Kubernetes Networking

Students, write your response!

Pear Deck Interactive Slide
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Cluster Networking

Cluster Networking

There are 4 distinct networking problems to address:

1. container-to-container communications:
   This is solved by Pods and localhost communications.

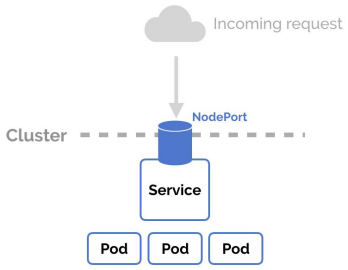
2. Pod-to-Pod communications:
   Each Kubernetes Pod gets its own IP address.

3. Pod-to-Service communications: this is covered by services.

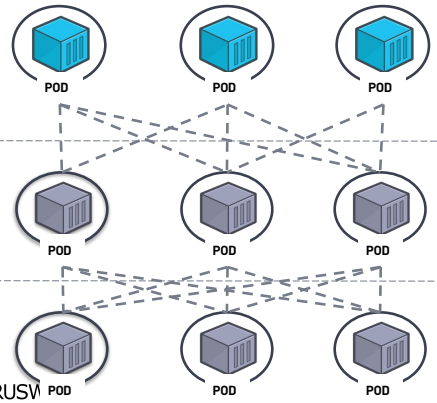
4. External-to-Service communications: this is covered by services.

2

Services

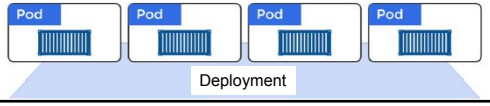


Services



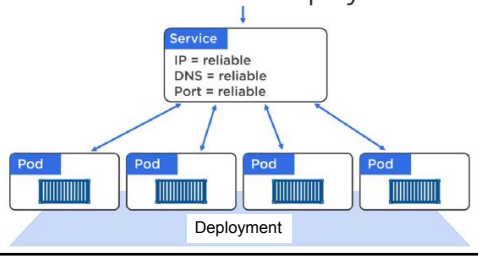
Services

Each Kubernetes Pod gets its own IP address. But Kubernetes **Pods** are mortal. They are born and when they die, they are not resurrected. If you use a Deployment to run your app, it can create and destroy Pods dynamically. So, Pod IPs are unreliable.



Services

A **Service** offers a single **DNS entry** for a containerized application managed by the Kubernetes cluster, regardless of the number of replicas, by providing a common **load balancing** access point to a set of pods logically grouped and managed by a **controller** such as a Deployment or ReplicaSet.

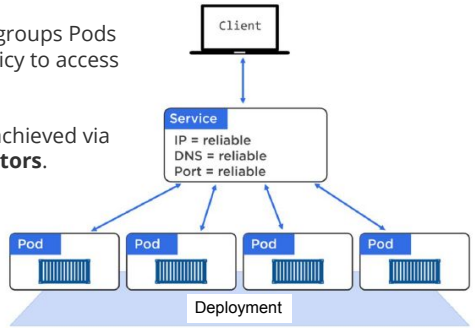


Services

The **Service** is associated with the Pods, and provides them with a stable IP, DNS and port. It also **loadbalances** requests across the Pods.

Service logically groups Pods and defines a policy to access them.

This grouping is achieved via **Labels** and **Selectors**.



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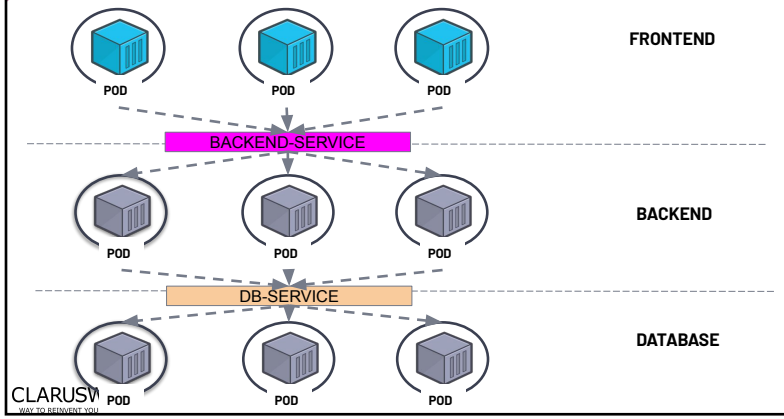
Services



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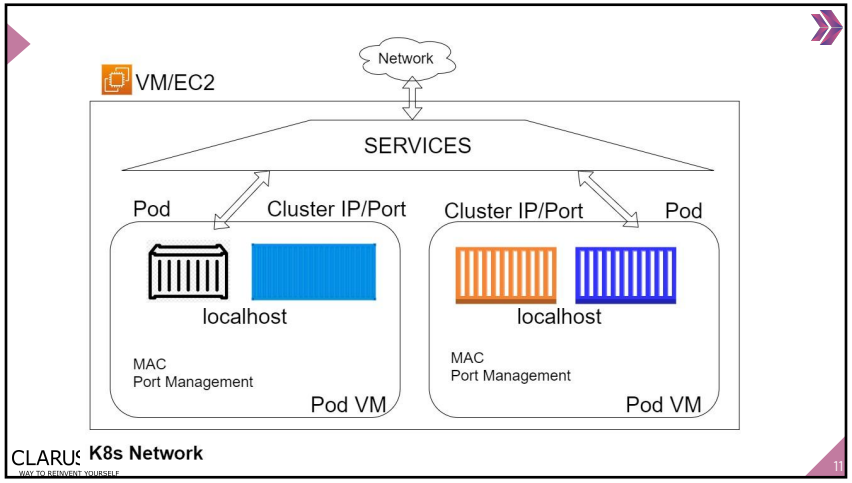
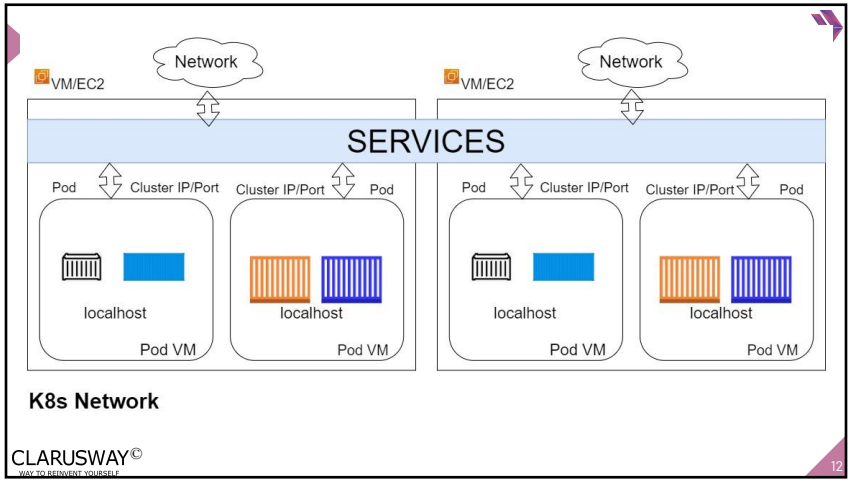

Network
VM/EC2
SERVICES
Pod
Cluster IP/Port
Cluster IP/Port
Pod
localhost
localhost
MAC
Port Management
MAC
Port Management
Pod VM
Pod VM
K8s Network
11


Network
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SERVICES
Pod
Cluster IP/Port
Cluster IP/Port
Pod
Pod
Cluster IP/Port
Cluster IP/Port
Pod
localhost
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localhost
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Pod VM
Pod VM
Pod VM
Pod VM
K8s Network
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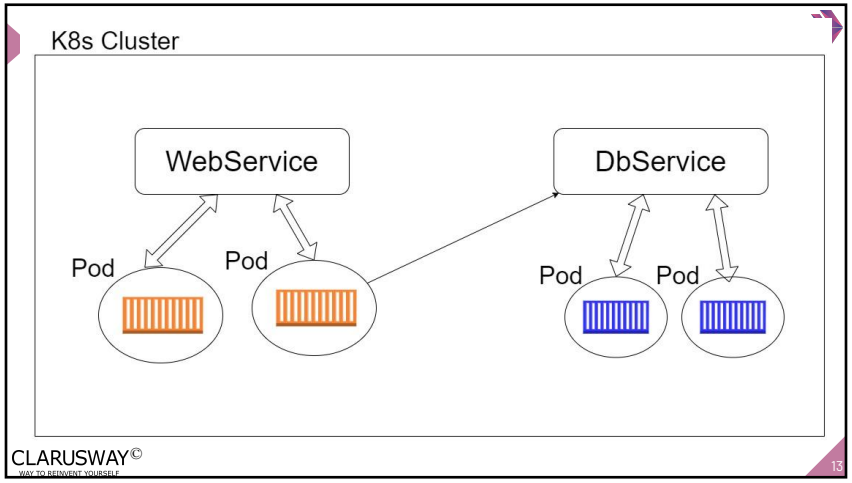


kube-proxy

- Each cluster node runs a daemon called **kube-proxy**, that watches the API server on the master node for the addition, updates, and removal of Services and endpoints.
- `kube-proxy` is responsible for ***implementing the Service configuration*** on behalf of an administrator or developer, in order to enable traffic **routing** to an exposed application running in Pods.
- For each new Service, on each node, `kube-proxy` configures **iptables** rules to capture the traffic for its `ClusterIP` and forwards it to one of the Service's endpoints.
- Therefore any node can receive the external traffic and then route it internally in the cluster based on the **iptables** rules.
- When the Service is removed, `kube-proxy` removes the corresponding **iptables** rules on all nodes as well.

Service Discovery

- Kubernetes has an add-on for **DNS**, which creates a DNS record for each Service and its format is:

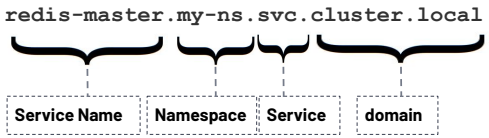
  `web-svc.my-namespace.svc.cluster.local`

- Services within the same Namespace find other Services just by their names.
- If we add a Service `redis-master` in `my-ns` Namespace, all Pods in the same `my-ns` Namespace lookup the Service just by its name, `redis-master`.

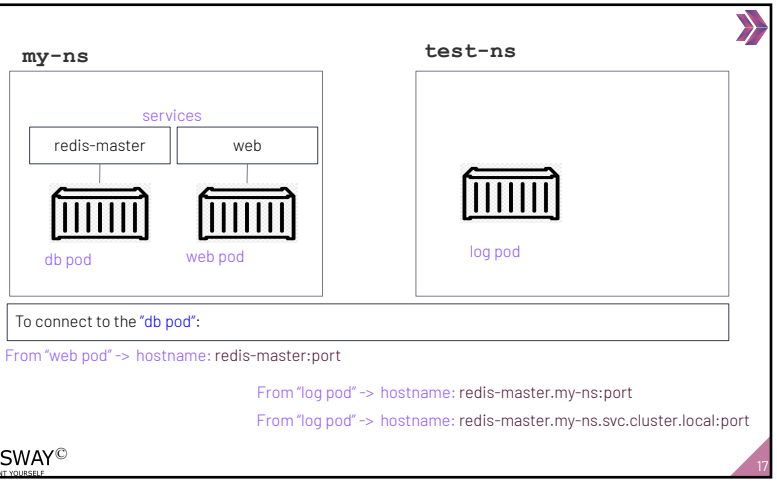
FQDN: fully qualified domain name

Service Discovery

- Pods from other Namespaces, such as `test-ns`, lookup the same Service by adding the respective Namespace as a suffix, such as `redis-master.my-ns` or providing the **FQDN** of the service as below.



FQDN: fully qualified domain name



To connect to the "db pod":

From "web pod" -> hostname: redis-master:port

From "log pod" -> hostname: redis-master.my-ns:port

From "log pod" -> hostname: redis-master.my-ns.svc.cluster.local:port

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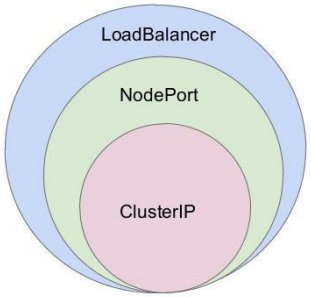
Service Types

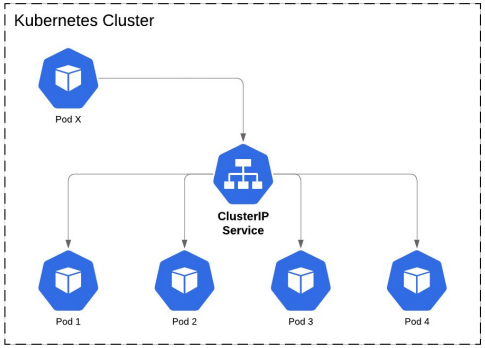
Service Types

There are 4 major service types:

- ClusterIP (default)
- NodePort
- LoadBalancer
- ExternalName



Service Types/ClusterIP



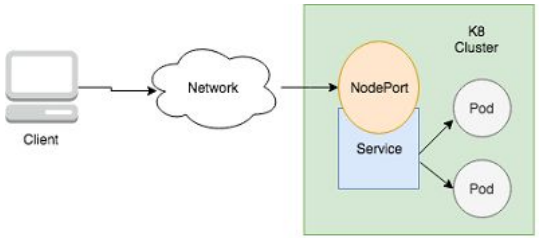
ClusterIP:
Exposes the Service on a cluster-internal IP. Choosing this value makes the Service only reachable from within the cluster. This is the default ServiceType.

Good for service of database & back-end apps.

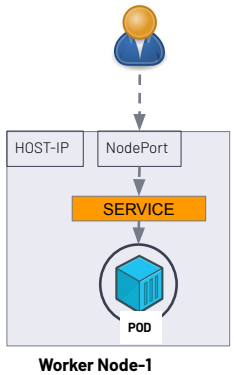
Service Types/NodePort

NodePort: Exposes the Service on each Node's IP at a static port (the NodePort). A ClusterIP Service, to which the NodePort Service **routes**, is automatically created. Port can either be **statically** defined, or **dynamically** taken from a range between 30000-32767.

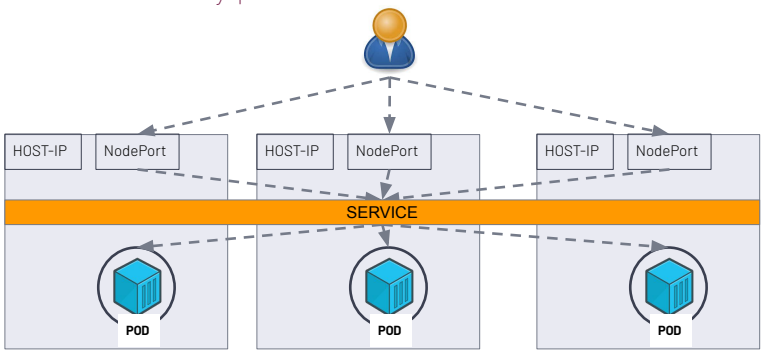
With the **NodePort** *ServiceType*, in addition to a ClusterIP, a high-port is mapped to the respective Service, from all the worker nodes.



Service Types/NodePort



Service Types/NodePort

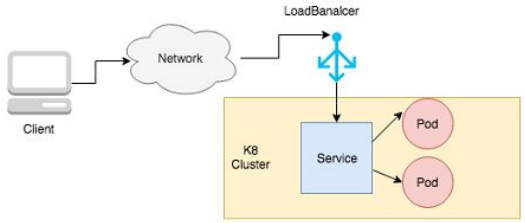


Service Types/NodePort

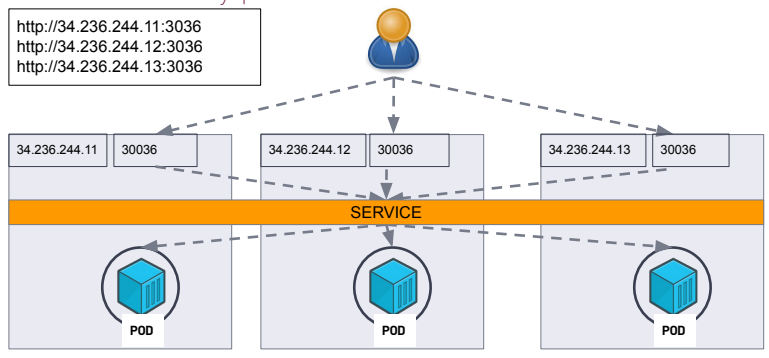
- The **NodePort** ServiceType is useful when we want to make our Services accessible from the external world.
- The end-user connects to any worker node on the specified high-port, which proxies the request internally to the ClusterIP of the Service, then the request is forwarded to the applications running inside the cluster.
- Let's not forget that the Service is load balancing such requests, and only forwards the request to one of the Pods running the desired application.

Service Types/LoadBalancer

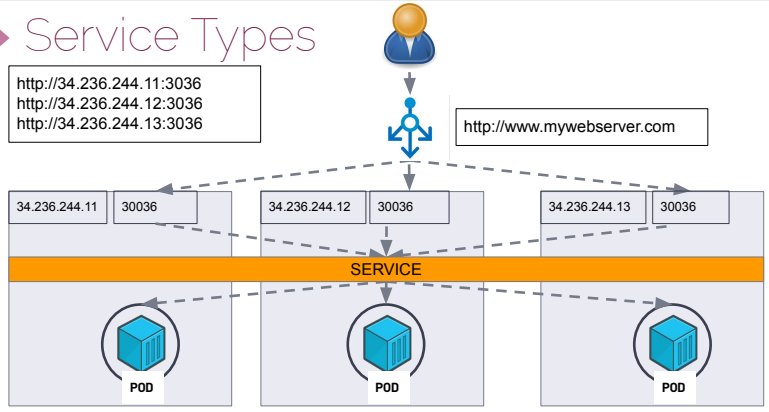
LoadBalancer: Exposes the Service externally using a cloud provider's load balancer. NodePort and ClusterIP are automatically created, and the external load balancer will route to them.



Service Types/LoadBalancer



Service Types



Service Types/LoadBalancer

LoadBalancer:

- The **LoadBalancer** *ServiceType* will only work if the underlying infrastructure supports the automatic creation of Load Balancers and have the respective support in Kubernetes, as is the case with the Google Cloud Platform and AWS.

- If no such feature is configured, the ***LoadBalancer IP*** address field is **not populated**, it remains in **Pending** state, but the ***Service will still work as a typical NodePort type Service***.

Service Types/ExternalName

ExternalName: Maps the Service to the contents of the externalName field (e.g. example.com), by returning a CNAME record with its value.

```yaml
apiVersion: v1
kind: Service
metadata:
  name: example-prod
spec:
  type: ExternalName
spec:
  externalName: example.com
```


Service Types/ExternalName

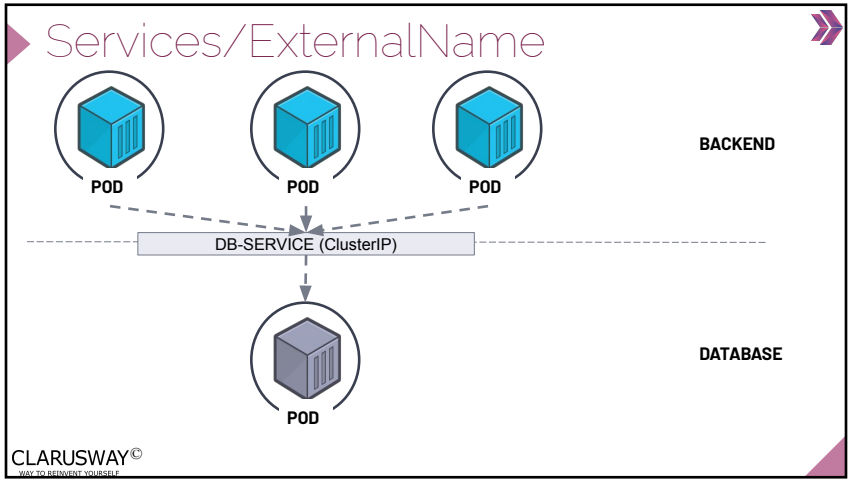
ExternalName is a special *ServiceType*, that has no Selectors and does not define any endpoints.

When accessed within the cluster, it returns a **`CNAME`** record of an externally configured Service.

The primary use case of this *ServiceType* is to make externally configured Services like **`my-database.example.com`** available to applications inside the cluster.

If the externally defined Service resides within the same Namespace, using just the name **`my-database`** would make it available to other applications and Services within that same Namespace.

CNAME : Canonical Name Record or Alias Record


Services/ExternalName
POD
POD
POD
BACKEND
DB-SERVICE (ClusterIP)
POD
DATABASE
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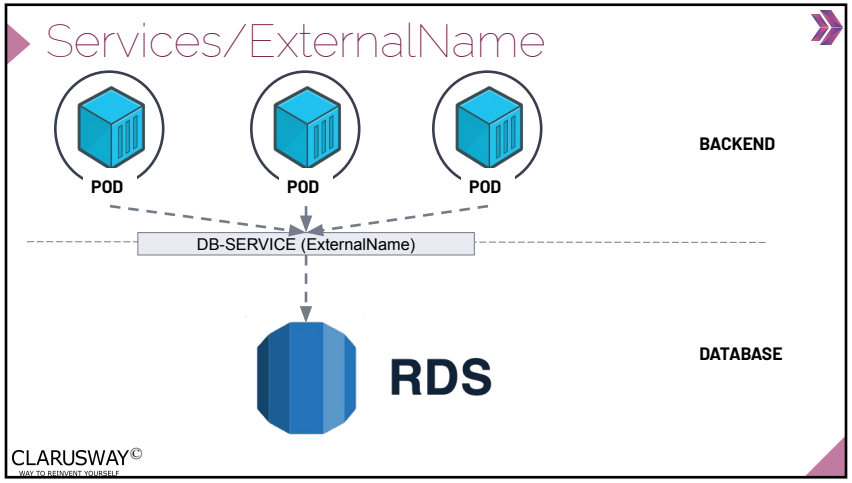
Services/ExternalName
POD
POD
POD
BACKEND
DB-SERVICE (ExternalName)
RDS
DATABASE
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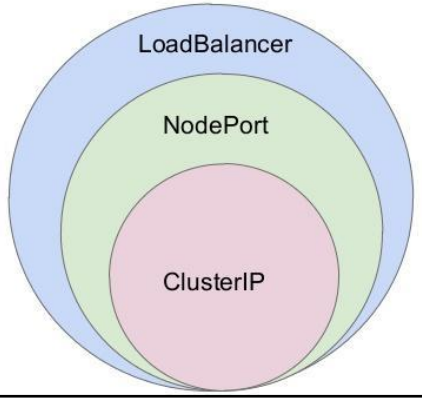
Service Types

- **LoadBalancer** Service has **NodePort** and **ClusterIp** features.
- **NodePort** Service has **ClusterIp** features.



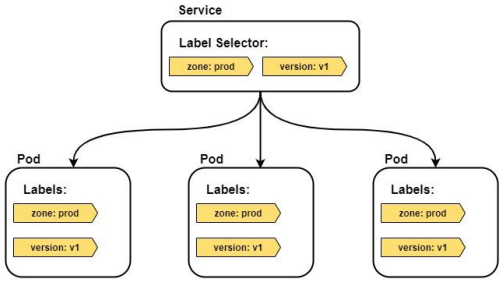
4 Labels and loose coupling

Labels and loose coupling

- Labels and Selectors use a **key/value** pair format.
- Pods and Services are loosely coupled via labels and label selectors.
- For a Service to match a set of Pods, and therefore provide stable networking and load-balance, it only needs to match some of the Pods labels.
- However, for a Pod to match a Service, the Pod must match all of the values in the Service's label selector.

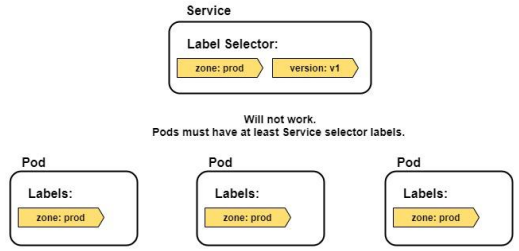
Labels and loose coupling

The figure below shows an example where 3 Pods are labeled as **`zone=prod`** and **`version=1`**, and the Service has a label selector that matches. This Service provides stable networking to all three Pods. It also provides simple load-balancing.



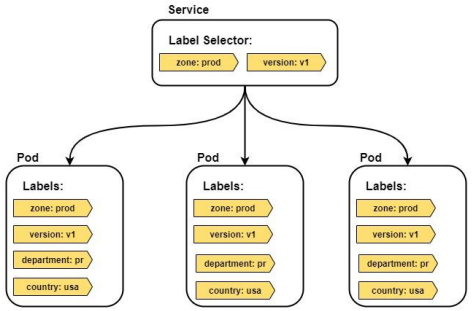
Labels and loose coupling

The figure below shows an example where the Service does not match any of the Pods. This is because the Service is selecting on two labels, but the Pods only have one of them. The logic behind this is a Boolean AND operation.



Labels and loose coupling

This figure shows an example that does work. It doesn't matter that the Pods have additional labels that the Service is not selecting on.



5

Kubernetes hands-on-03

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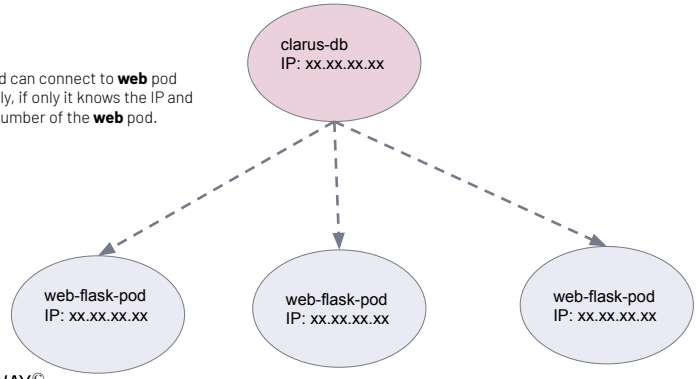
Pod to Pod Connection

db pod can connect to **web** pod directly, if only it knows the IP and port number of the **web** pod.



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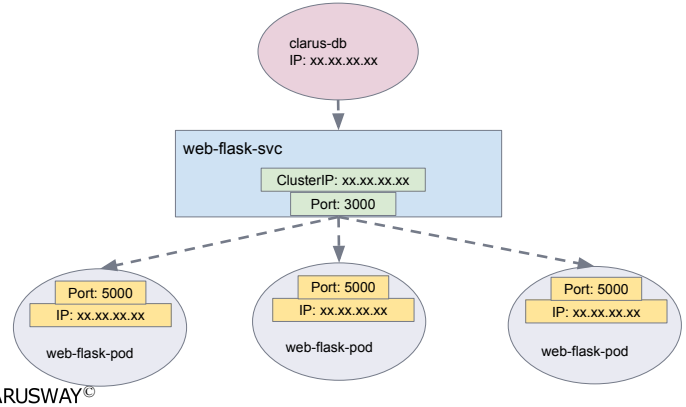
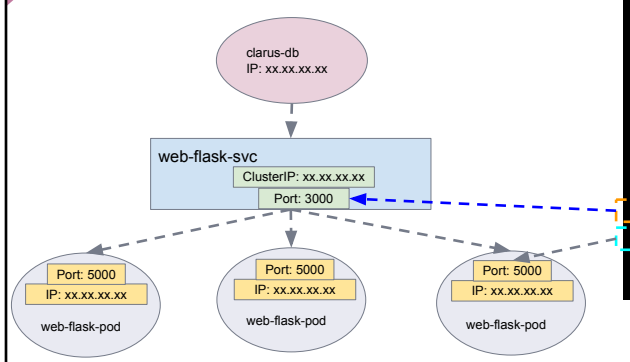
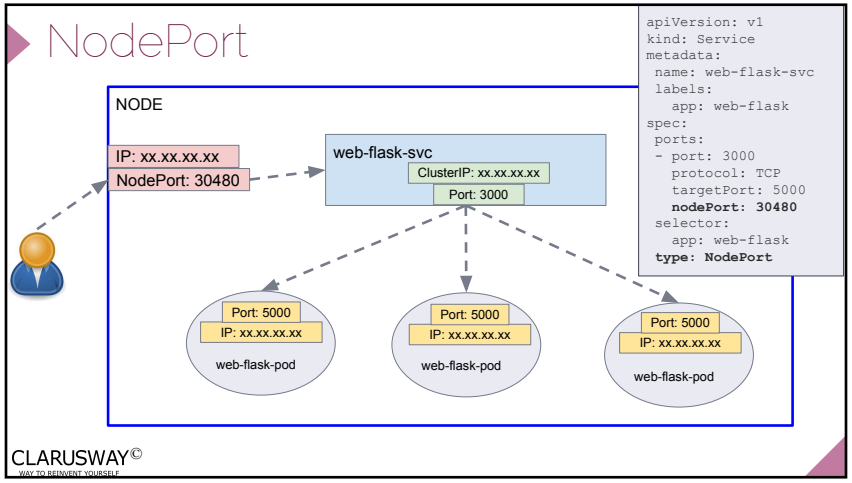
ClusterIP



ClusterIP



NodePort




```
apiVersion: v1
kind: Service
metadata:
 name: web-flask-svc
 labels:
   app: web-flask
spec:
 ports:
 - port: 3000
   protocol: TCP
   targetPort: 5000
   nodePort: 30480
 selector:
   app: web-flask
 type: NodePort
```

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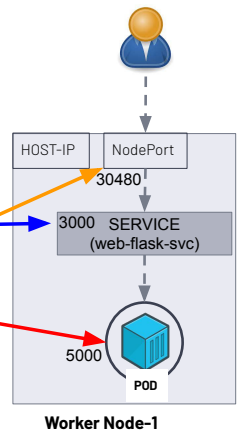
```
apiVersion: v1
kind: Service
metadata:
 name: web-flask-svc
 labels:
   app: web-flask
spec:
 ports:
 - port: 3000
   protocol: TCP
   targetPort: 5000
   nodePort: 30480
 selector:
   app: web-flask
 type: NodePort
```



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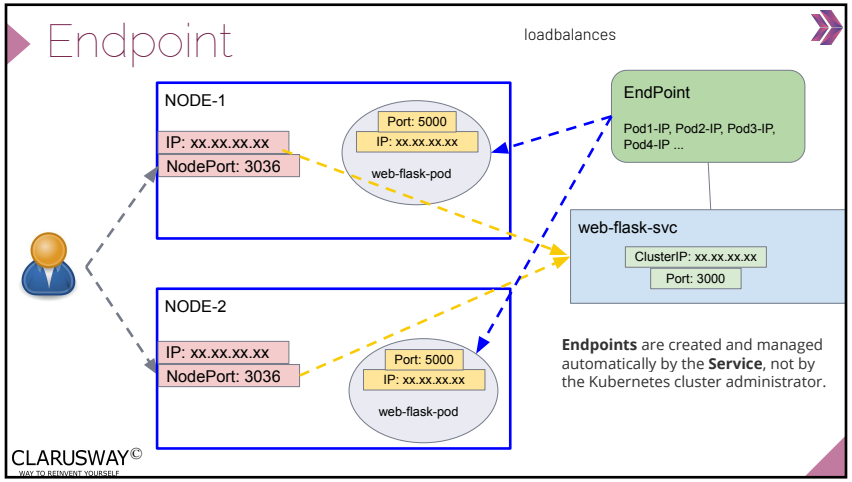
Endpoint



Endpoints are created and managed automatically by the **Service**, not by the Kubernetes cluster administrator.

THANKS!

Any questions?

You can find me at:

- joe@clarusway.com