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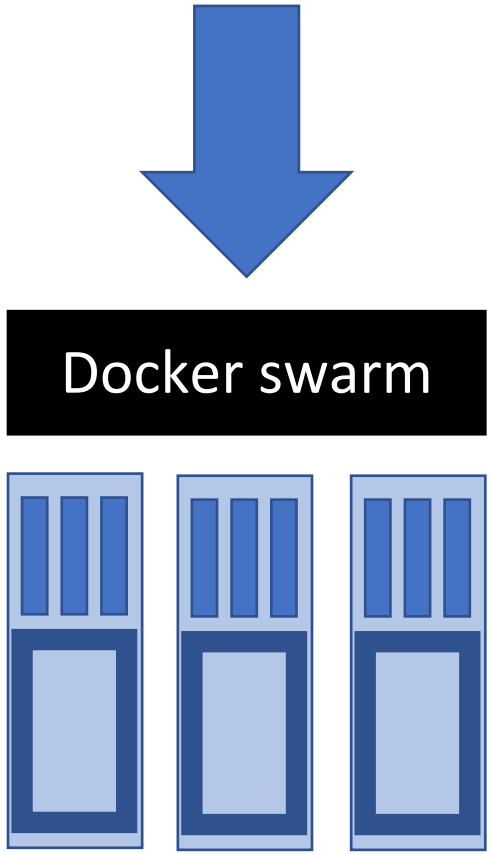
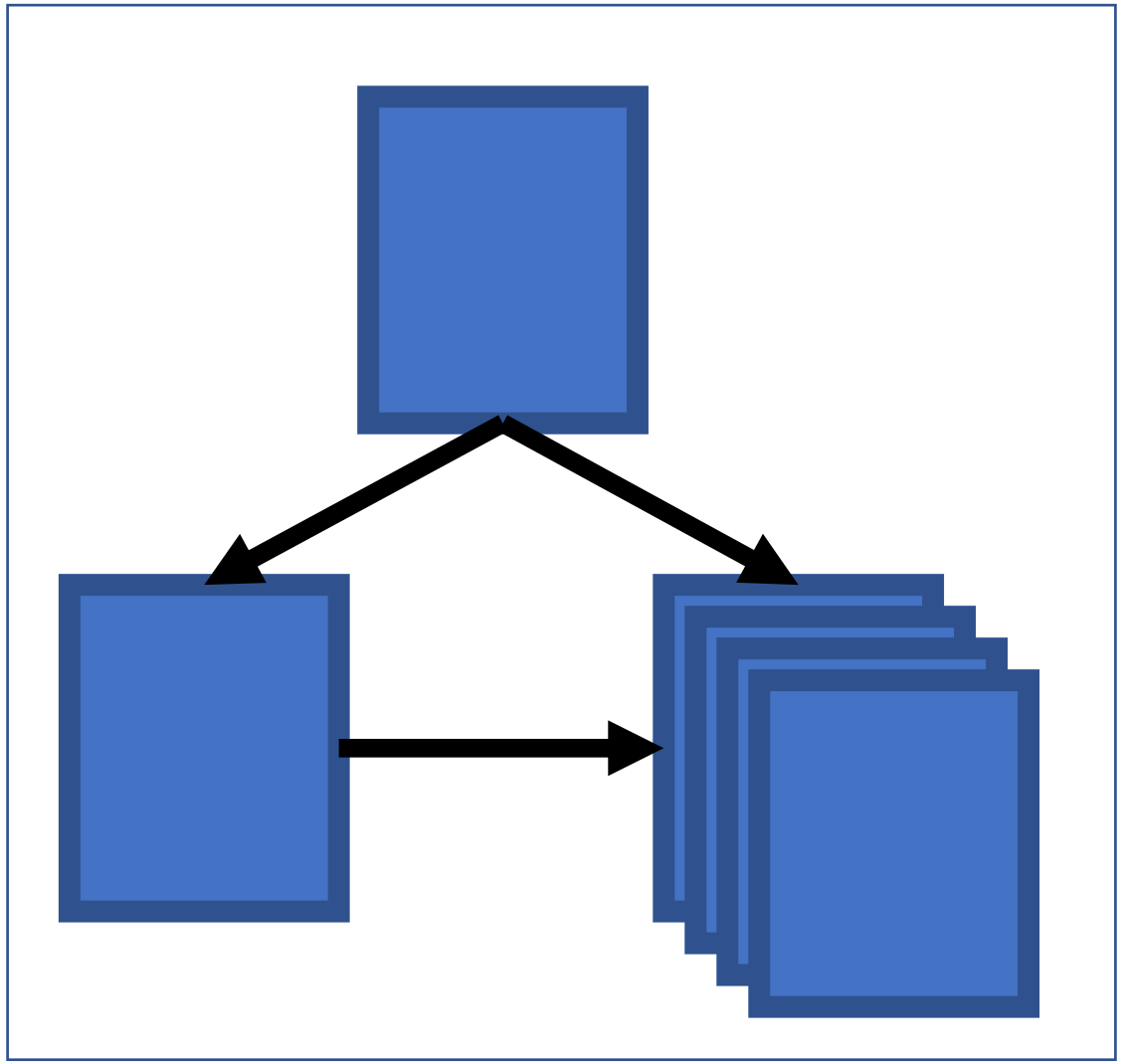
Lecture 13 – Kubernetes etc,

Docker swarm - docker compose

Orchestration



Docket compose



Kubernetes (k8s)

- An advanced tool for orchestration of containers (or other similar things)
- Comes with several features supporting automation and monitoring
- Has as steep learning curve
- Open source released by Google in 2004 (apache license)
- Now maintained by Cloud Native Computing Foundation (https://www.cncf.io)
- "platform for automating deployment, scaling, and operations of application containers across clusters of hosts”
- Is “job interview stuff”

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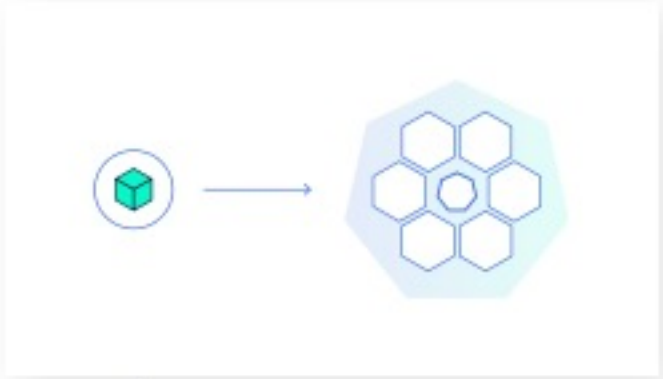
Modules of kubernetes.io tutorial

(source: https://kubernetes.io/docs/tutorials/kubernetes-basics/)

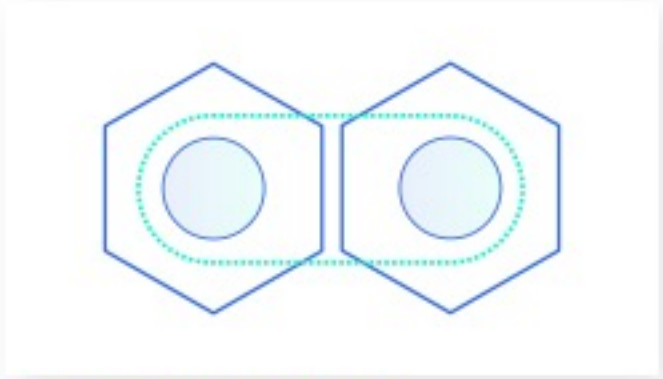
1. Create a Kubernetes cluster



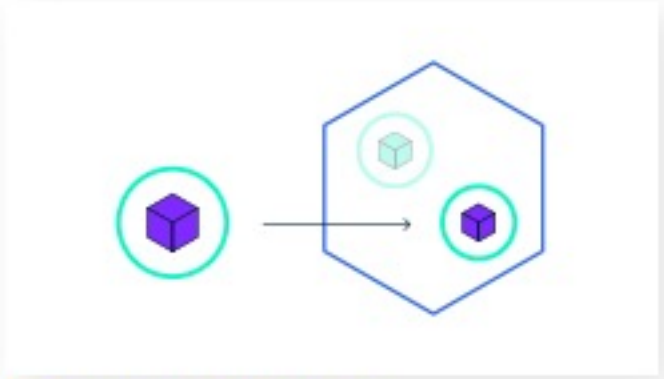
2. Deploy an app

3. Explore your app

4. Expose your app publicly

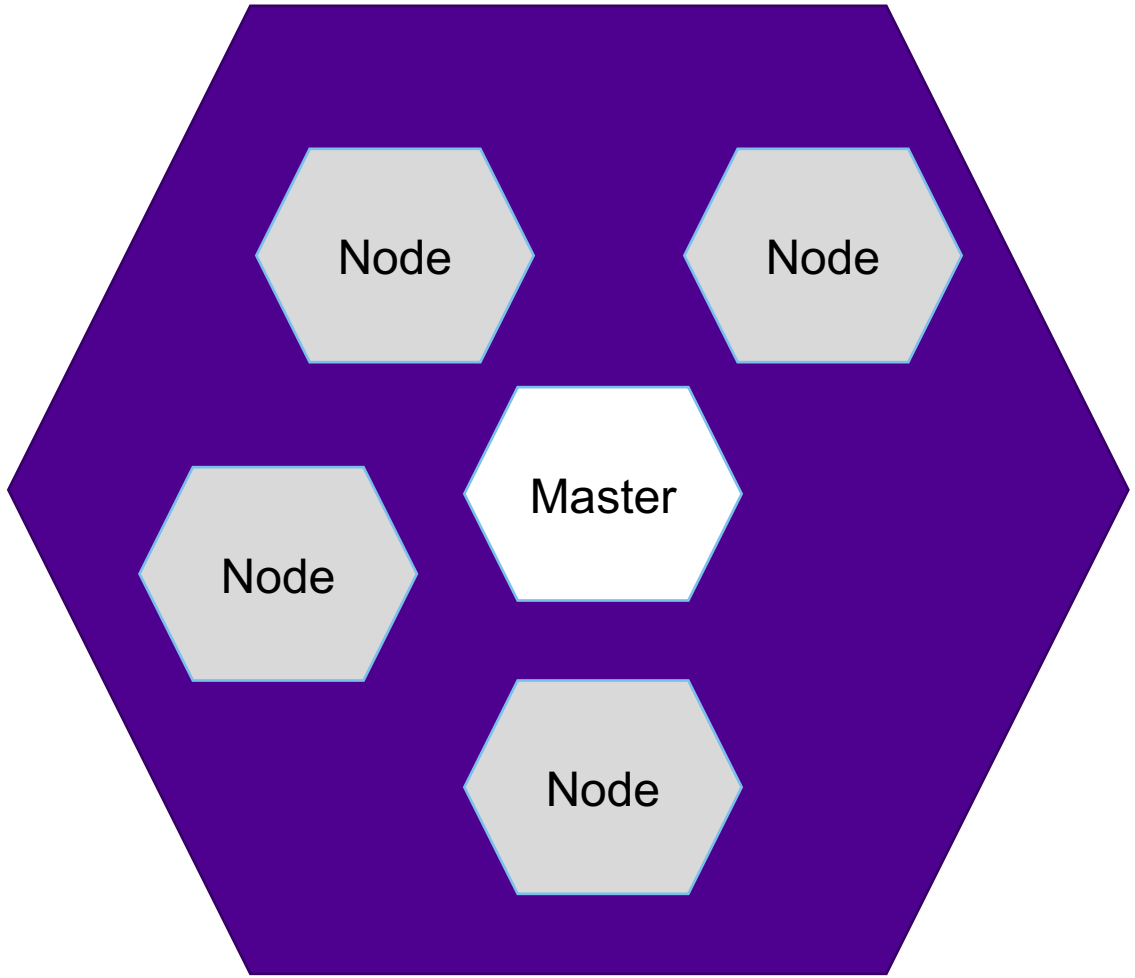


5. Scale up your app

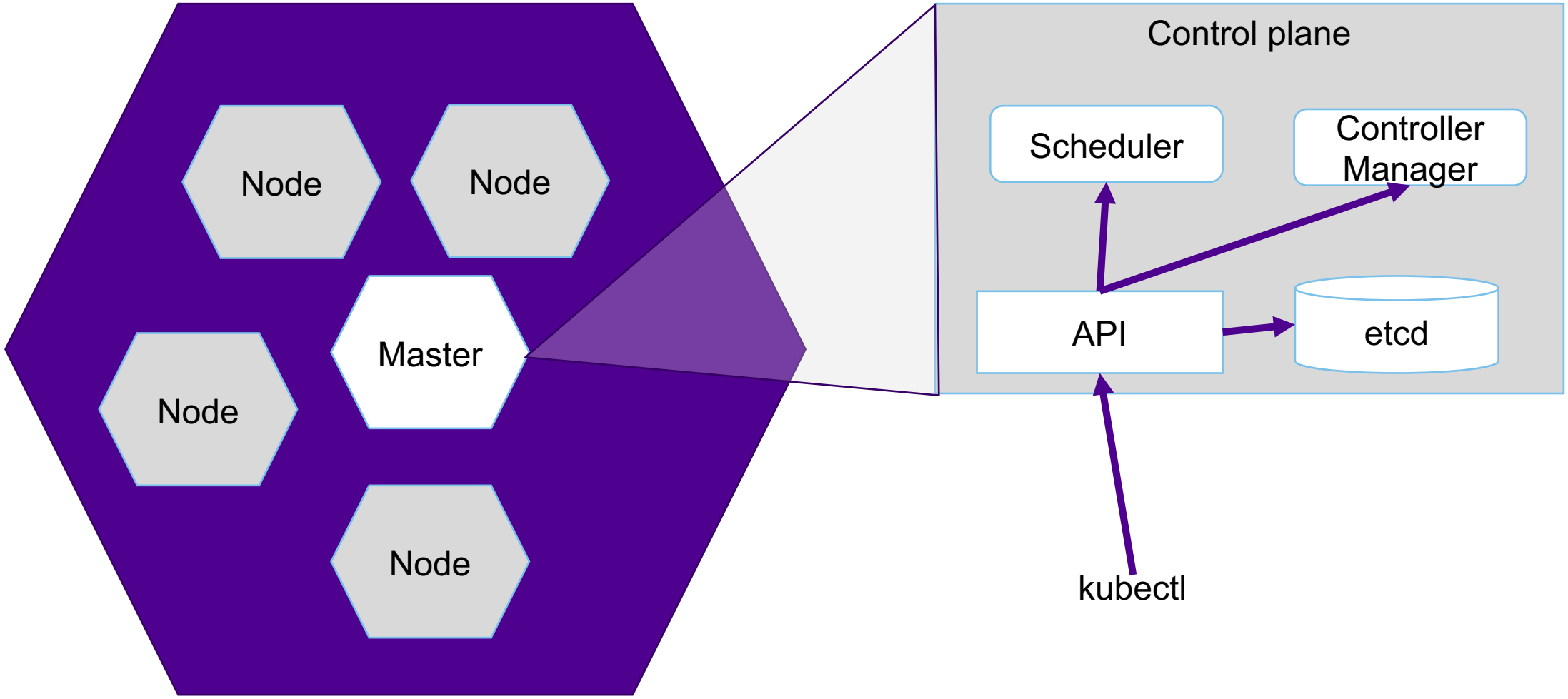


6. Update your app

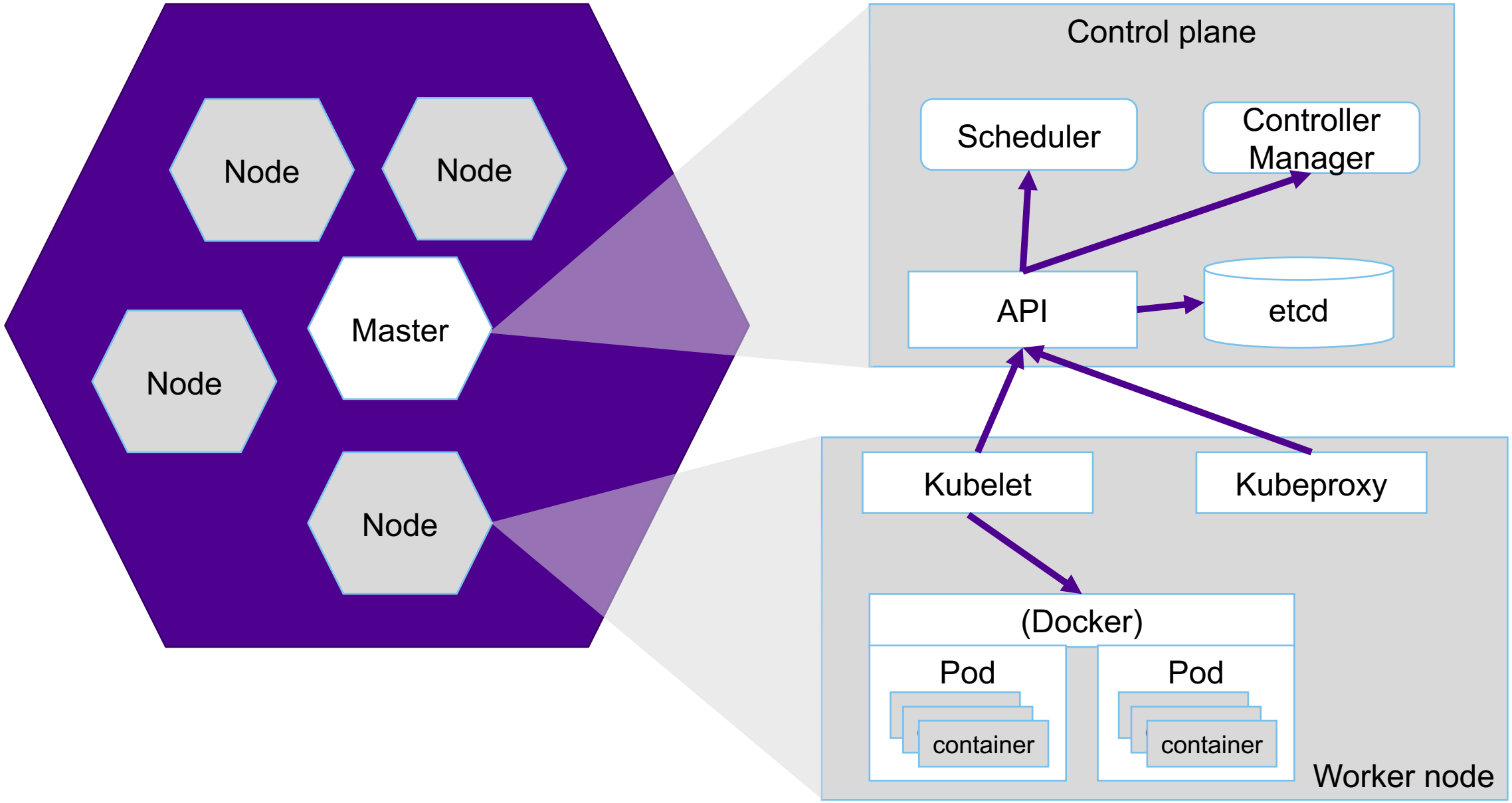
Kubernetes Kluster



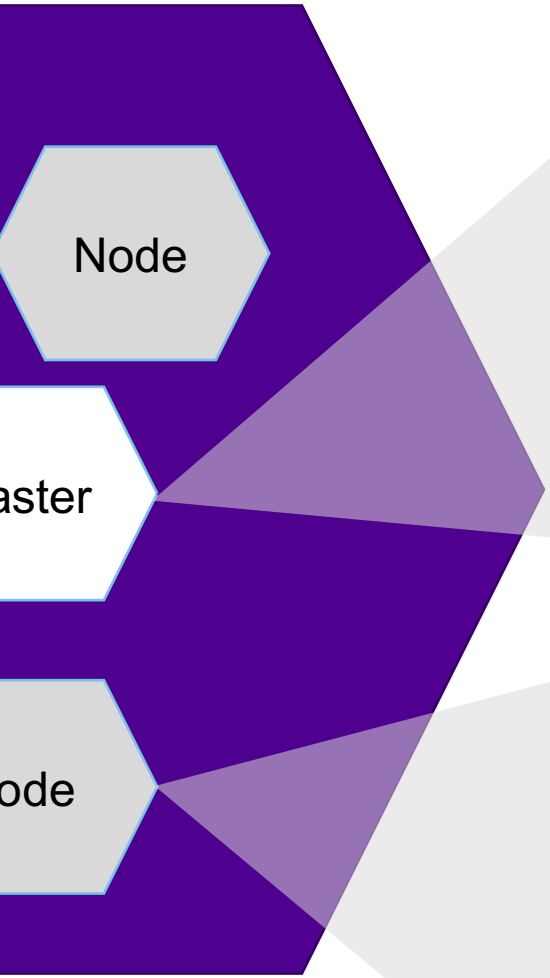
Kubernetes Kluster

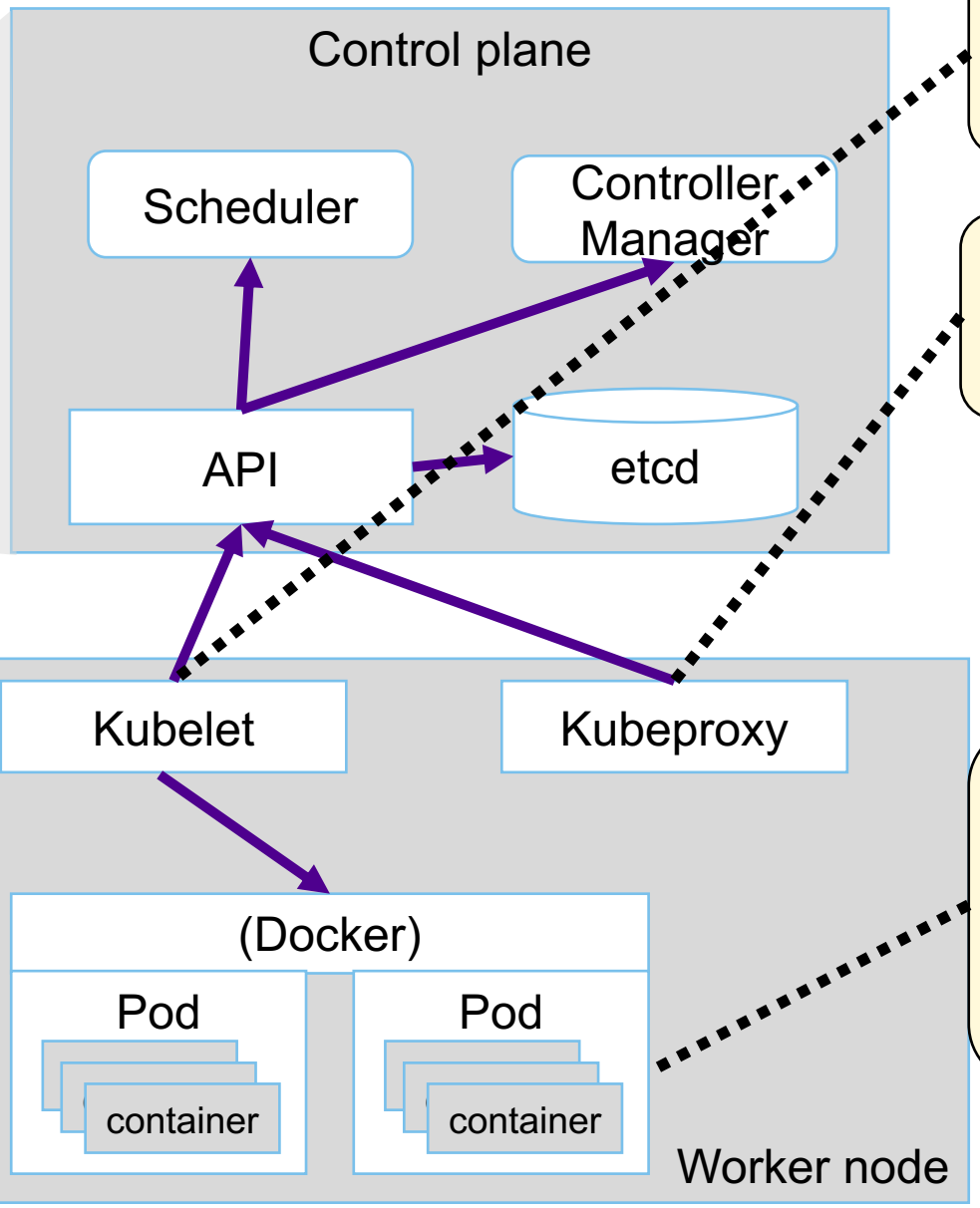


Kubernetes Kluster



Worker node



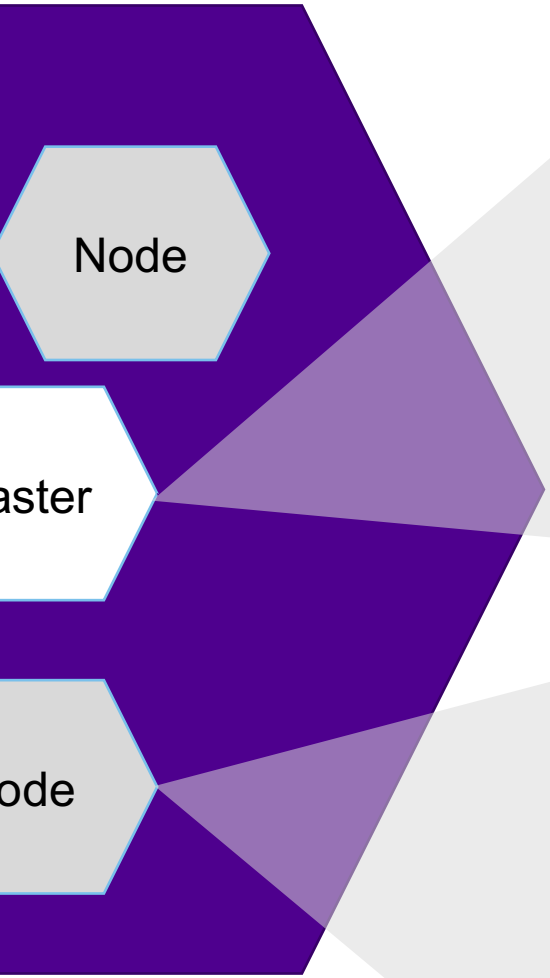


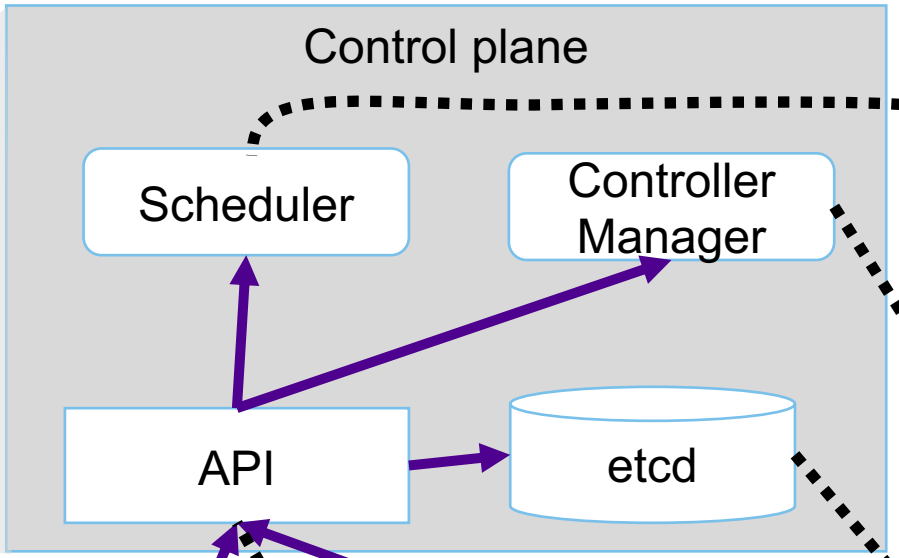
Agent to control the node. Starts (and stops) the containers.

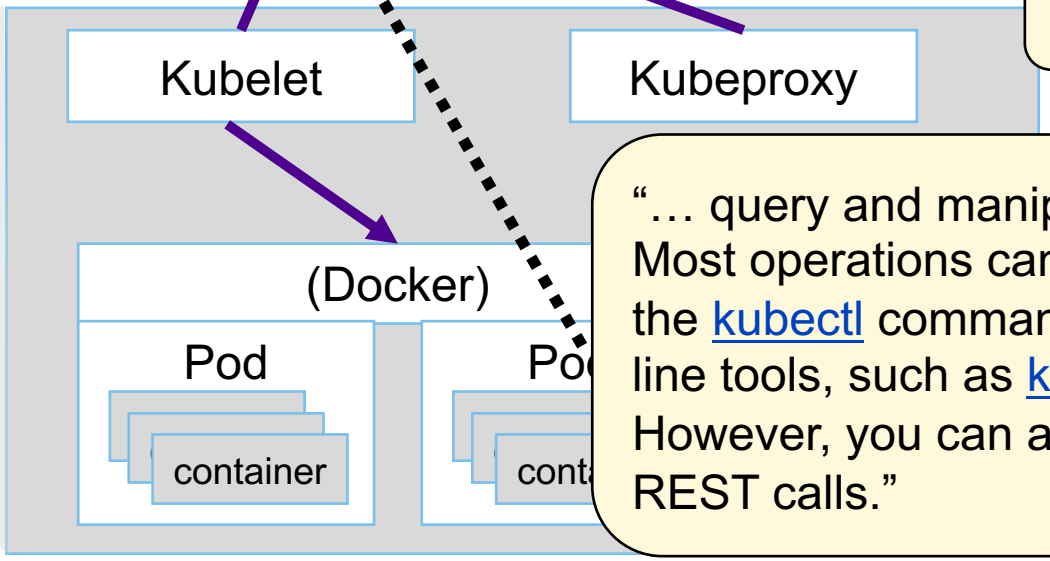
Nework proxy

Smallest unit. Can have several containers that share resources with each other.
Every Pod has a unique IP address within the kluster

Control plane







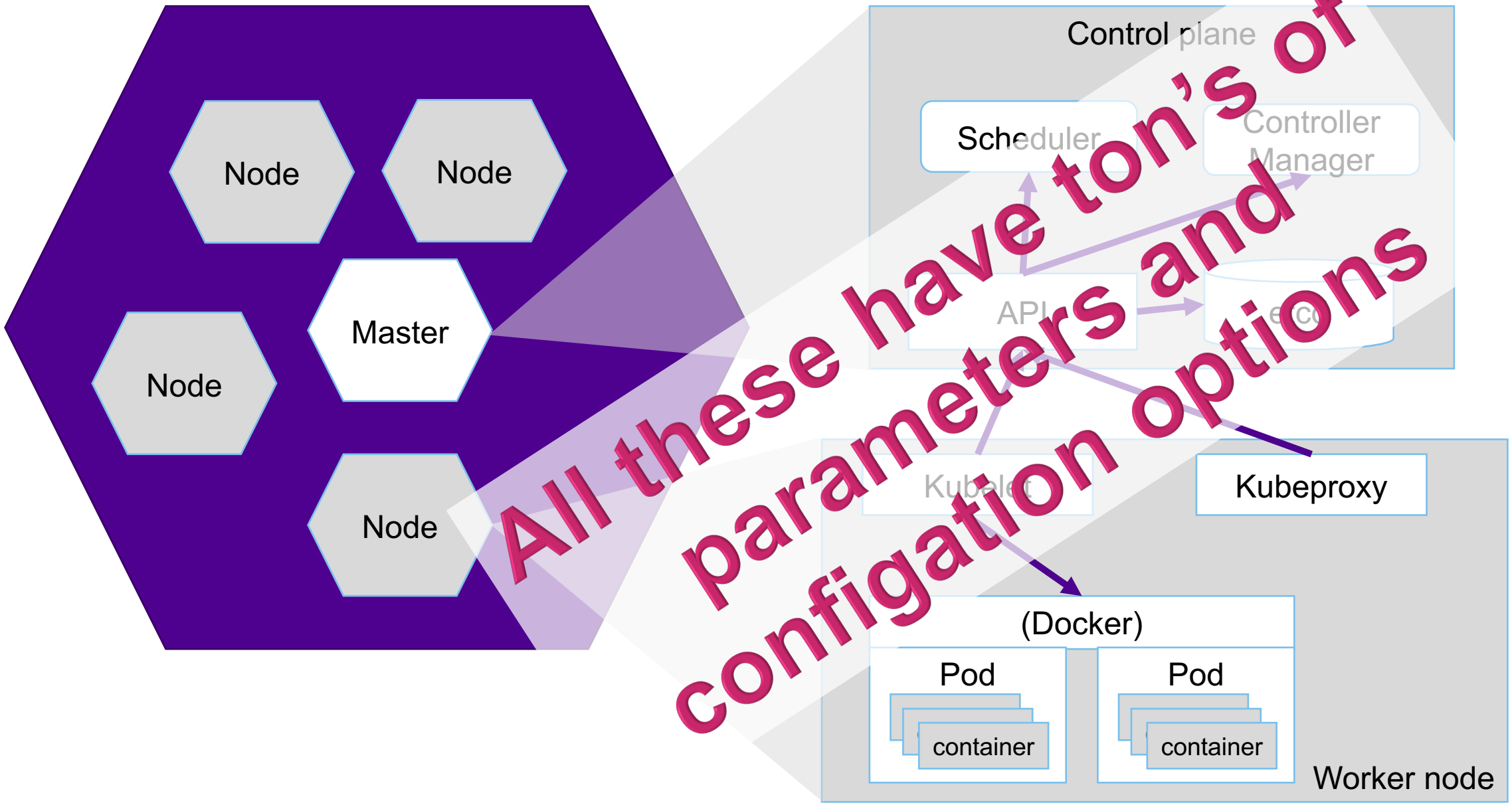
Sees that every Pod has a Node to run it.
Finds the most suitable node

" a control loop that watches the shared state of the cluster through the apiserver and makes changes attempting to move the current state towards the desired state"

Key-value store for all kind of configuration information

"… query and manipulate the state of objects … Most operations can be performed through the kubectl command-line interface or other command-line tools, such as kubeadm, which in turn use the API. However, you can also access the API directly using REST calls."

Kubernetes Kluster



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Then next step

(source: https://kubernetes.io/docs/tutorials/kubernetes-basics/)

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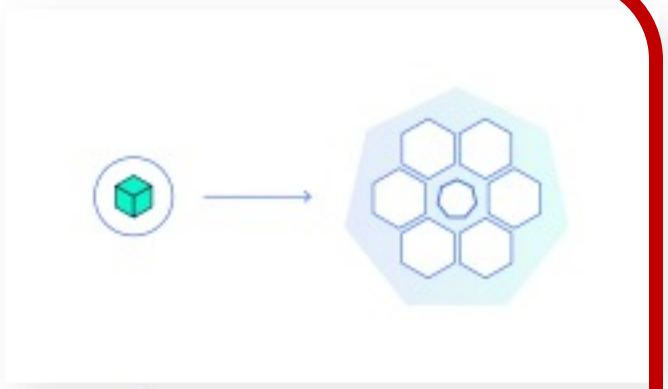

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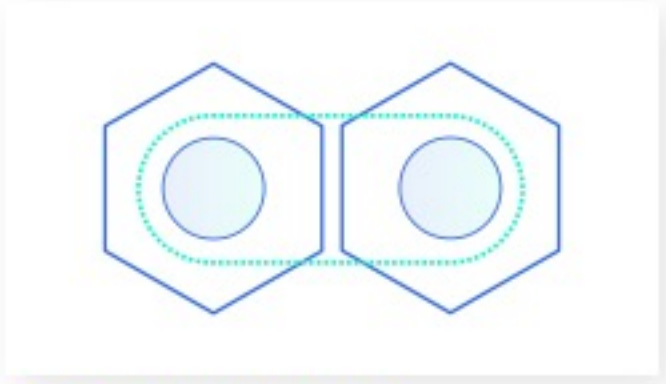

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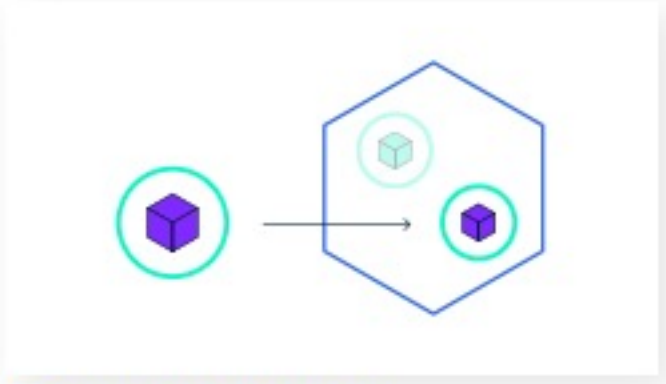

6. Update your app

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Deployment to Kubernetes

- Step 1: create Deployment (configuration)
- “A Deployment is responsible for creating and updating instances of your application”

```
$ kubectl apply -f
    https://k8s.io/examples/controllers/nginx-deployment.yaml
```

```
$ kubectl get deployments
```

```
NAME               READY   UP-TO-DATE   AVAILABLE   AGE
nginx-deployment   0/3     0            0           1s
```

```
$ kubectl get deployments
```

```
NAME               READY   UP-TO-DATE   AVAILABLE   AGE
nginx-deployment   3/3     3            3           18s
```

```yaml
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
  labels:
    app: nginx
spec:
  replicas: 3
  selector:
    matchLabels:
      app: nginx
  template:
    metadata:
      labels:
        app: nginx
    spec:
      containers:
      - name: nginx
        image: nginx:1.14.2
        ports:
        - containerPort: 80
```

Then next step

(source: https://kubernetes.io/docs/tutorials/kubernetes-basics/)

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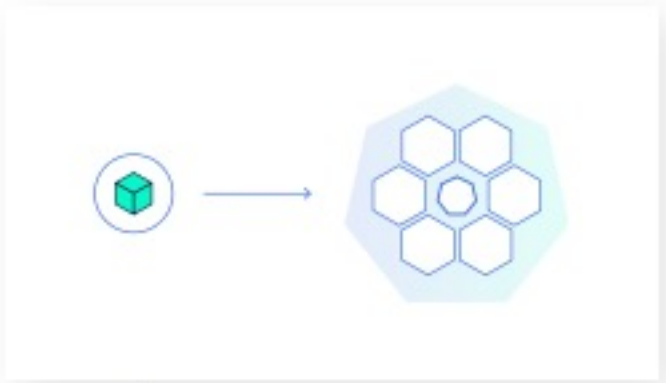

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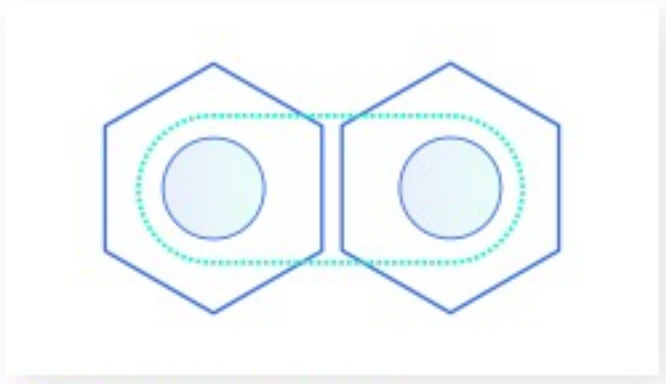

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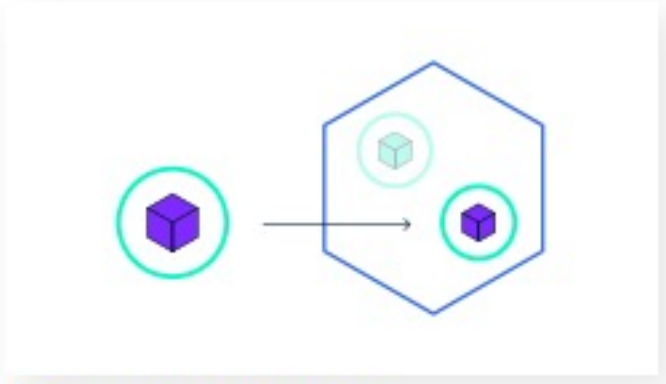

6. Update your app

Examples of tools for trouble shooting

- **kubectl get** - list resources
- **kubectl describe** - show detailed information about a resource
- **kubectl logs** - print the logs from a container in a pod
- **kubectl exec** - execute a command on a container in a pod

Then next step

(source: https://kubernetes.io/docs/tutorials/kubernetes-basics/)

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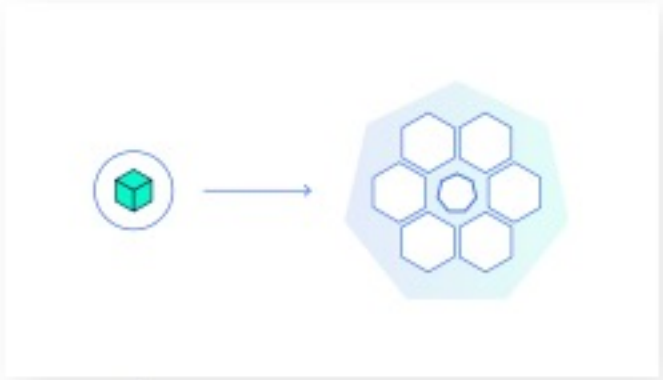

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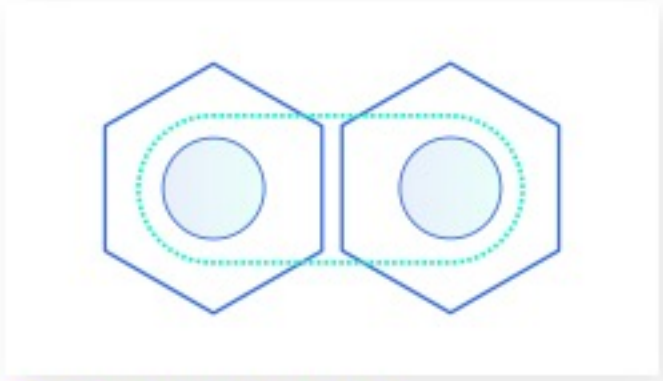

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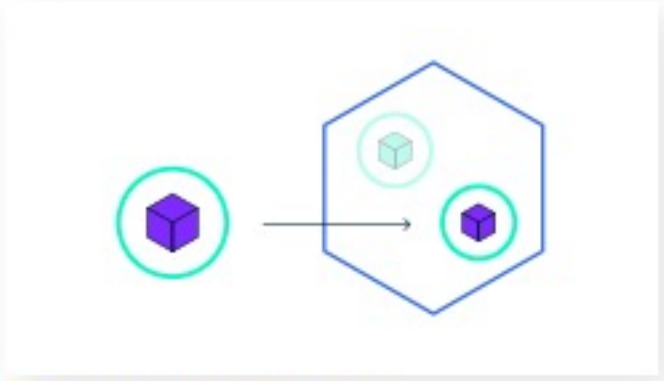

6. Update your app

Kubernetes services

- Service
  - External IP and port
  - Load balancer
  - External name

Then next step

(source: https://kubernetes.io/docs/tutorials/kubernetes-basics/)

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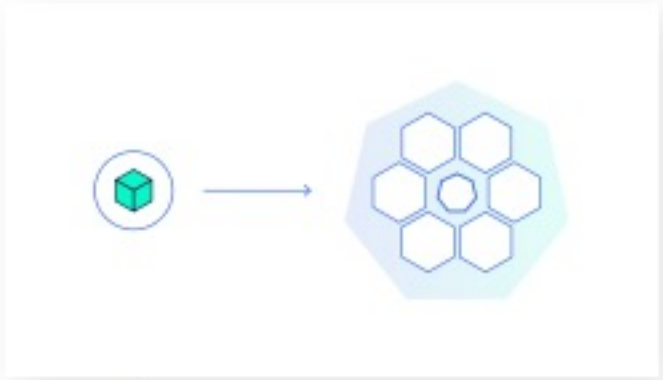

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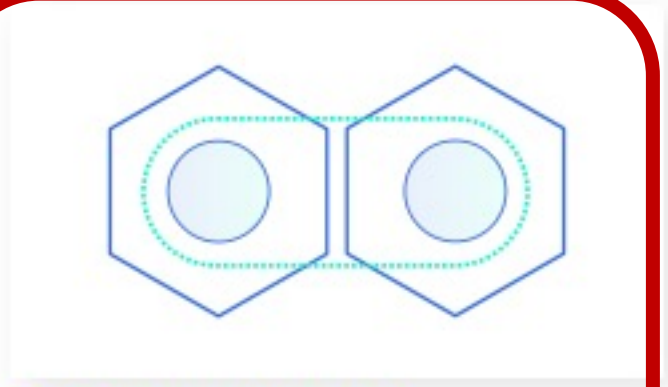

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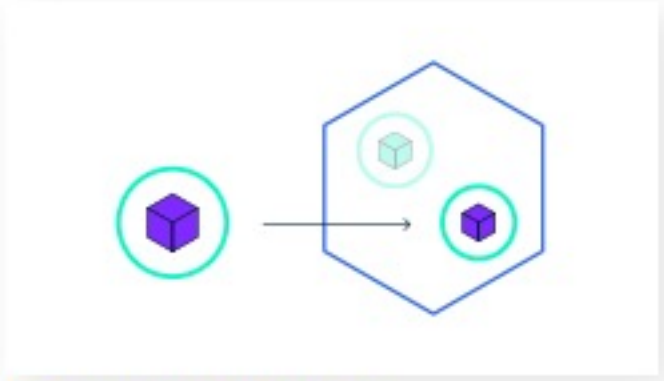

6. Update your app

Scaling in Kubernets

- Scaling out a of Deployment increases the number of Pods to the new desired state.
- Kubernetes also supports auto scaling.
- Scaling to zero is also possible, and it will terminate all Pods of the specified Deployment.
- Services have an integrated load-balancer that will distribute network traffic to all Pods of an exposed Deployment.
- Services will monitor continuously the running Pods using endpoints, to ensure the traffic is sent only to available Pods.

Then next step

(source: https://kubernetes.io/docs/tutorials/kubernetes-basics/)

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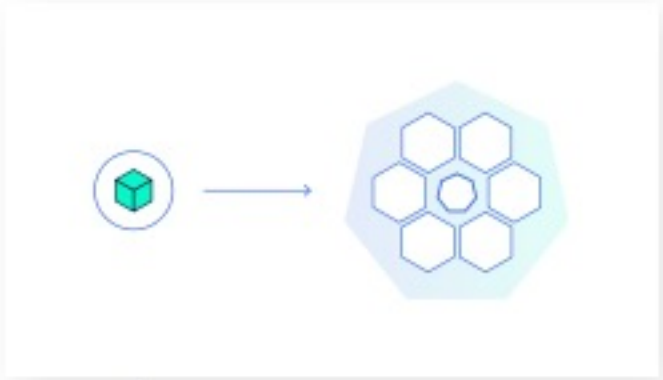

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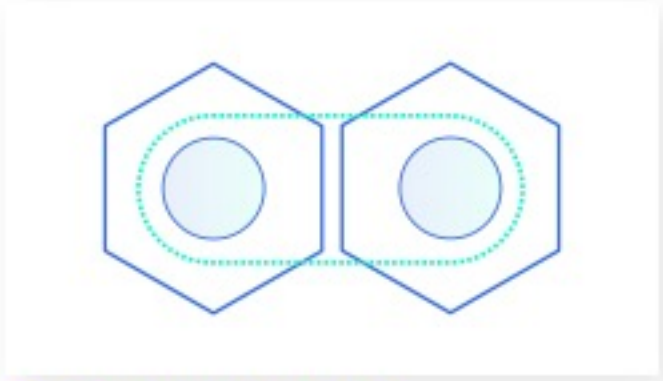

5. Scale up your app

6. Update your app

Updating an application

- Kubernetes uses **rolling updates**
- Zero down-time is the target

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According to the marketing material the supported features of Kubernetes include

- *Automatic binpacking*. Kubernetes automatically schedules the containers based on resource usage and constraints, without sacrificing the availability.
- *Self-healing*. Kubernetes automatically replaces and reschedules the containers from failed nodes. It also kills and restarts the containers which do not respond to health checks, based on existing rules/policy.
- *Horizontal scaling*. Kubernetes can automatically scale applications based on resource usage like CPU and memory. In some cases, it also supports dynamic scaling based on customer metrics.
- *Service discovery and Load balancing*. Kubernetes groups sets of containers and refers to them via a Domain Name System (DNS). This DNS is also called a Kubernetes service. Kubernetes can discover these services automatically, and load-balance requests between containers of a given service.
- *Automated rollouts and rollbacks*. Kubernetes can roll out and roll back new versions/configurations of an application, without introducing any downtime.
- *Secrets and configuration management*. Kubernetes can manage secrets and configuration details for an application without re-building the respective images. With secrets, we can share confidential information to our application without exposing it to the stack configuration, like on GitHub.
- *Storage orchestration*. With Kubernetes and its plugins, we can automatically mount local, external, and storage solutions to the containers in a seamless manner, based on software-defined storage (SDS).
- *Batch execution*. Besides long running jobs, Kubernetes also supports batch execution.

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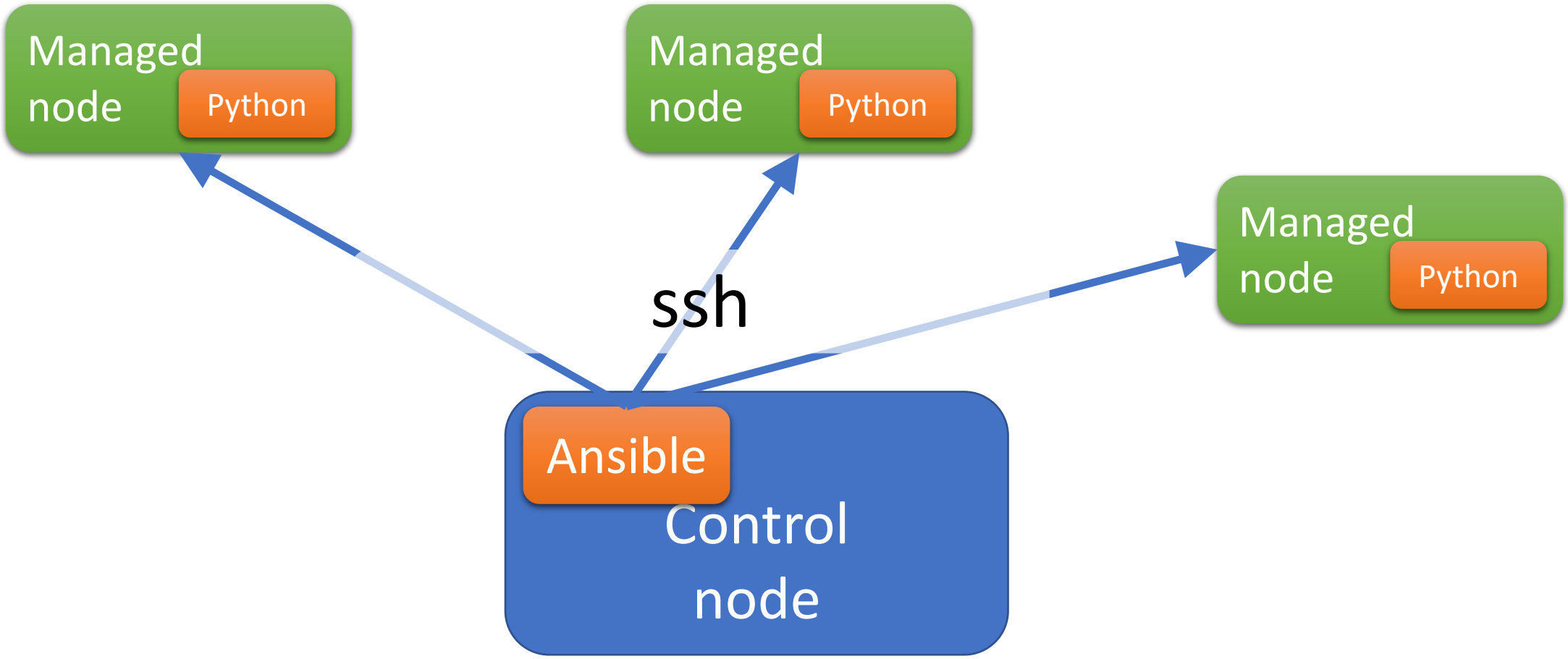
BSc thesis of Petteri Strömberg

Table 1. *Functional differences between Docker Swarm and Kubernetes.*

Layer	Feature	Docker Swarm	Kubernetes
Resource Management	Memory	+	+
	CPU	+	+
	Local Volumes	+	+
	Remote Volumes	+	++
	Networking	+	+
Scheduling	Placement	+	+
	Scaling	+	+
	Automatic Scaling		+
	Readiness Checking		+
	Restarting	+	+
	Rolling Updates	+	+
	Co-location		+
Service Management	Labels	+	+
	Groups		+
	Load Balancing	+	++

+ basic functionality, ++ advanced functionality

Reminder about Ansible



Tampereen yliopisto
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Other alternatives to Ansible

- **Chef:** Chef is written in the Ruby programming language and its CLI uses a Ruby-based DSL. Chef assumes an agent in the controlled nodes.
- **SaltStack:** Written in Python, SaltStack(Salt) holds your inventory's state on a master server, with YAML being the default format for storing configurations. SaltStack templates use the Jinja templating language, which will be familiar to Python users.
- **Puppet:** Another tool on the configuration management side, Puppet requires a master server, called the Puppet master, which stores the configuration of your infrastructure and pushes changes out to clients.
- **Terraform:** A different approach to both Ansible and Chef. Terraform focuses on setting up your entire infrastructure and provisioning servers. As such, it falls on the orchestration side of the spectrum, but it can be used alongside configuration focused tools like Chef and Ansible

Example of an alternative approach: CloudFoundry

- Claim: "*Cloud Foundry makes going from code to running apps as easy as a single cf push command. Don't spend your time writing infrastructure config for Kubernetes and Istio. Stay focused on your code.*"
- "First, equating the Cloud Foundry experience to a Kubernetes experience is like equating apples and walnuts. They're not at all related. Kubernetes is all about being an infrastructure abstraction, but that's not optimized for developers, and it has a more broadly applicable set of use cases – you can take a legacy app, slap it into a container and run it on Kubernetes; you could craft your own containers that are for a more modern architecture and run that on Kubernetes; and a whole bunch of things in between. The Cloud Foundry experience is focused on optimizing for the developer that's writing custom software for business or, in many cases, government applications. It's all about custom code."
- CloudFoundry may run on top of Kubernetes

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About the future

- I suspect that the programmatic and simpler approaches are coming.
- CDK presented in the guest lecture last week is an example of that development.

Terraform

- Declarative approach, too.
  - User writes a specification of the target state
- Pluggable architecture
  - Can have providers for AWS, Azure, gCloud
- Code – (plan –)apply

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example.tf

```
terraform {
    required_providers {
        aws = {
            source = "hashicorp/aws"
            version = "~> 2.70"
        }
    }
}
provider  aws  {
   profile = "default"
   region = "us-west-2"
}

resource "aws_instance" "example" {
     ami = "ami-830c94e3"
     instance_type = "t2.micro"
}
```

```
$ terraform show
# aws_instance.example:
resource "aws_instance" "example" {
    ami                          = "ami-830c94e3"
    arn                          = "arn:aws:ec2:us-east-
1:130490850807:instance/i-0bbf06244e44211d1"
    associate_public_ip_address  = true
    availability_zone            = "us-west-2"
    cpu_core_count               = 1
    cpu_threads_per_core         = 1
    disable_api_termination      = false
    ebs_optimized                = false
    get_password_data            = false
    id                           = "i-0bbf06244e44211d1"
    instance_state               = "running"
    instance_type                = "t2.micro"
    ipv6_address_count           = 0
    ipv6_addresses               = []
    monitoring                   = false
    primary_network_interface_id = "eni-0f1ce5bdae258b015"
    private_dns                  = "ip-172-31-61-141.ec2.internal"
    private_ip                   = "172.31.61.141"
    public_dns                   = "ec2-54-166-19-naws.com"
    public_ip                    = "54.166.19.244"
    security_groups              = [
        "default",
    ]
    source_dest_check            = true
    subnet_id                    = "subnet-1facdf35"
    tenancy                      = "default"
    volume_tags                  = {}
    vpc_security_group_ids       = [
        "sg-5255f429",
    ]
```

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From WikiPedia

Tool	Released by	Method	Approach	Written in	Comments
Pulumi	Pulumi[13]	Push	Declarative	Typescript, Python, Go	
Chef	Chef (2009)	Pull	Declarative and imperative	Ruby	
Otter	Inedo	Push	Declarative and imperative	-	Windows oriented
Puppet	Puppet (2005)	Pull	Declarative	C++ & Clojure from 4.0, Ruby	
SaltStack	SaltStack	Push and Pull	Declarative and imperative	Python	
CFEngine	CFEngine	Pull	Declarative	-	
Terraform	HashiCorp (2014)	Push	Declarative	Go	
DSC	Microsoft	Push/Pull	Declarative/Imperative	PowerShell	
Ansible / Ansible Tower	RedHat (2012)	Push	Declarative and imperative	Python	

Other tools include AWS CloudFormation, cdist, StackStorm and Juju (software).

Another: Heroku

https://devcenter.heroku.com/articles/how-heroku-works

- “Heroku lets you deploy, run and manage applications written in Ruby, Node.js, Java, Python, Clojure, Scala, Go and PHP.”
- “Heroku is a polyglot platform – it lets you build, run and scale applications in a similar manner across all the languages – utilizing the dependencies and Procfile. The Procfile exposes an architectural aspect of your application…”
- Architectural principles:
  - Strict separation of code and configuration, explicit dependency declaration, tight development iterations and parity between environments.
  - Applications are run as independent, lightweight, and stateless processes with quick startup and shutdown.
  - Execute auxiliary tasks in one-off processes and view application output via collated log-stream.

Automation challenges

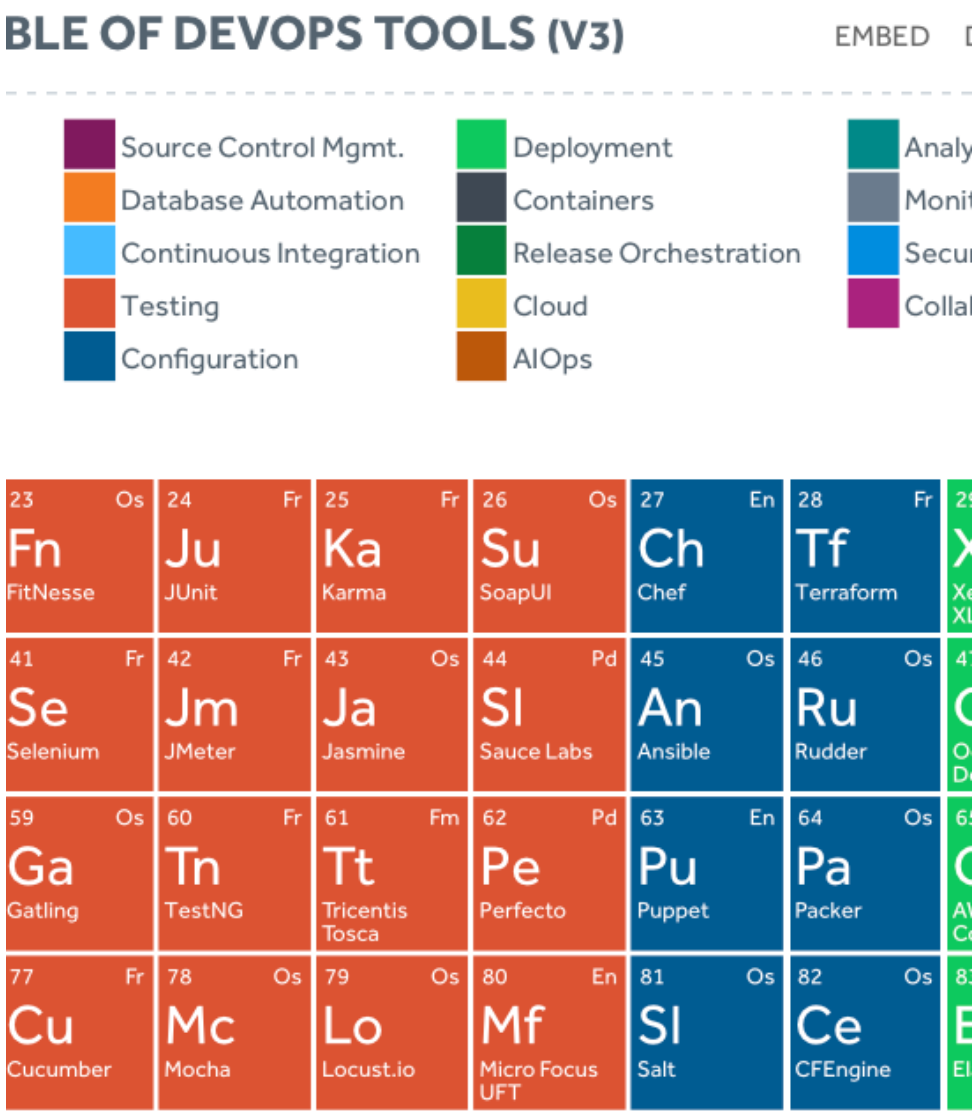
- ”…provisioning scripts were considered error-prone and, according to developers, they did not work in some environments…”
- ”…automation of the network in was said to be difficult in addition to dealing with legacy system…”
- ”Networks are pretty hard. Some of the databases are pretty hard too because the old relational databases haven’t been designed to be clustered…”

Reminders about infrastructure as code

All SW engineering principles should be applied.

- Testing
- Maintenance
- Documentation
- Version and configuration management

- Bugs may stop the whole engine


BLE OF DEVOPS TOOLS (V3)
EMBED
Source Control Mgmt.
Database Automation
Continuous Integration
Testing
Configuration
Deployment
Containers
Release Orchestration
Cloud
AIOps
23 Os Fn FitNesse
24 Fr Ju JUnit
25 Fr Ka Karma
26 Os Su SoapUI
27 En Ch Chef
28 Fr Tf Terraform
41 Fr Se Selenium
42 Fr Jm JMeter
43 Os Ja Jasmine
44 Pd Sl Sauce Labs
45 Os An Ansible
46 Os Ru Rudder
59 Os Ga Gatling
60 Fr Tn TestNG
61 Fm Tt Tricentis Tosca
62 Pd Pe Perfecto
63 En Pu Puppet
64 Os Pa Packer
77 Fr Cu Cucumber
78 Os Mc Mocha
79 Os Lo Locust.io
80 En Mf Micro Focus UFT
81 Os Sl Salt
82 Os Ce CFEngine

From:

https://tutorials.cloudfoundry.org/cf-and-k8s/docs/comparing/

Design Approach

- **Cloud Foundry** is an **opinionated set of components** that are designed and distributed to work together.
- **Kubernetes** is a **flexible and extensible** system with a wide range of open source components from which you can choose, install, configure and maintain.

Built-in Functionality

- **Cloud Foundry** embodies an **opinionated workflow**, and automates the building of container images from application code, configuration of HTTPS access to your apps, and comes pre-configured with multi-tenancy access controls that are suitable for use in banks and governments.
- **Kubernetes** offers a considerable amount of flexibility, and **can be configured and extended to support virtually any workflow**. As such, you could assemble your own set of components on Kubernetes that replicate the functionality of Cloud Foundry.