Kubernetes

Let’s talk about container orchestration!

Then let’s turn into peiratés!

Cloud Native's Birth: the API (Service) Moment

- All teams will henceforth expose their data and functionality through service interfaces.
- Teams must communicate with each other through these interfaces.
- There will be no other form of inter-process communication allowed: no direct linking, no direct reads of another team's data store, no shared-memory model, no back-doors whatsoever. The only communication allowed is via service interface calls over the network.
- It doesn't matter what technology you use.
- All service interfaces, without exception, must be designed from the ground up to be externalize-able. That is to say, the team must plan and design to be able to expose the interface to developers in the outside world. No exceptions.
- The mandate closed with: Anyone who doesn't do this will be fired. Thank you; have a nice day!

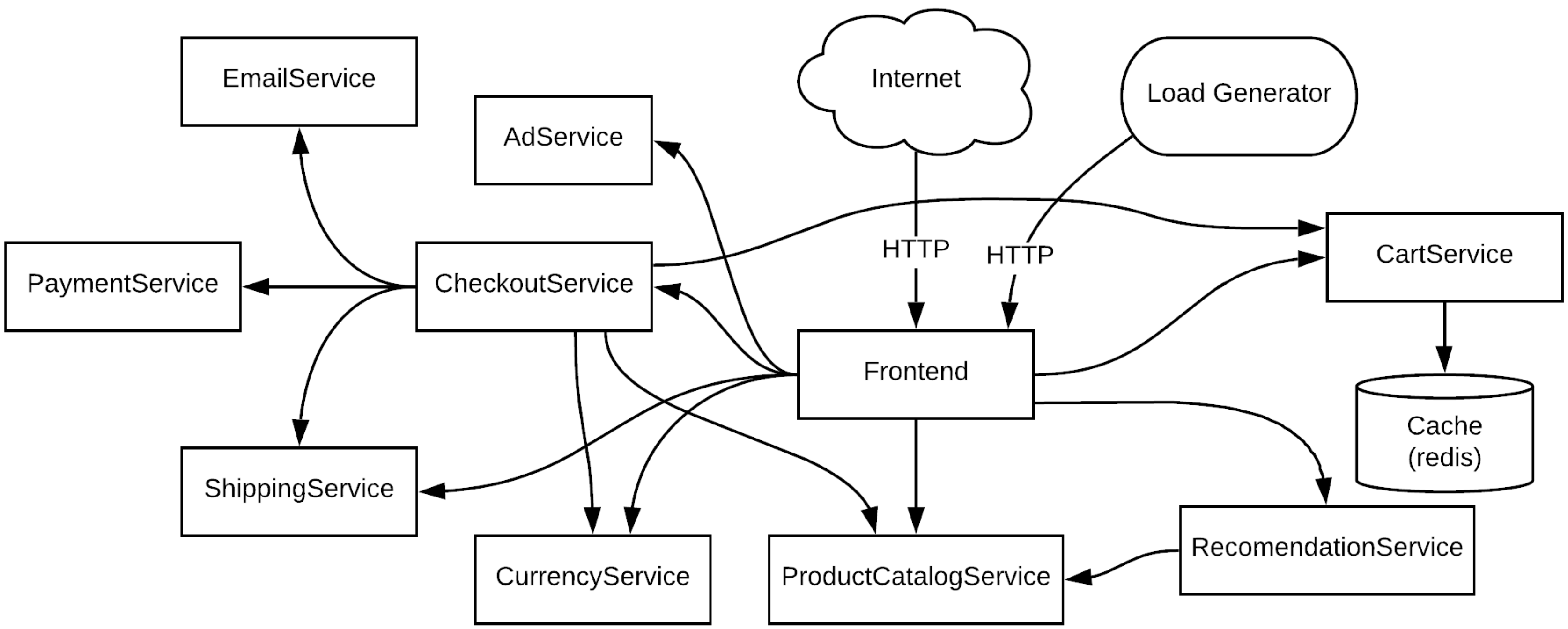
Jeff Bezos' 2002 API Mandate Memo

Amazon Web Services

- The memo forced every single connectable software project at Amazon to function as a product.
- In 2002, the same year as the memo, Amazon went from an online retailer to the cloud service provider that also operated a retail business.
- Amazon's market share in cloud services is 33%, which is larger than the next three players put together (as of 2022).

<u>Market Share</u>
AWS: 33%
Azure: 22%
GCP: 9%

Microservice Architecture



Google launched 2 billion containers per week in 2014

(approx. 3,300/second)

They did this with roughly 2.5 million servers in 2016.

Hard drives had an annualized failure rate of 1.95% in 2016

At one drive per server, that's 133 drive failures per day, or every 9 minutes.

What features would you need to manage that?

Reference and Fascinating Presentation:
Joe Beda, GlueCon 2014 Presentation

https://bit.ly/3fmYzu0

Kubernetes Features

- Bin Packing (Assigning workloads to machines)
- Self Healing
- Horizontal Scaling
- Service Discovery and Load Balancing
- Secret and Configuration Management
- Storage Orchestration
- Automated Rollouts and Rollbacks
- A/B Testing

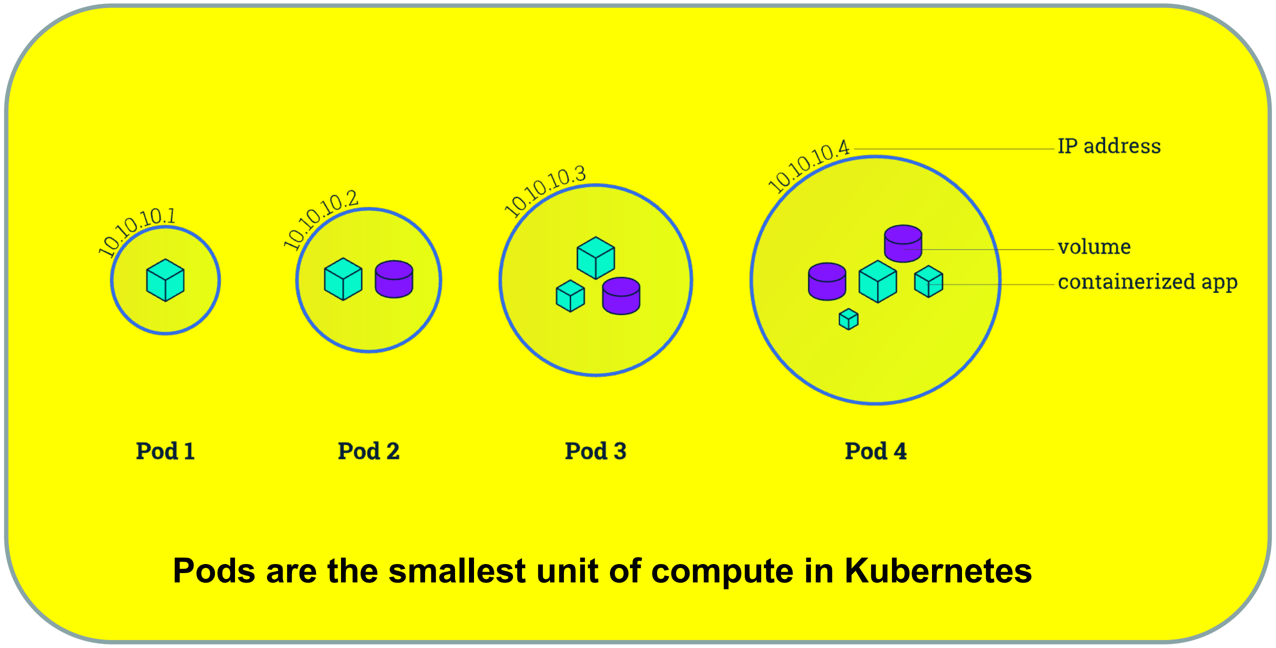
Software-defined Datacenter via Container Orchestration

Control Loops and the Declarative Model make this possible

Kubernetes Concepts and Terms

- Pods and Volumes
- Nodes
- Services
- Deployments
- Namespaces

Pods: Containers and Volumes



All containers in a pod share an IP address and may share the volumes defined in that pod.

Reference: Pods

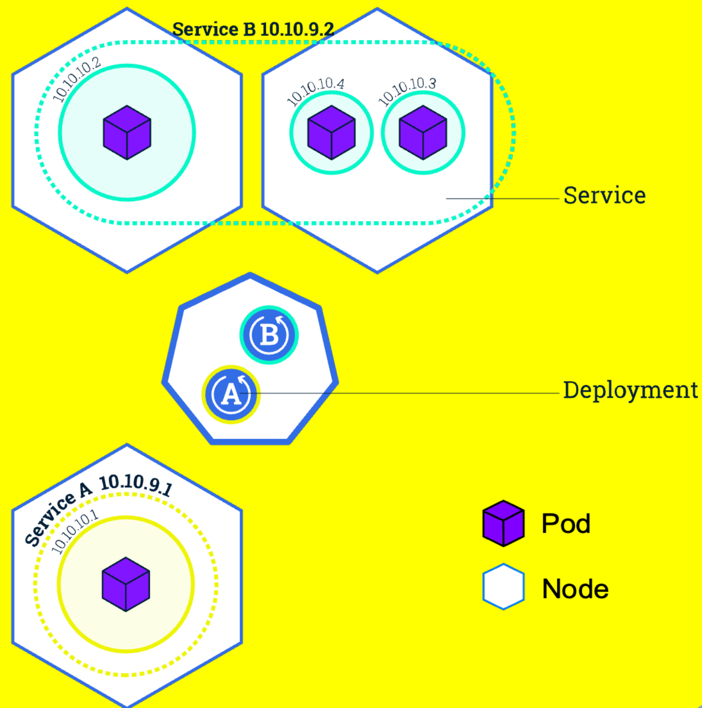
- a collection of one or more containers
- the smallest unit of work in Kubernetes
  - Expresses shares-a-host dependency between containers
  - If two programs absolutely must be placed onto the same node, use separate containers sharing a pod
- always includes a “pause” container
- shares a single network kernel namespace between containers
  - All containers in a pod have the same IP address
  - Programs across a pod must avoid binding to the same port numbers
- may define a volume for storage, which can be mounted into one or more of the containers' filesystems.

Deployment: Creating and Maintaining Pods

Deployment:

A deployment creates pods from the image you specify.

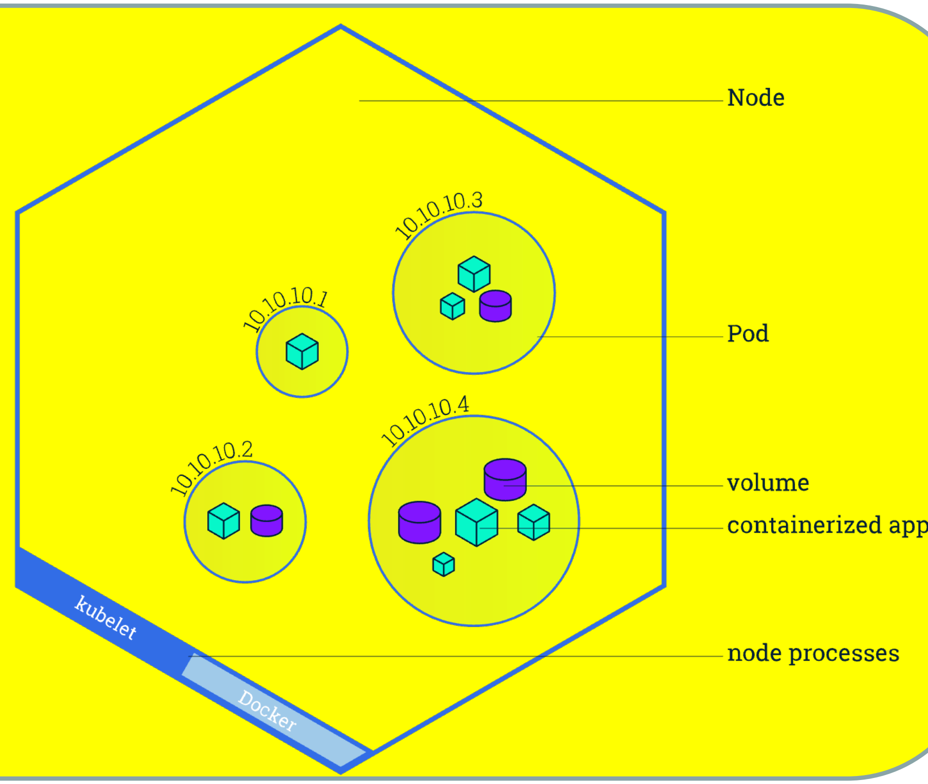
It maintains and scales the right number of pods, through both crashes and load increases/decreases.



Nodes: Hosts in the Cluster

Nodes run:

- **Kubelet**
- **Container Runtime (Docker, containerd, ...)**
- **Kube-Proxy**



Reference: Nodes

- A node is a Kubernetes host (virtual or physical machine) where containers are staged.
- A node has these components:
  - A container runtime (Docker, containerd, CRI-O,…)
  - `kubelet`
  - `kube-proxy`

- **Container runtime:** instructs the kernel to create containers
- **`kubelet`:** tells the container runtime what to create, destroy or configure.
- **`kube-proxy`:** configures `iptables`, IPVS, and otherwise proxies traffic.

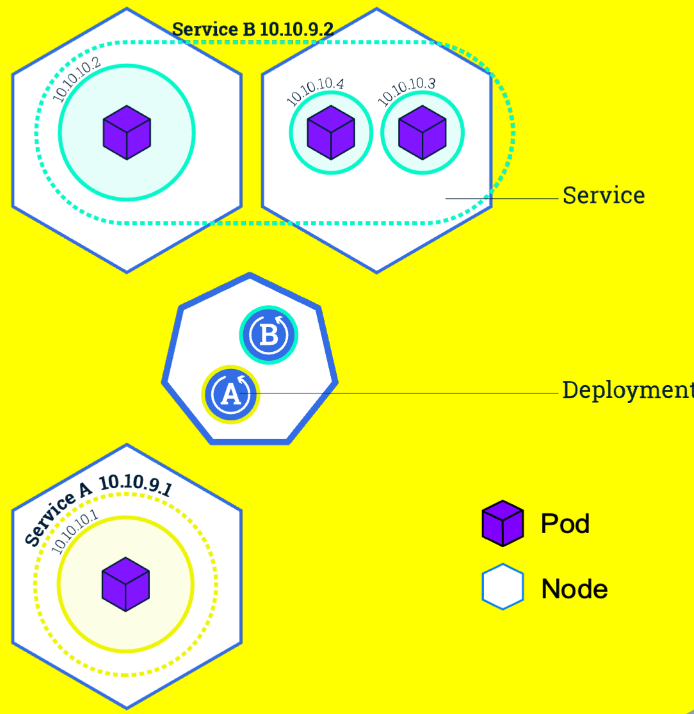
Services: Load Balancers

Service: a load balancer

A service creates:

- **a DNS name**
- **a virtual IP address**
- **an incoming/outgoing port pair**

These redirect traffic to pods whose labels match those specified in the service's manifest.



Services: DNS Names

Services create a DNS name (A record) in DNS:

app.default.svc.cluster.local

Services also create SVC records for the named port:

_80-80._tcp.**app.default.**svc.cluster.local


```yaml
apiVersion: v1
kind: Service
metadata:
  name:      app
  namespace: default
  labels:
    app:  app
spec:
  type: ClusterIP
  selector:
    app:  app
  ports:
  - name:       80-80
    port:       80
    protocol:   TCP
    targetPort: 80
status:
  loadBalancer: {}
```

Namespaces Organize Objects

- A namespace is a logical grouping for Kubernetes objects (pods, roles, …)
- Namespaces might separate projects, users, or departments – it's up to the admins.
- Every cluster starts with a default namespace and at least three kube- namespaces.
- The primary two universal namespaces you'll interact with are:

`default:`	Resources are deployed here when namespace isn't specified
`kube-system:`	Kubernetes' default control plane components are here.

Any namespace that begins with `kube-` is considered a control-plane namespace.

Kubernetes Glossary

• Containers:	Linux namespace and control group-based "lightweight VMs"
• Pods:	collections of containers, the smallest unit of work in Kubernetes
• Nodes:	hosts on which the containers/pods run
• Services:	load balancers, allowing pods to scale and fail
• Deployments:	method for creating pods and handling scaling and failing
• Namespaces:	logical groupings of resources, possibly by tenant, department or application

Control Loops

- Kubernetes is a "declarative" system, rather than an "imperative" one.
- You tell Kubernetes to keep (5) copies of a container running, by creating a deployment.
- Kubernetes takes responsibility for keeping five containers staged, spread out to as many as five machines (nodes), watching for container or node failures.
- It does this by running control loops, which continually check the reality of the cluster against the desired state you've specified.
- Whenever the reality doesn't match the desired state, a controller takes action to correct that, without waiting for a human to notice.

Control Plane Node-Only Components (1/2)

The following Kubernetes control plane components are run only on control plane nodes:

- Kubernetes API Server
  - Accepts declarative object configurations, generated by kubectl and API requests.
  - Serves as the first point of contact for the cluster.
- etcd Server
  - Retains the state of every object in the cluster.
  - Allows "is the answer different from the last time I asked" queries.
- Controller Manager
  - Runs control loops to bring the cluster's state to parity with etcd's contents
  - Contains multiple controllers, all compiled into one binary.

Control Plane Node-Only Components (2/2)

- Scheduler
  - Chooses a node for each new pod, subject to constraints.   (i.e., "bin packs workloads")
- CoreDNS (replacing Kube-DNS)
  - Gives every endpoint a DNS name, like postgres.mktg.svc.cluster.local

Vital Kubernetes Target Components: All Nodes

- Kubelet
  - Bridges the Kubernetes infrastructure to the container runtime (e.g., containerd, CRI-O, Docker,...)
- Container Runtime
  - Pulls container images and instructs the kernel to create/destroy containers, as well as other functionality.
- Kube-Proxy
  - configures `iptables`, IPVS, and otherwise proxies traffic.
- Pods
  - Control plane components
  - Workloads.