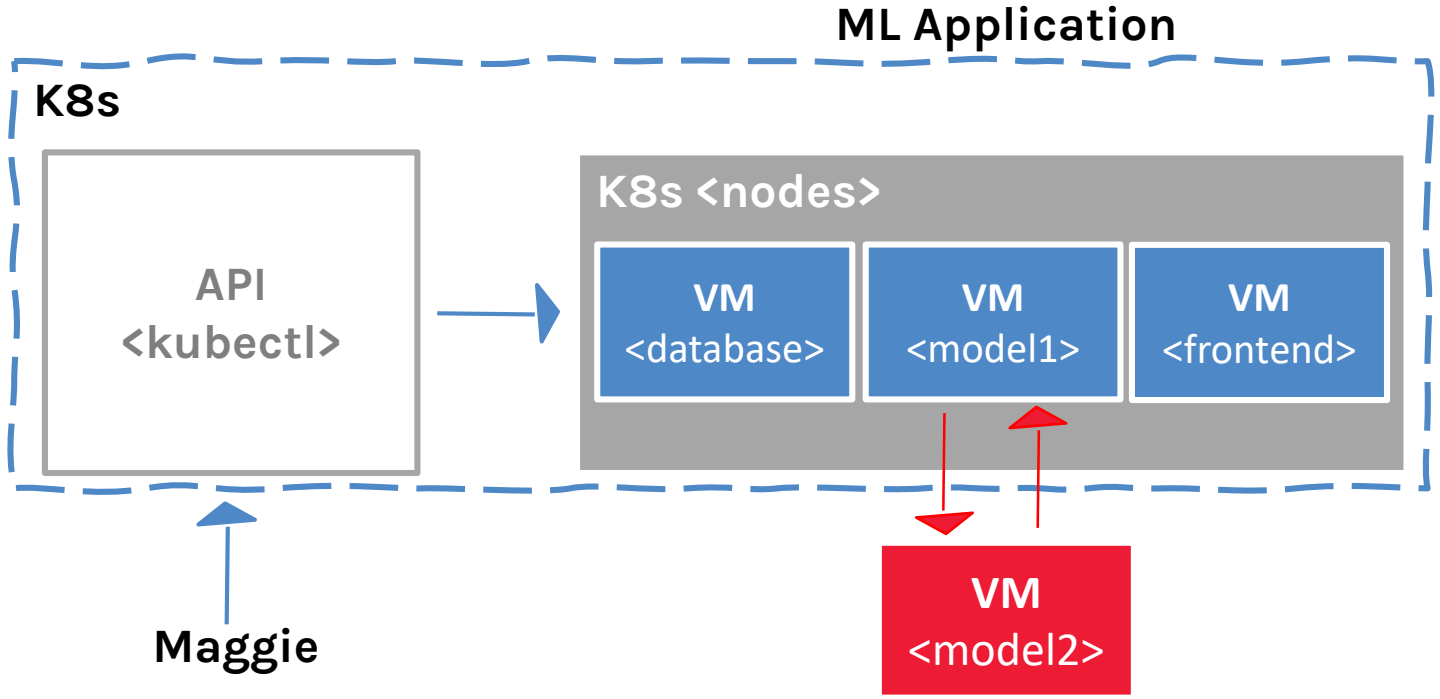
- Velocity
- Scaling (of both software and teams)
- Abstracting the infrastructure
- Efficiency



Velocity

It is the speed with which you can respond to innovations developed by others (e.g. change in software industry from shipping CDs to delivering over the network)

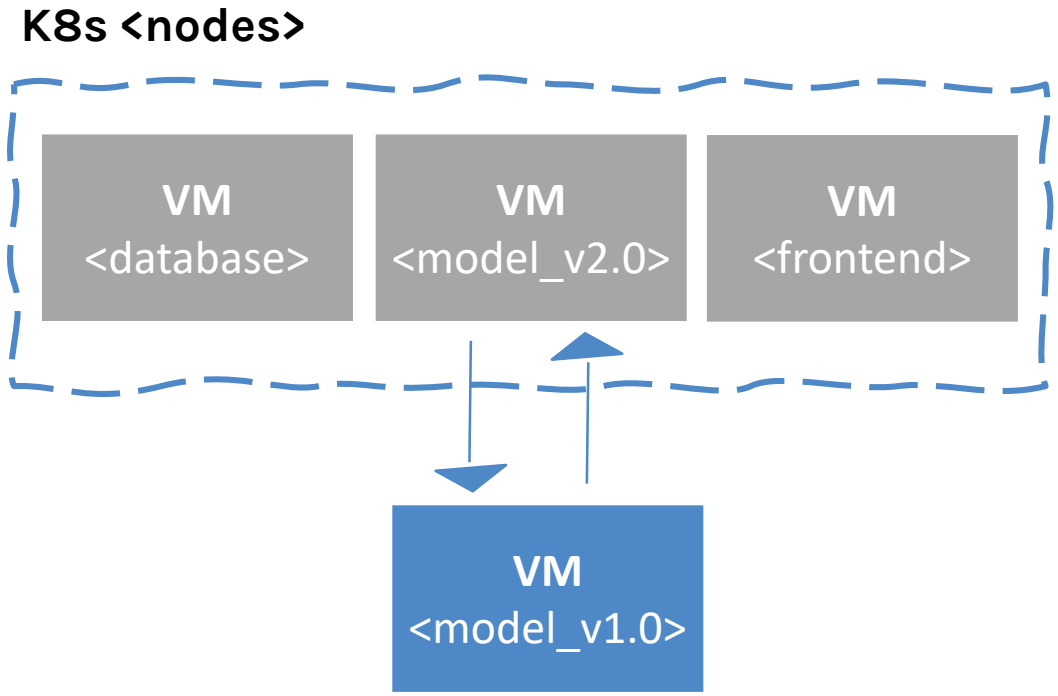
Velocity is measured not in terms of the number of things you can ship while maintaining a highly available service



Velocity <cont>

Velocity is enabled by:

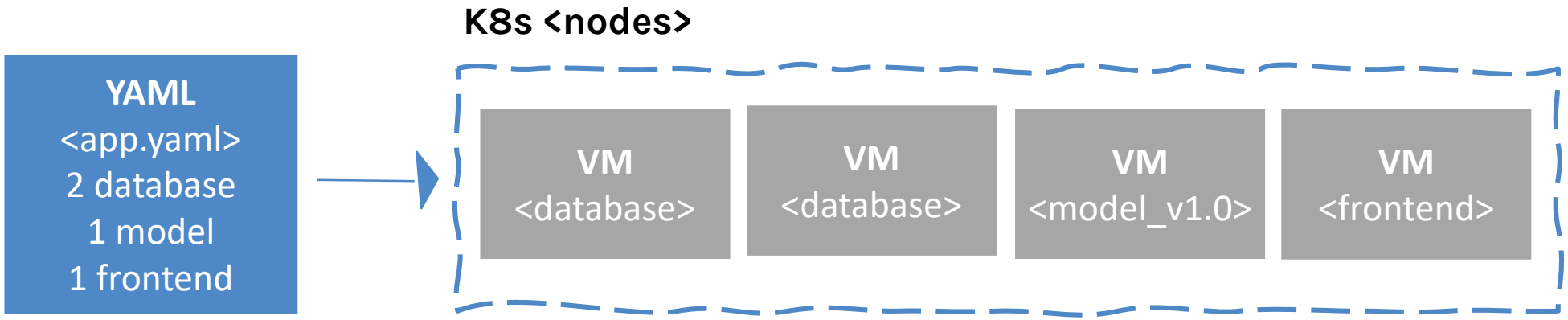
- **Immutable system:** you can't change running container, but you create a new one and replace it in case of failure (allows for keeping track of the history and load older images)



Velocity <cont>

Velocity is enabled by:

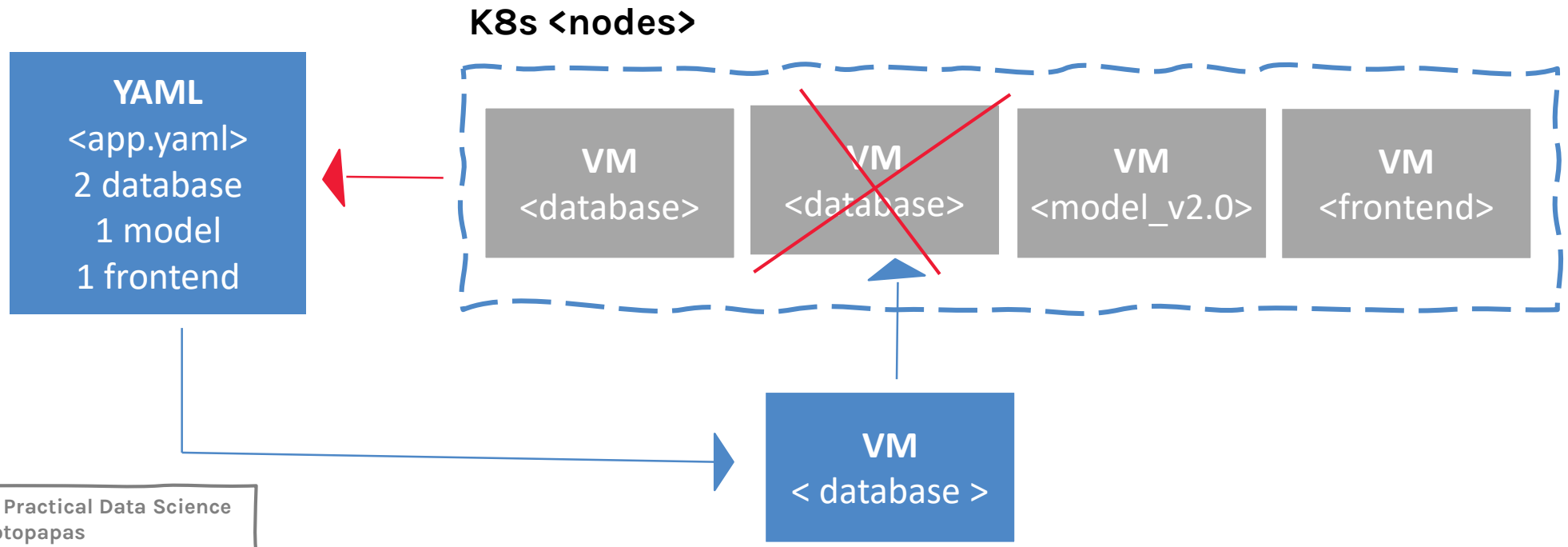
- **Declarative configuration:** you can define the desired state of the system restating the previous declarative state to go back. ***Imperative*** configuration are defined by the execution of a series of instructions, but not the other way around.



Velocity <cont>

Velocity is enabled by:

- **Online self-healing systems:** k8s takes actions to ensure that the current state matches the desired state (as opposed to an operator enacting the repair)



Velocity <recap>

Velocity is enabled by:

- Immutable system
- Declarative configuration
- Online self-healing systems

All these aspects relate to each other to speed up process that can reliably deploy software.

Scaling

As your product grows, it's inevitable that you will need to scale:

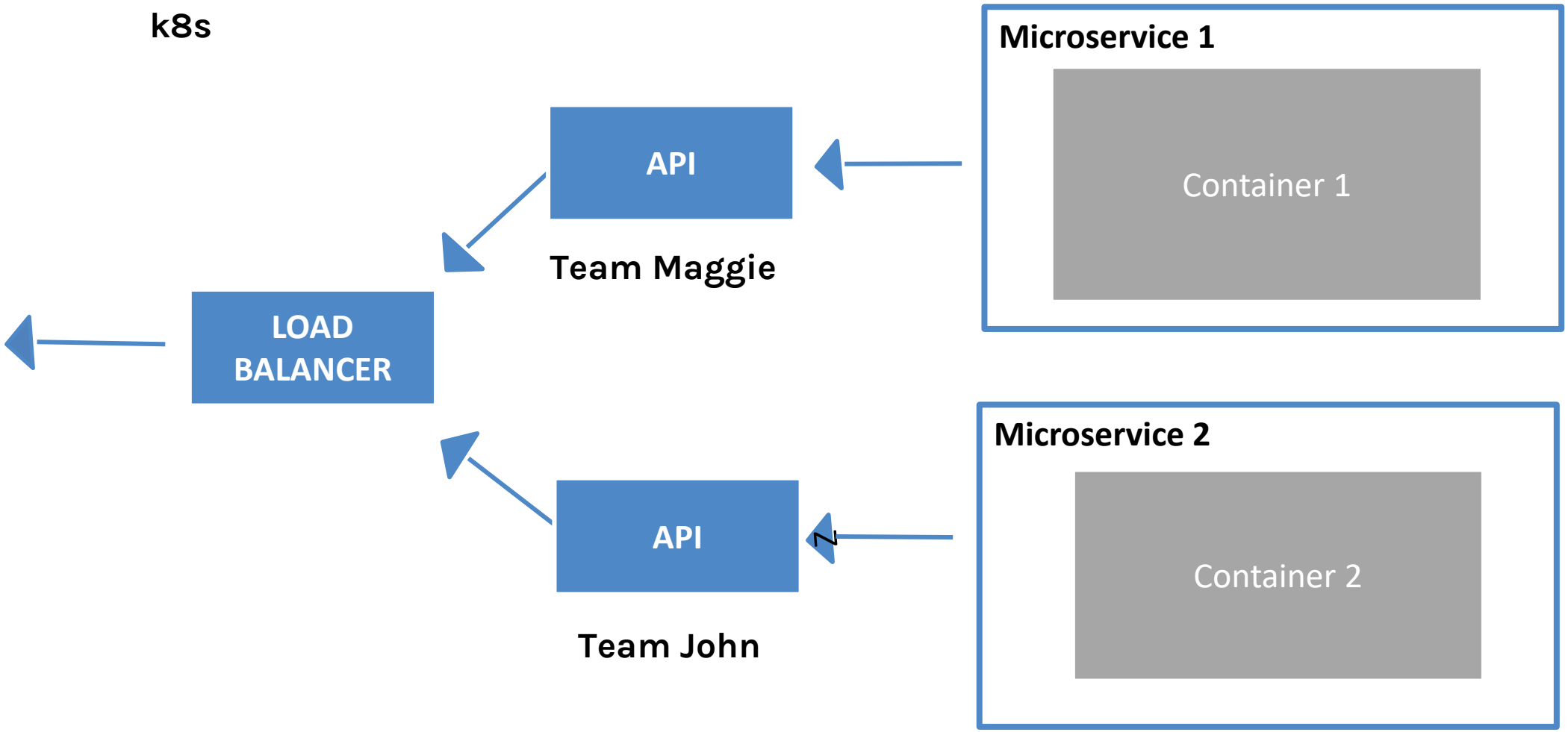
- Software
- Team/s that develop it

Scaling

Kubernetes provides numerous advantages to address scaling:

- **Decoupled architectures**: each component is separated from other components by defined APIs and *service load balancers*.
- **Easy scaling for applications and clusters**: simply changing a number in a configuration file, k8s takes care of the rest (part of declarative).
- **Scaling development teams with microservices**: small team is responsible for the design and delivery of a service that is consumed by other small teams (optimal group size: 2 pizzas team).

Scaling <cont>



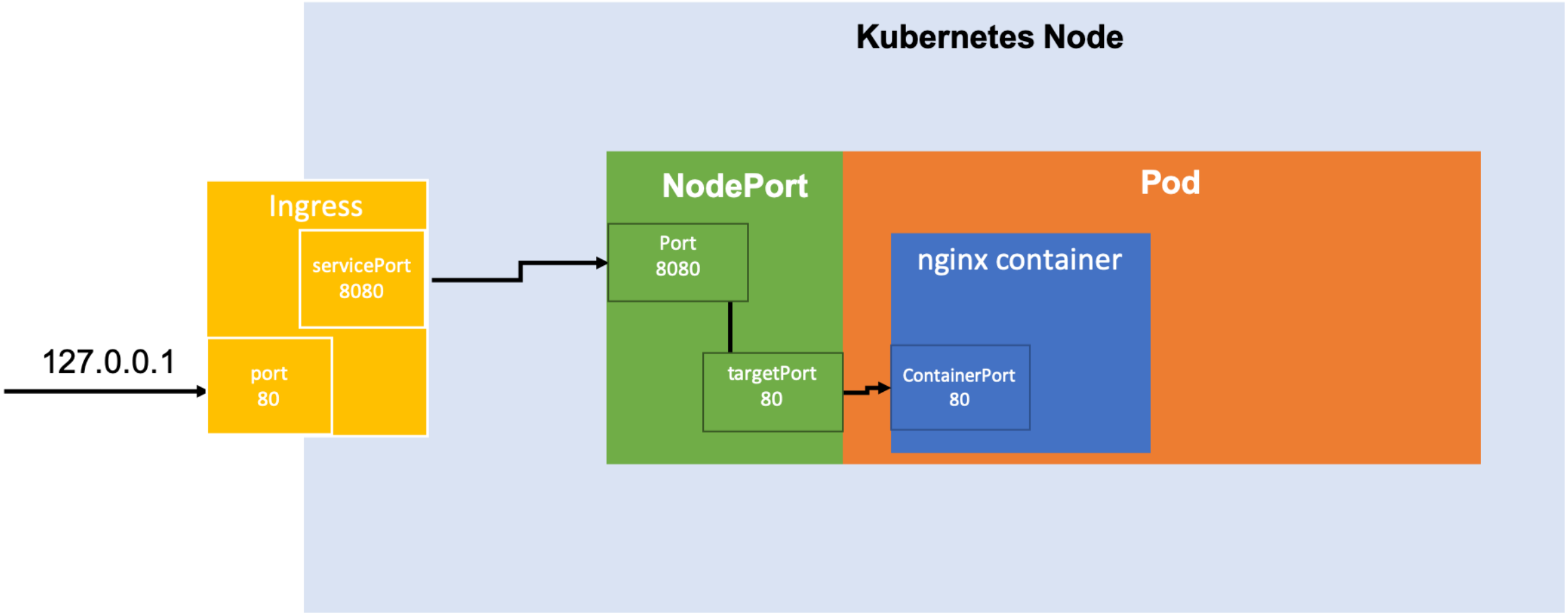
Scaling <cont>

Kubernetes provides numerous **abstractions** and APIs that help building these decoupled microservice architectures:

- **Pods** can group together container images developed by different teams into a single deployable unit (similar to docker-compose)
- **Other services to isolate** one microservice from another such (e.g. load balancing, naming, and discovery)
- **Namespaces** control the interaction among services
- **Ingress** combine multiple microservices into a single externalized API (easy-to-use frontend)

K8s provides full spectrum of solutions between doing it “the hard way” and a fully managed service

Scaling <cont>



Abstracting your infrastructure

Kubernetes allows to build, deploy, and manage your application in a way that is portable across a wide variety of environments. The move to application-oriented container APIs like Kubernetes has two concrete benefits:

- **separation**: developers from specific machines
- **portability**: simply a matter of sending the declarative config to a new cluster

Efficiency

There are concrete economic benefit to the abstraction because tasks from multiple users can be packed tightly onto fewer machines:

- **Consume less energy** (ratio of the useful to the total amount)
- **Limit costs of running a server** (power usage, cooling requirements, datacenter space, and raw compute power)
- **Create quickly a developer's test environment** as a set of containers
- **Reduce cost of development instances in your stack**, liberating resources to develop others that were cost-prohibitive

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Creating and Running Containers | Review

We have already seen how to package an application using the Docker image format and how to start an application using the Docker container runtime:

- We discussed what containers are and what you should use them
- How to build images and update an existing image using Docker (i.e. Dockerfile)
- How to store images in a remote registry (i.e. tag and push to DockerHub)
- How to run container with Docker (generally in Kubernetes containers are launched by a daemon on each node called the kubelet)

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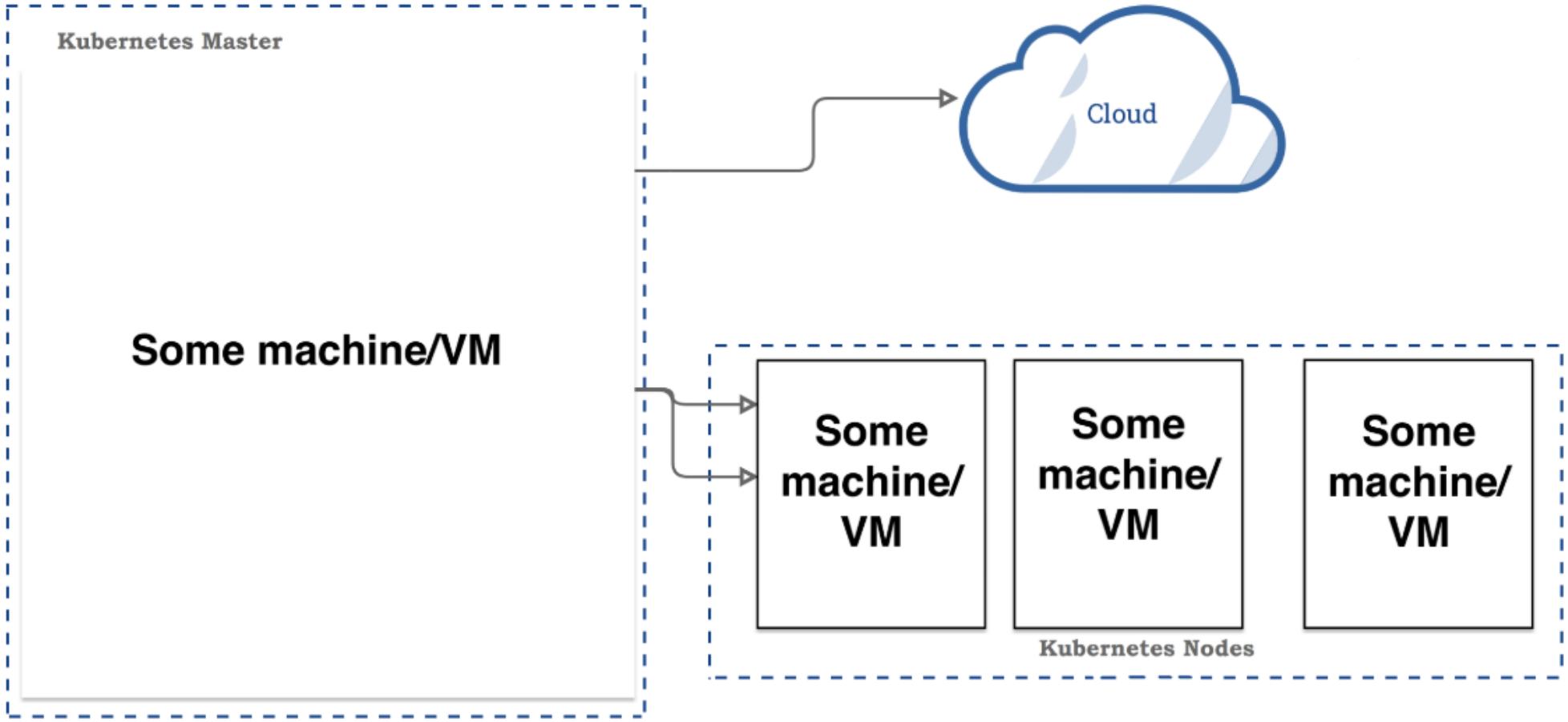
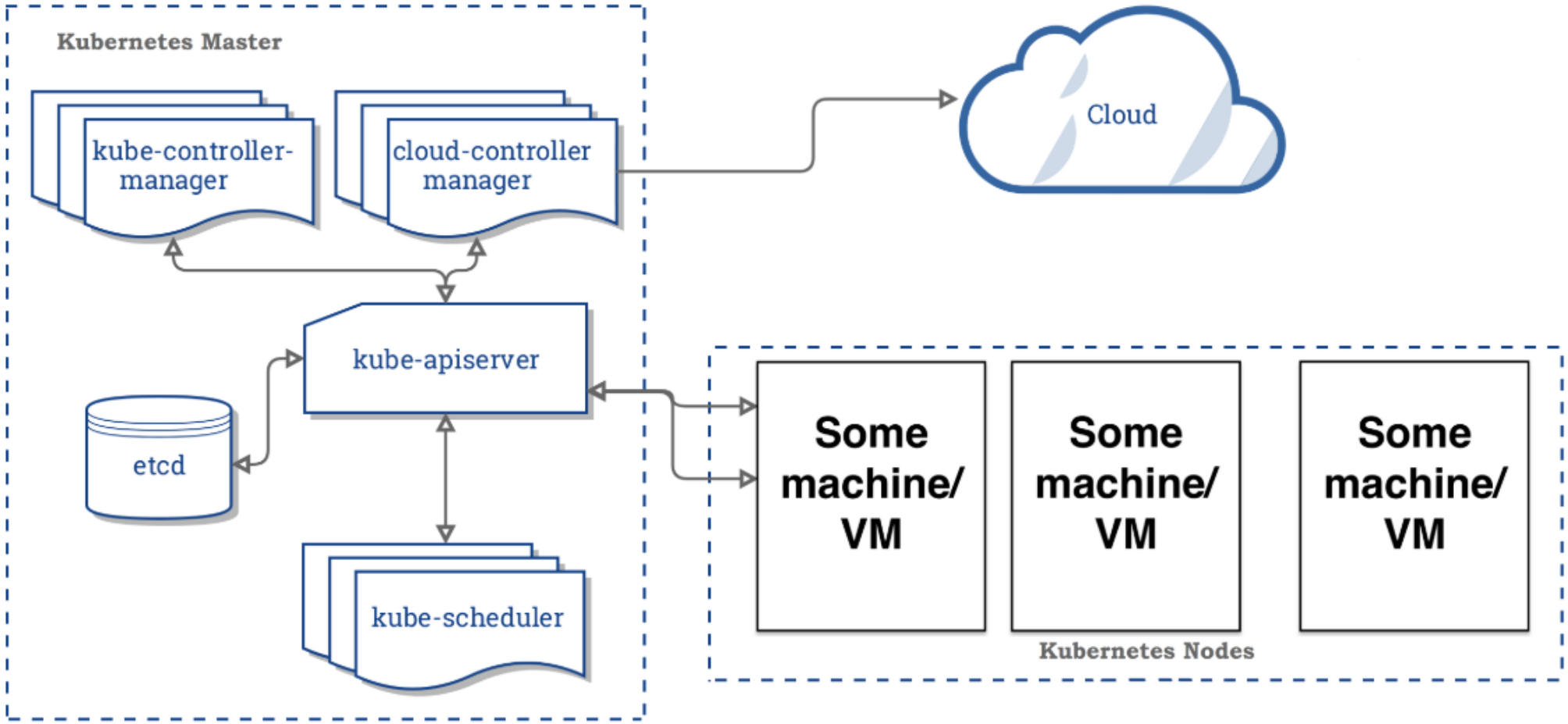
Anatomy of Kubernetes Cluster

- K8s works on a cluster of machines/nodes
- This could be VMs on your local machine or a group of machines through a cloud provider
- The cluster includes one master node and at least one worker node

Anatomy of Kubernetes Cluster <cont>



Anatomy of Kubernetes Cluster | Master Node



> to learn more on etcd <

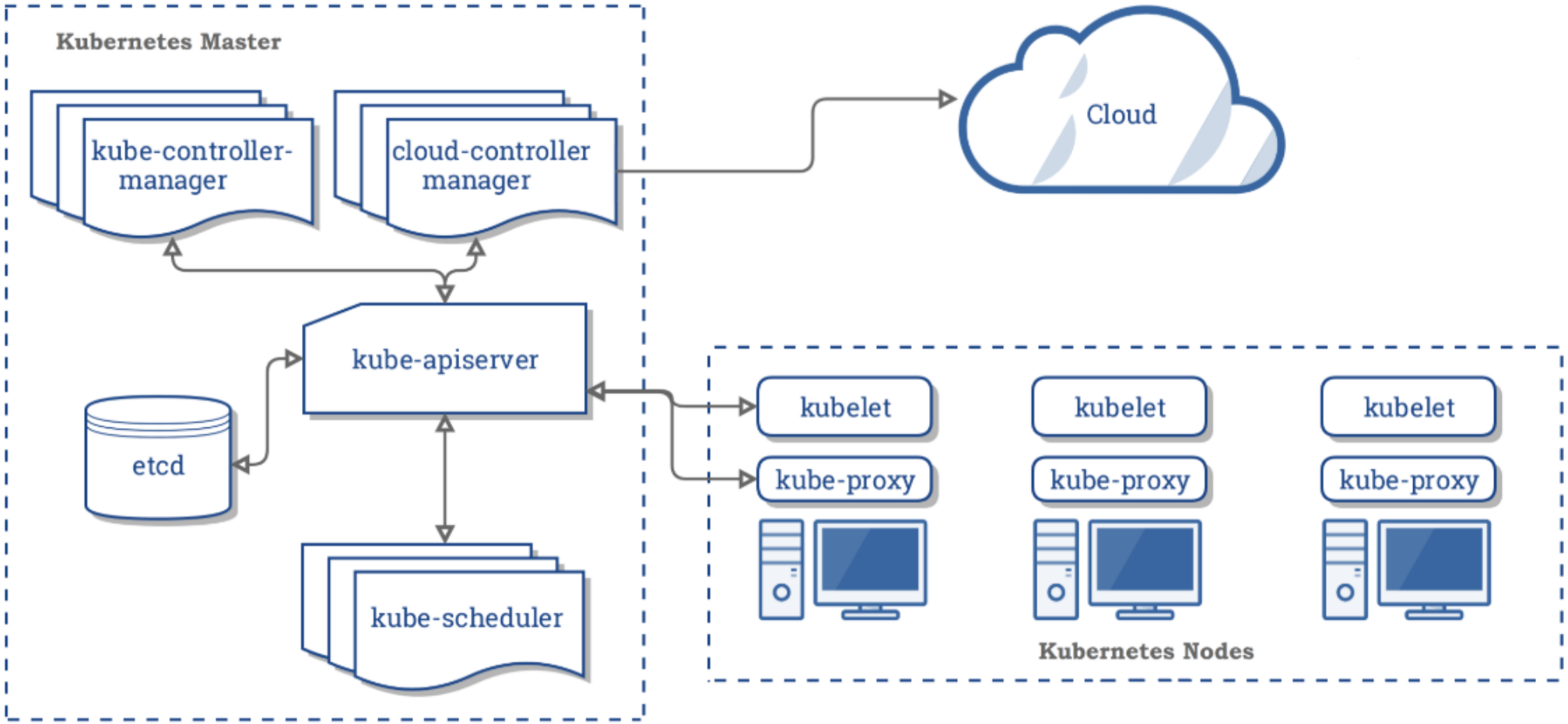
Anatomy of Kubernetes Cluster | Master Node

Master node main task is to manage the worker node(s) to run an application

The master node consists of:

1) **API server** contains various methods to directly access the Kubernetes
2) **Scheduler** assigns to each worker node an application
3) **Controller manager**
   3a) Keeps track of worker nodes
   3b) Handles node failures and replicates if needed
   3c) Provide endpoints to access the application from the outside world
4) **Cloud controller** communicates with cloud provide regarding resources such as nodes and IP addresses
5) **Etcd** works as backend for service discovery that stores the cluster's state and its configuration

Anatomy of Kubernetes Cluster | Worker Nodes



Anatomy of Kubernetes Cluster | Worker Nodes

A worker node consists of:

1) **Container runtime** that pulls a specified Docker image and deploys it on a worker node

2) **Kubelet** talks to the API server and manages containers on its node

3) **Kube-proxy** load-balances network traffic between application components and the outside world

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Deploying a Kubernetes Cluster

To deploy your cluster you must install Kubernetes. In the exercise you are going to use minikube to deploy a cluster in local mode.

- After installing minikube, use *start* to begin your session creating a virtual machine, *stop* to interupt it, and *delete* to remove the VM. Below are the commands to execute these tasks:

```
$ minikube start
$ minikube stop
$ minikube delete
```

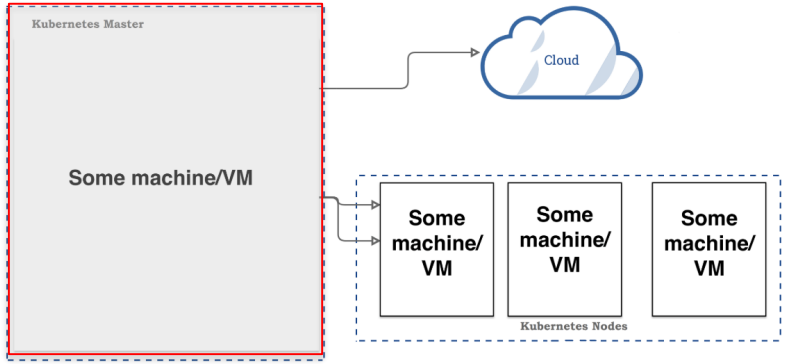
Deploying a Kubernetes Cluster

You can easily access the Kubernetes Client using the following command:

- to check your cluster status use:

```
$ kubectl get componentstatuses
```

- and should see output below:




```
NAME                 STATUS    MESSAGE             ERROR
scheduler            Healthy   ok
controller-manager   Healthy   ok
etcd-0               Healthy   {"health": "true"}
```

Deploying a Kubernetes Cluster

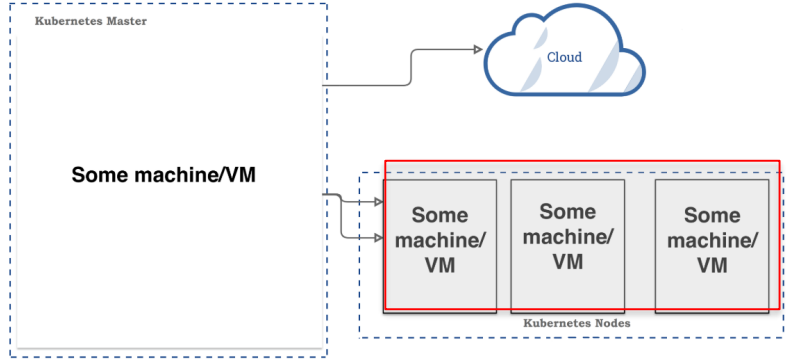
You can easily access the Kubernetes Client using the following command:

- to list the nodes in your cluster use:

```
$ kubectl get nodes
```

- and should see output below:

```
NAME          STATUS          AGE       VERSION
kubernetes    Ready,master    45d       v1.12.1
node-1        Ready           45d       v1.12.1
node-2        Ready           45d       v1.12.1
node-3        Ready           45d       v1.12.1
```



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Common kubectl Commands

Let’s practice Kubernetes! Access the exercise using the link below:

> LINK TO EXERCISE <

> LINK TO RESOURCES <

Common kubectl Commands

- Useful commands to complete the exercise:

```
$ kubectl create -f app-db-deploymnet.yaml
$ kubectl get deployment
$ kubectl get pods
$ kubectl get pods /
  -o=custom-columns=NAME:.metadata.name,IP:.status.podIP
$ kubectl create -f app-server-deploymnet.yaml
$ kubectl expose deployment /
app-deployment --type=LoadBalancer --port=8080
$ kubectl get services
$ kubectl delete service app-deployment
$ kubectl delete deployment app-server-deployment
$ kubectl delete deployment app-db-deployment
```

THANK YOU

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