# Kubernetes Networking

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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:

4. External-to-Service communications:

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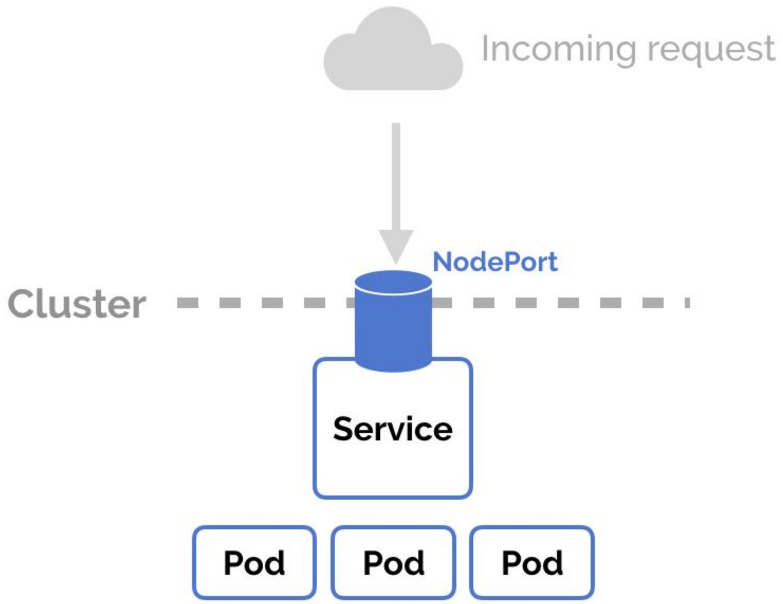
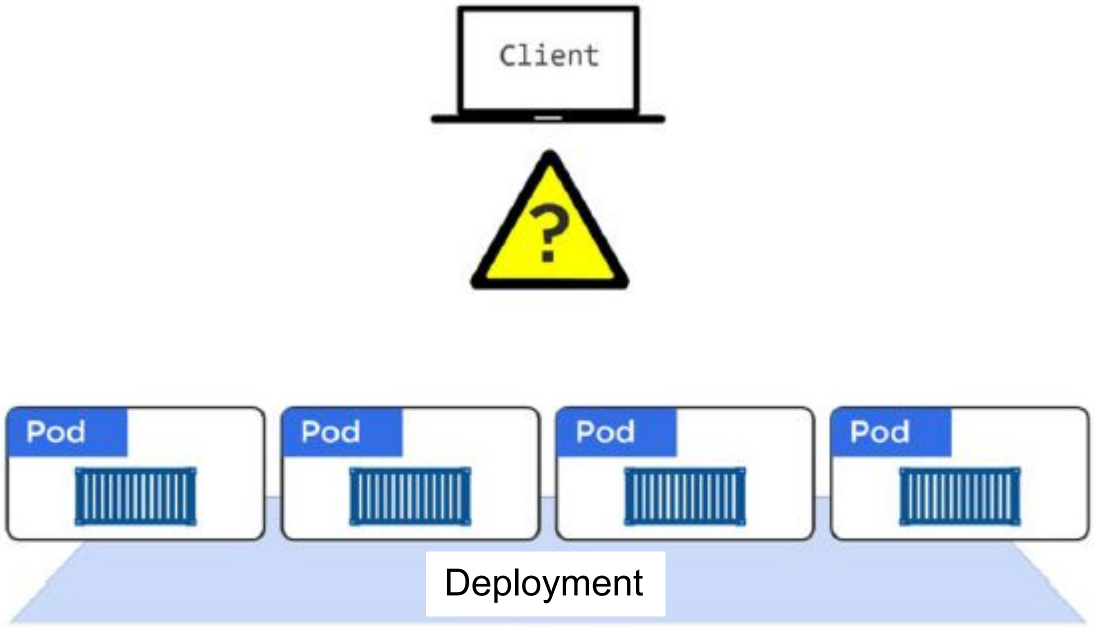
## Services



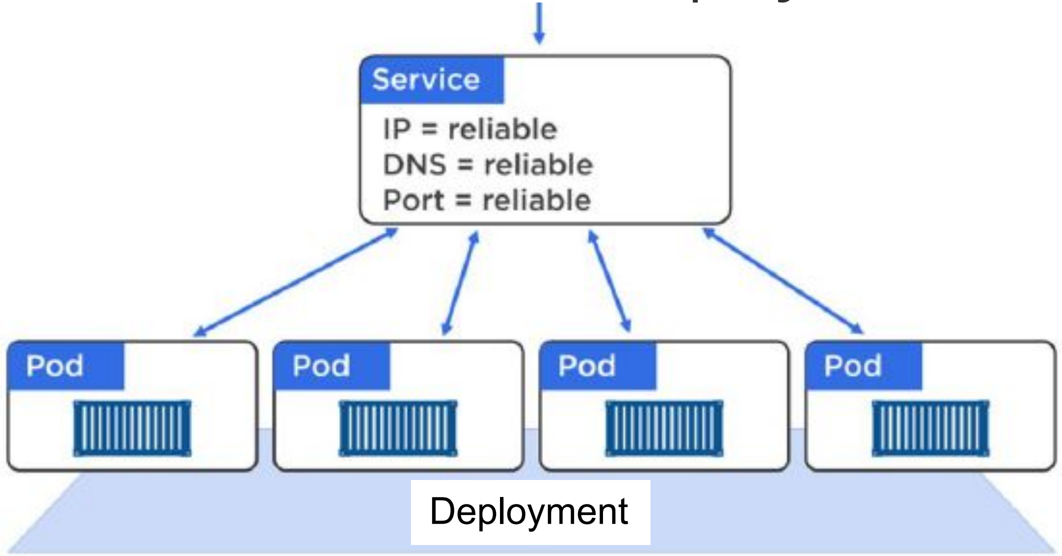
## Services

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, ReplicaSet, or DaemonSet.

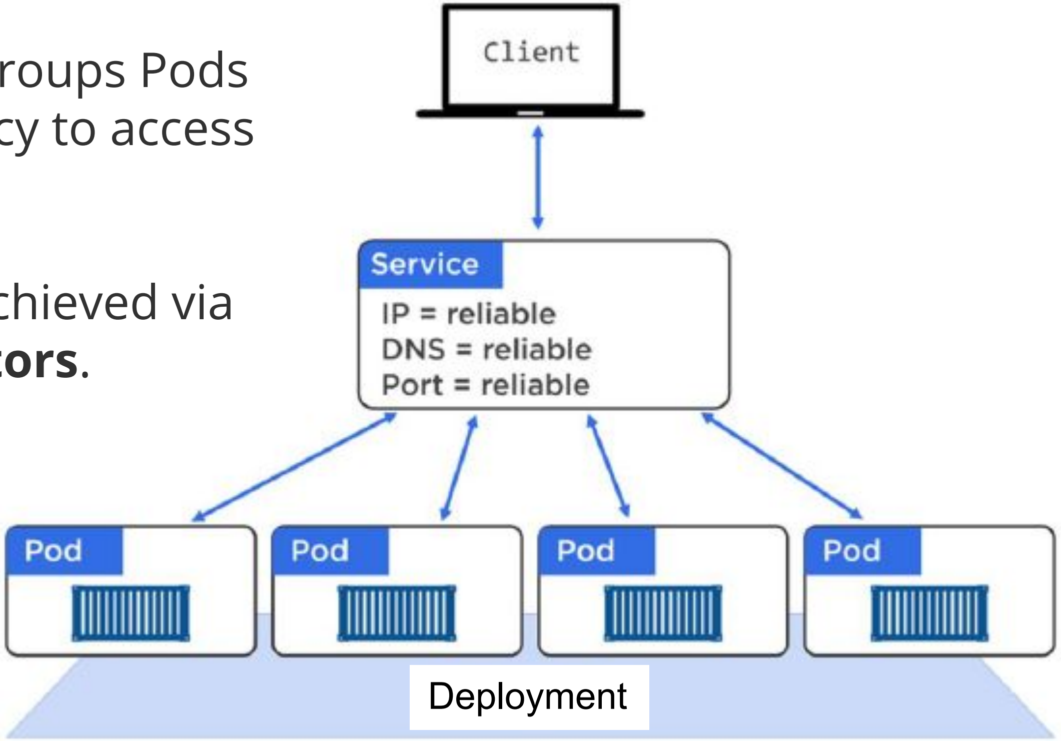


# Services

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

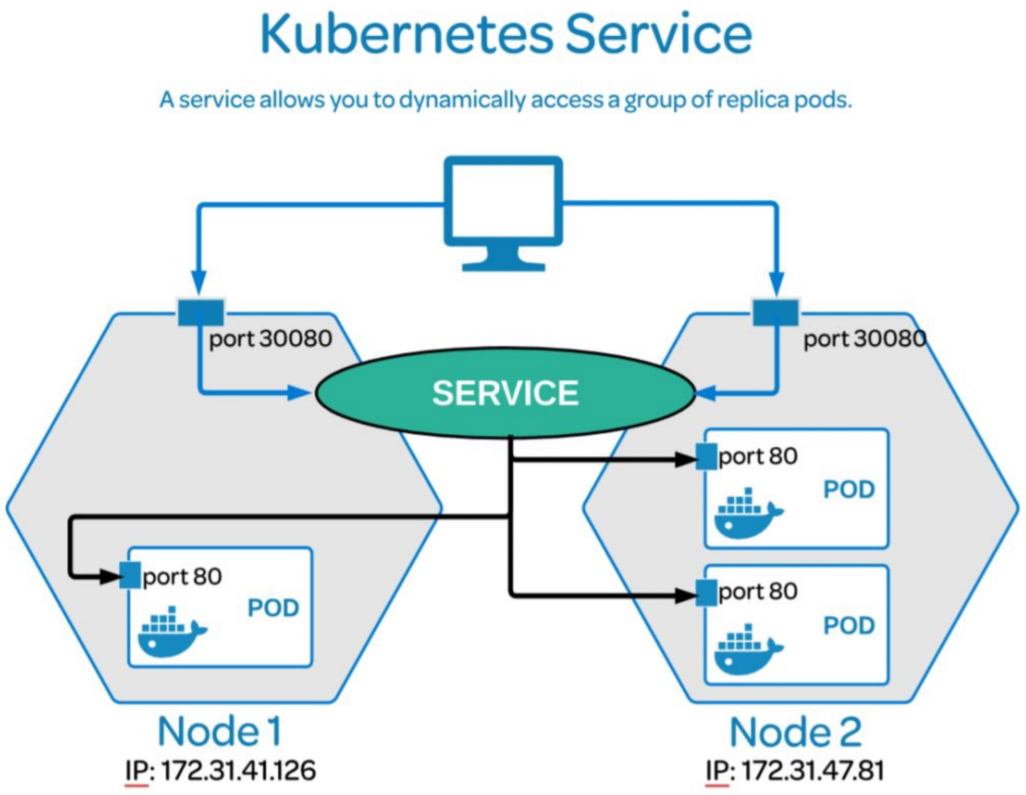
**Service** logically groups Pods and defines a policy to access them.

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



## Services

Kubernetes **Services** enable communication between various components within and outside of the application. Kubernetes Services helps us connect applications together with other applications or users.



# 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`**.
- 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 **`redis-master.my-ns.svc.cluster.local`**.

**FQDN: fully qualified domain name**

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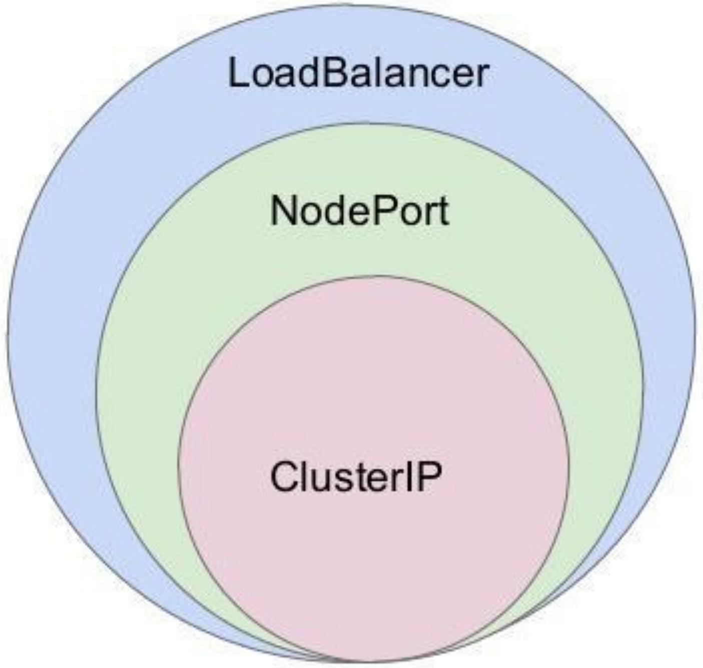
## Service Types

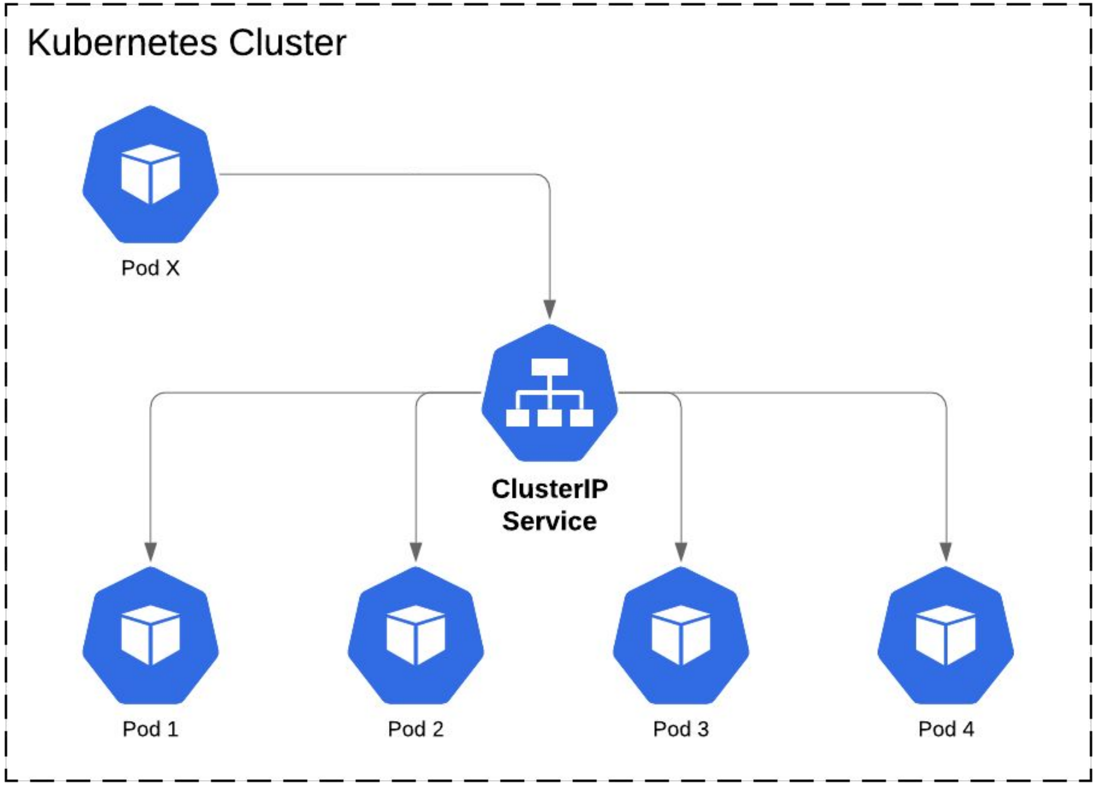
# Service Types

There are 4 major service types:

- ClusterIP (default)
- NodePort
- LoadBalancer
- ExternalName



## Service Types



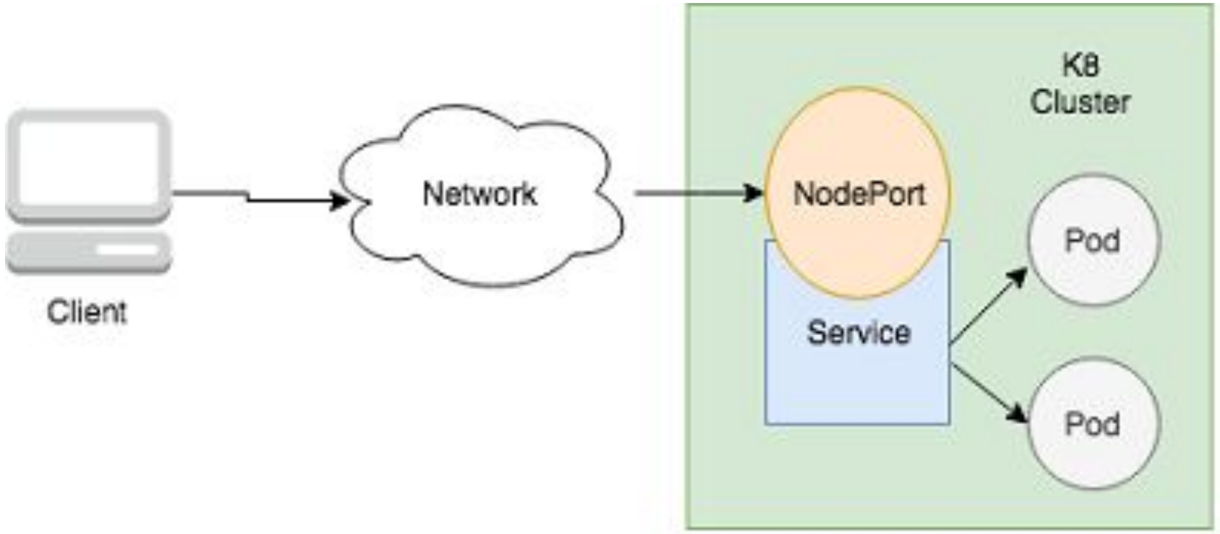
**ClusterIP:**
Exposes the Service on a cluster-internal IP. Choosing this value makes the Service only reachable from within the cluster. This is the default ServiceType.

Good for service of database & back-end apps.

# Service Types

**NodePort:** 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.

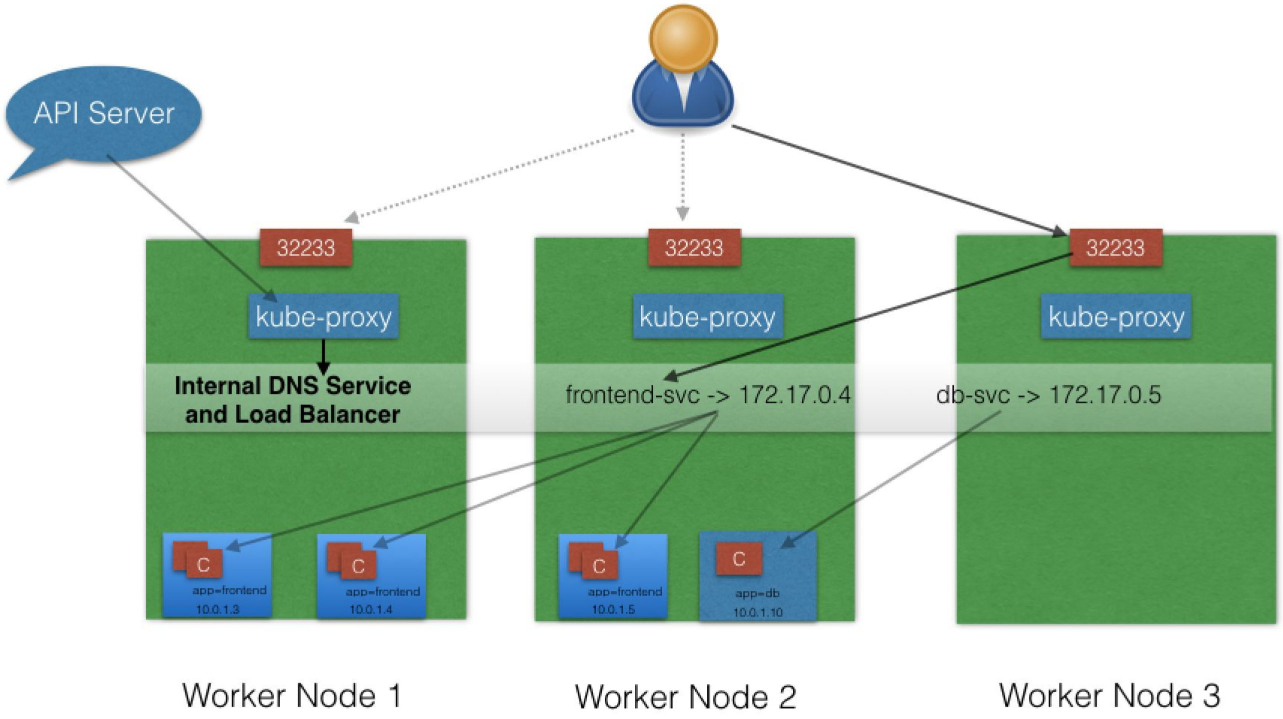


# Service Types

## NodePort:

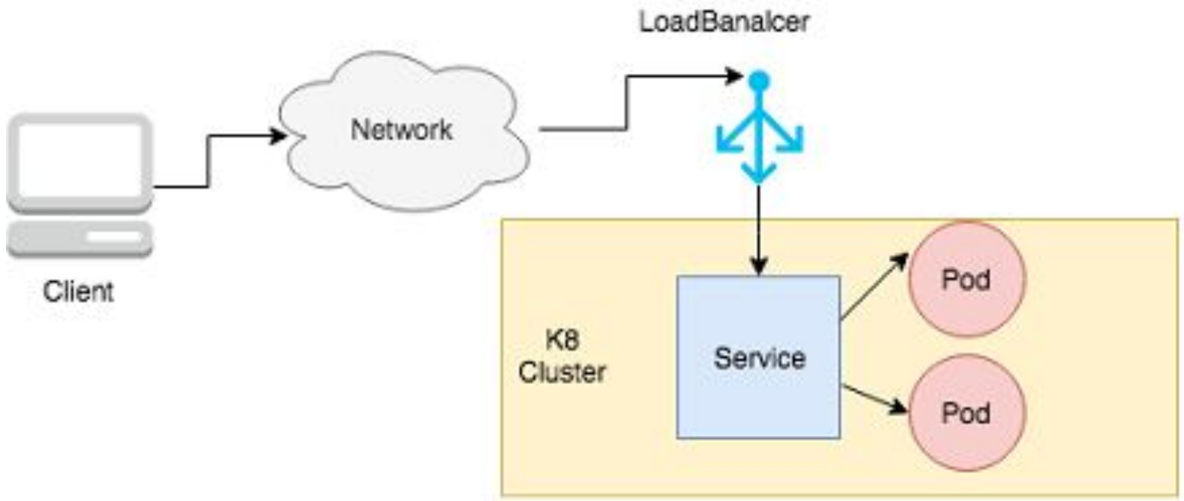
**db-svc : ClusterIP**
**frontend-svc : NodePort**

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. To manage access to multiple application Services from the external world, administrators can configure a reverse proxy - an ingress, and define rules that target specific Services within the cluster.



## Service Types

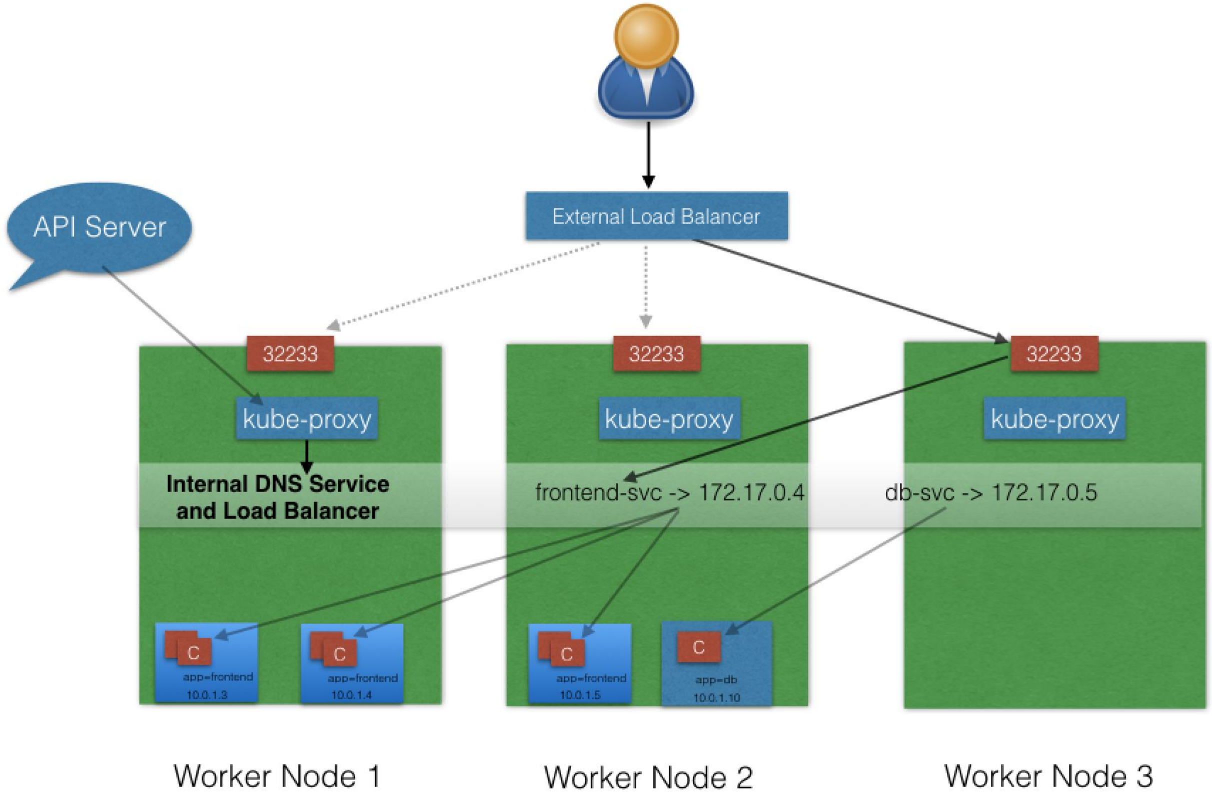
**LoadBalancer:** Exposes the Service externally using a cloud provider's load balancer. The external load balancer routes to the automatically created NodePort and ClusterIP Services.



# Service Types

## LoadBalancer:

- NodePort and ClusterIP are automatically created, and the external load balancer will route to them
- The Service is exposed at a static port on each worker node
- The Service is exposed externally using the underlying cloud provider's load balancer feature.



# Service Types

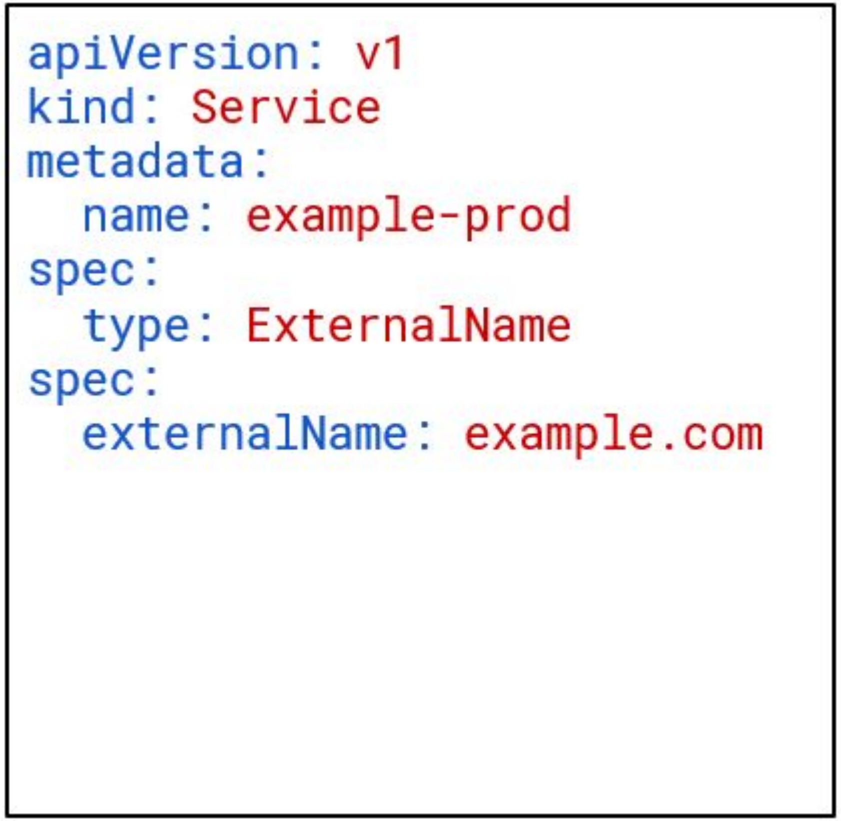
## LoadBalancer:

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

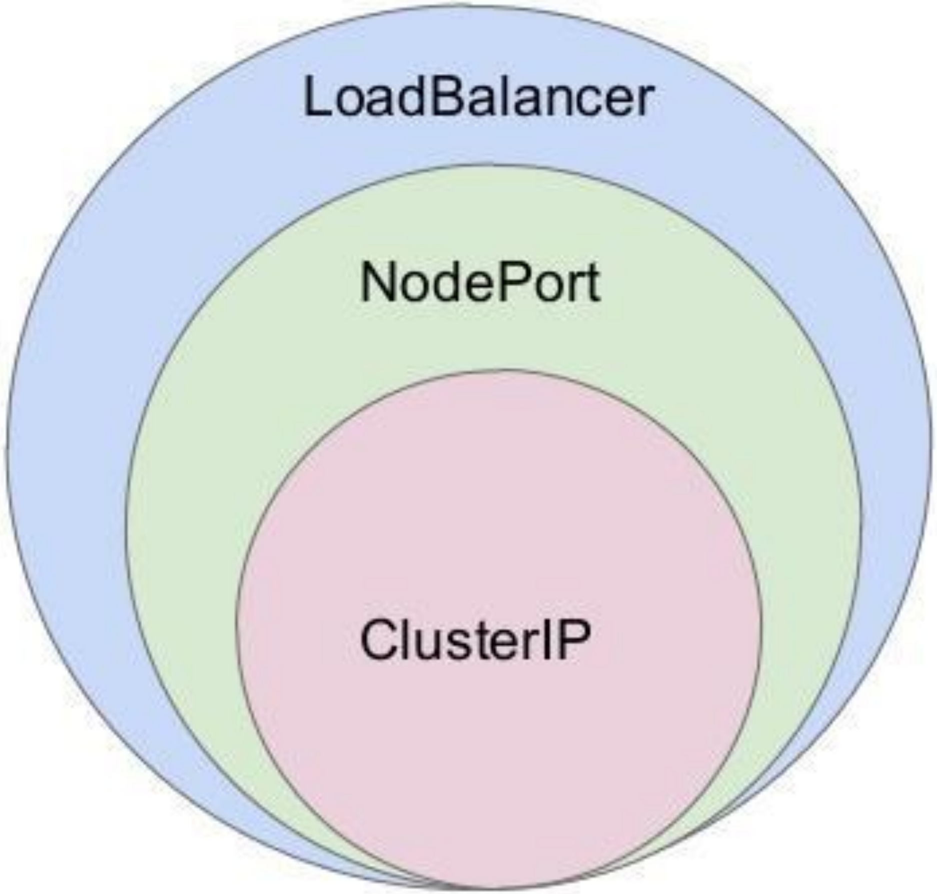
When accessed within the cluster, it returns a `CNAME` record of an externally configured Service.

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

## Service Types



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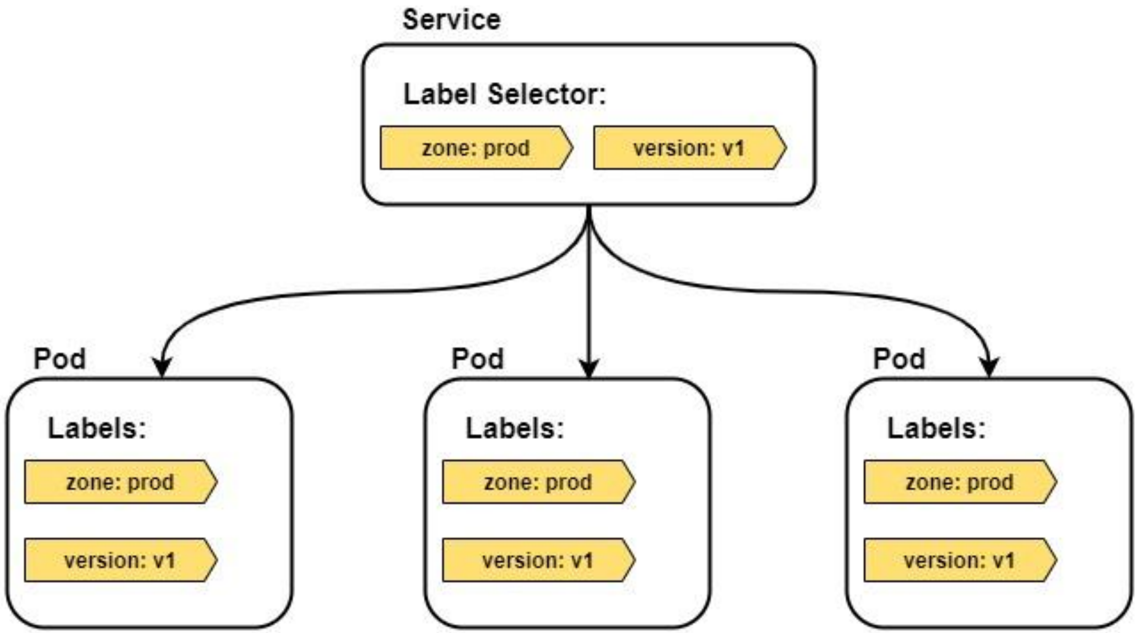
## Labels and loose coupling

# 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.

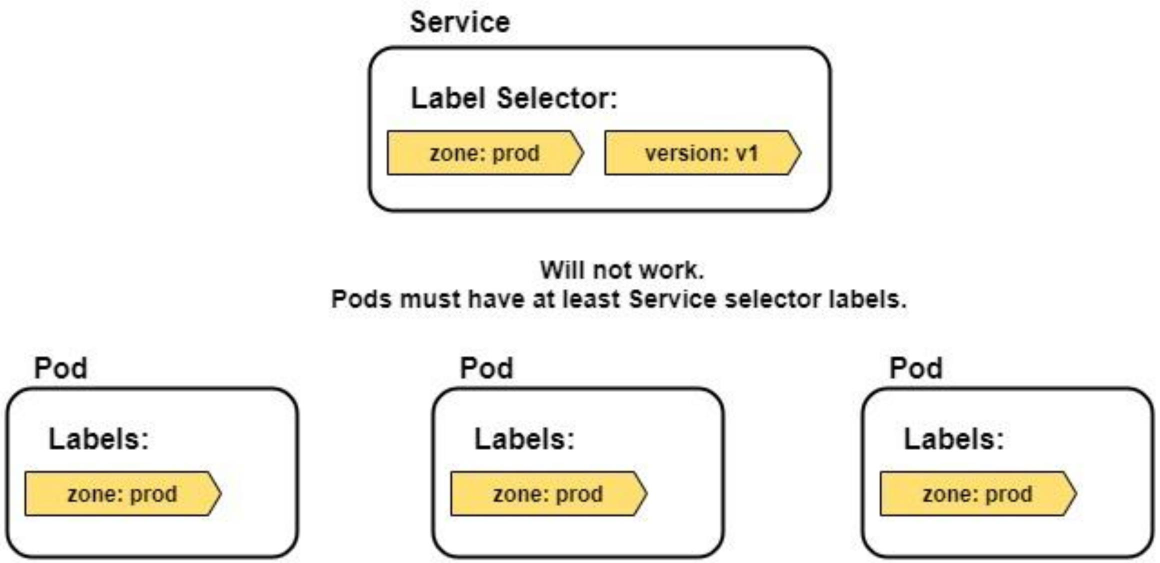
# Labels and loose coupling

The figure below shows an example where 3 Pods are labelled 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.



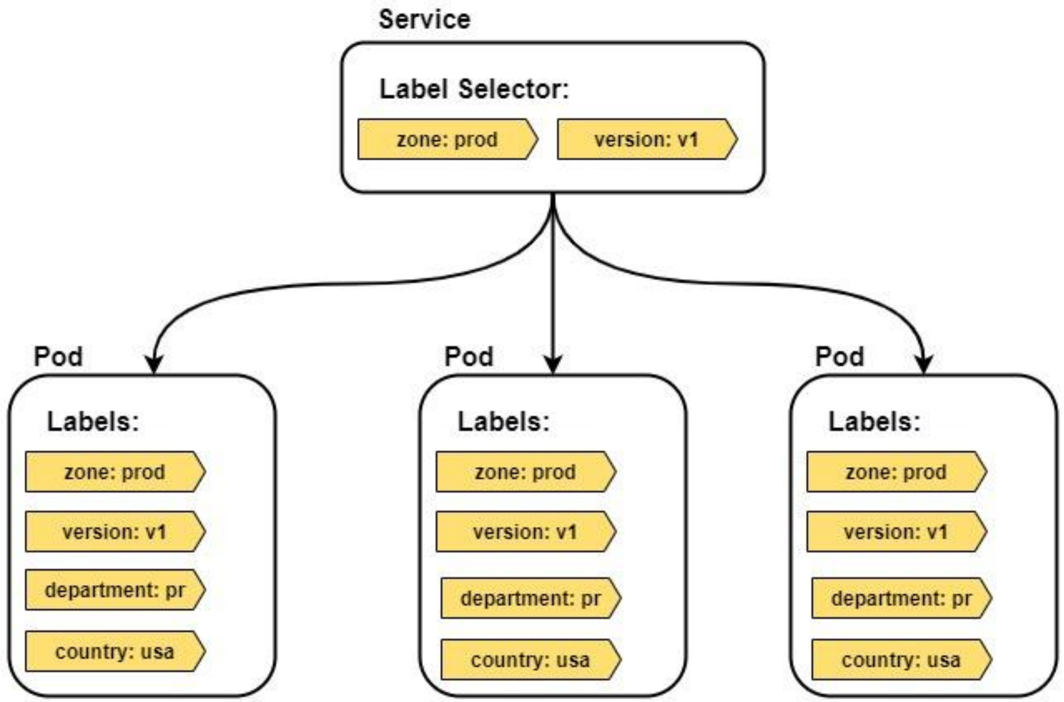
## Labels and loose coupling

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.



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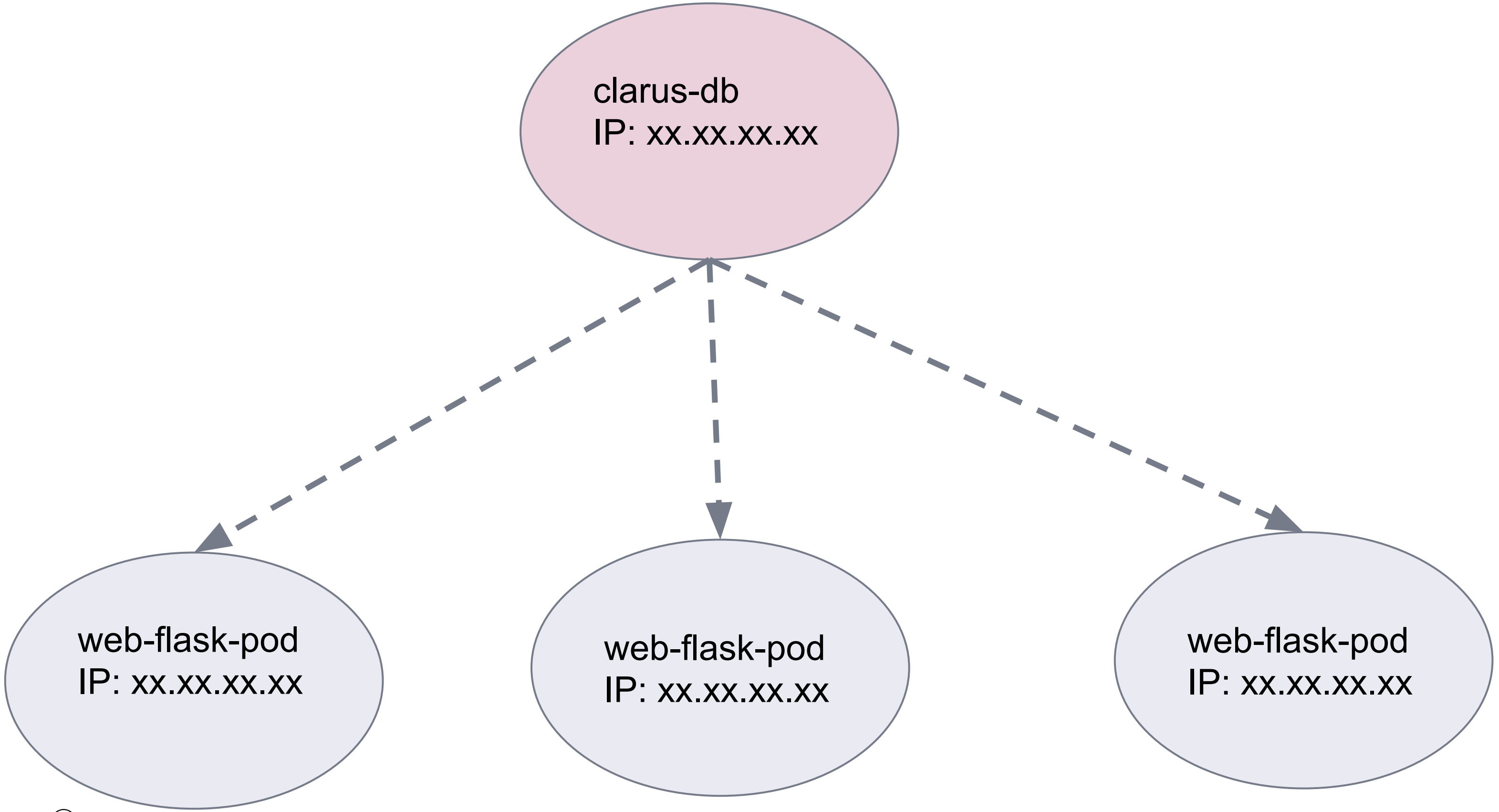
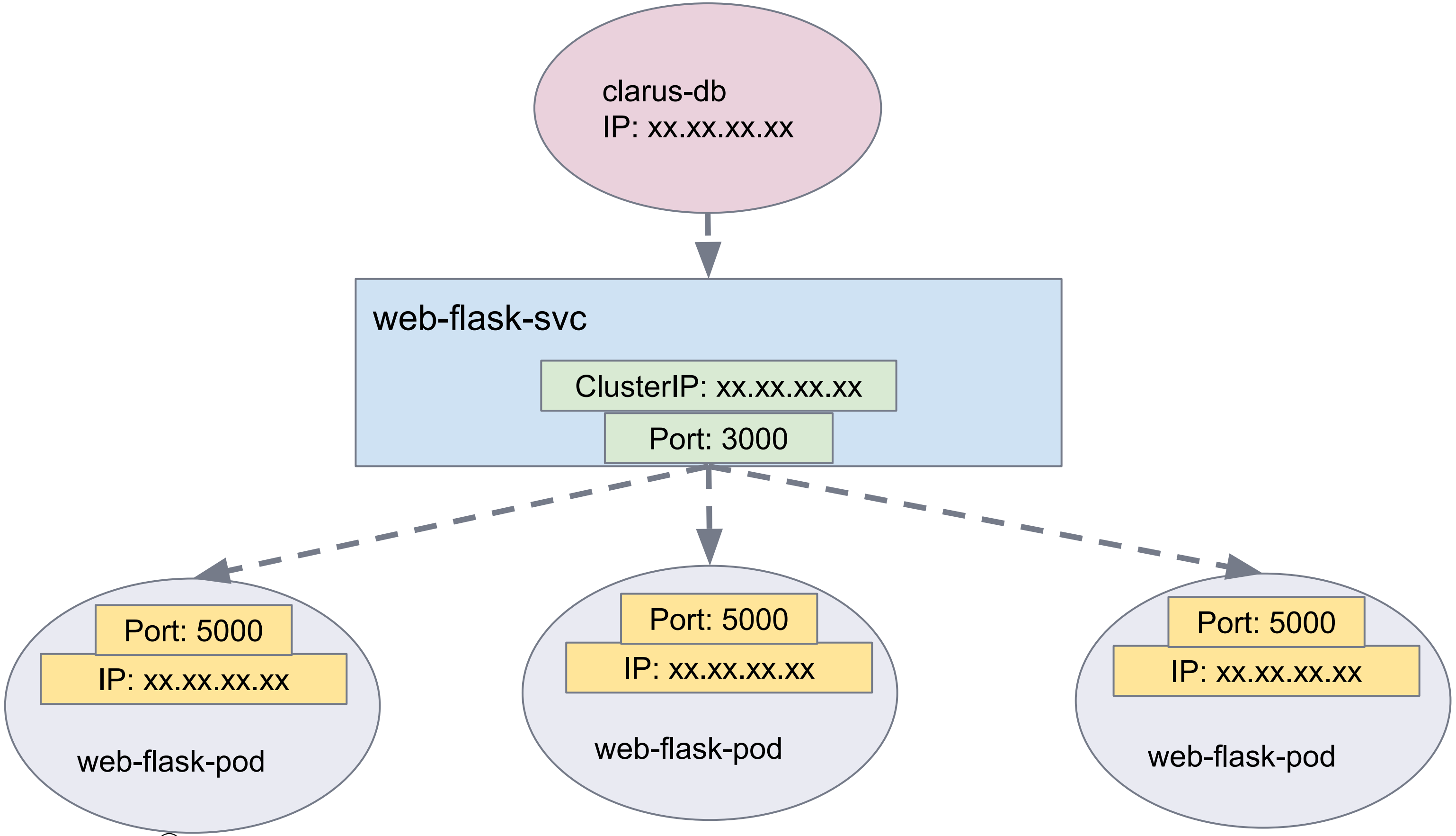
## Kubernetes hands-on-03

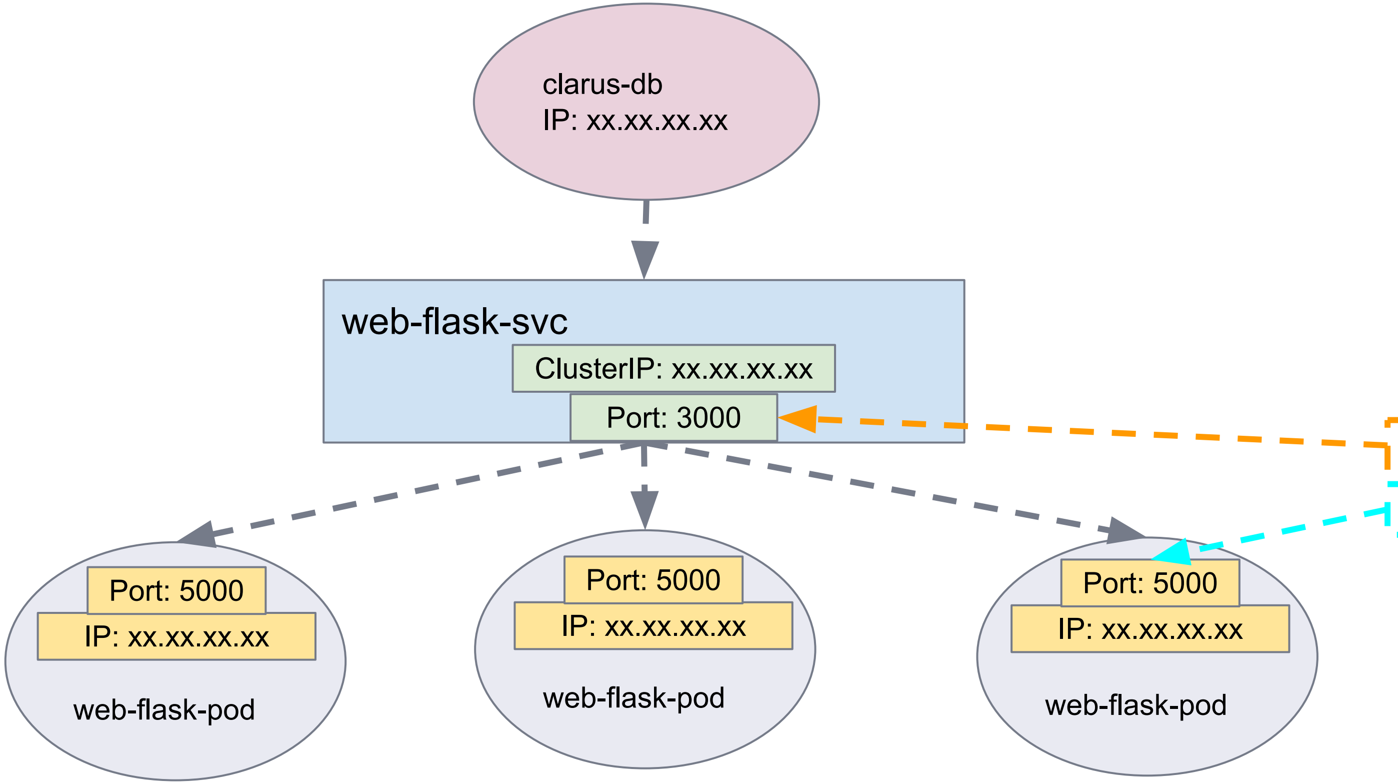
# Pod to Pod Connection



# ClusterIP

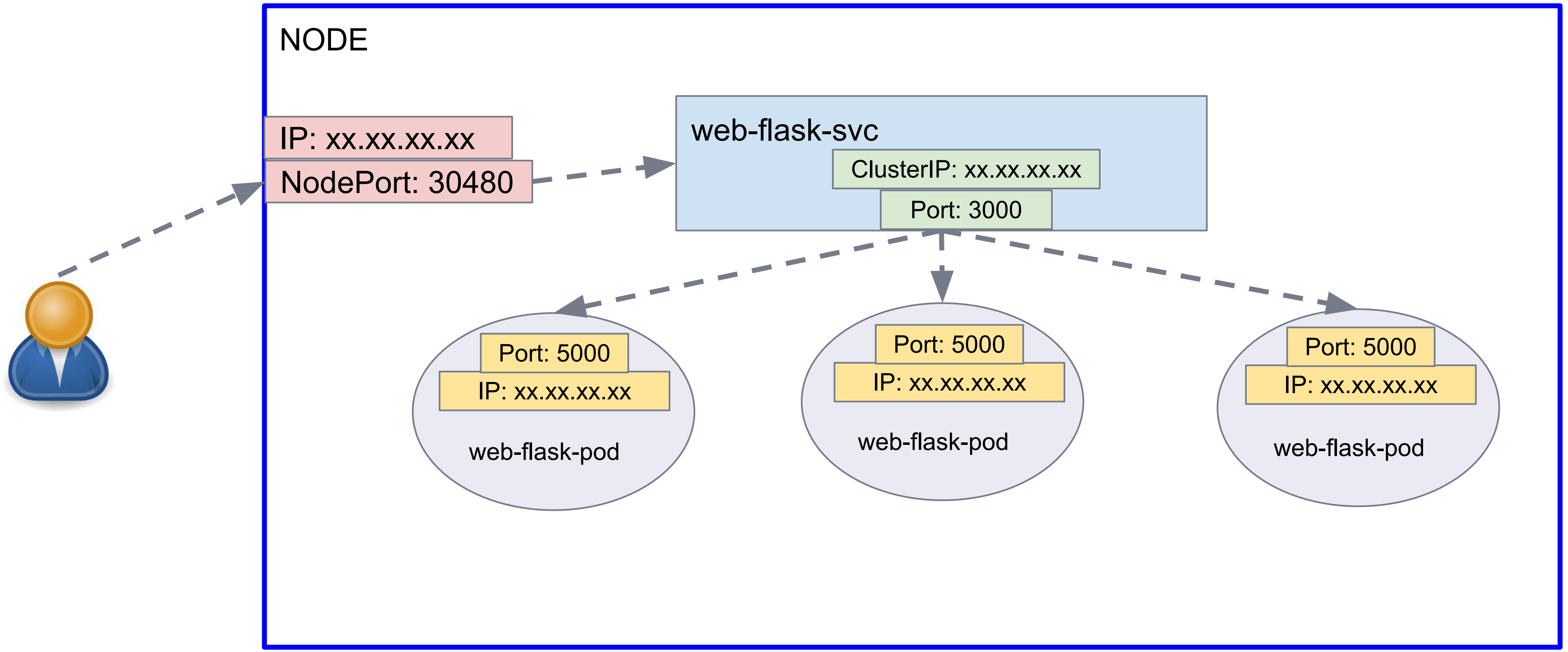

clarus-db
IP: xx.xx.xx.xx
web-flask-svc
ClusterIP: xx.xx.xx.xx
Port: 3000
Port: 5000
IP: xx.xx.xx.xx
web-flask-pod
Port: 5000
IP: xx.xx.xx.xx
web-flask-pod
Port: 5000
IP: xx.xx.xx.xx
web-flask-pod

# ClusterIP

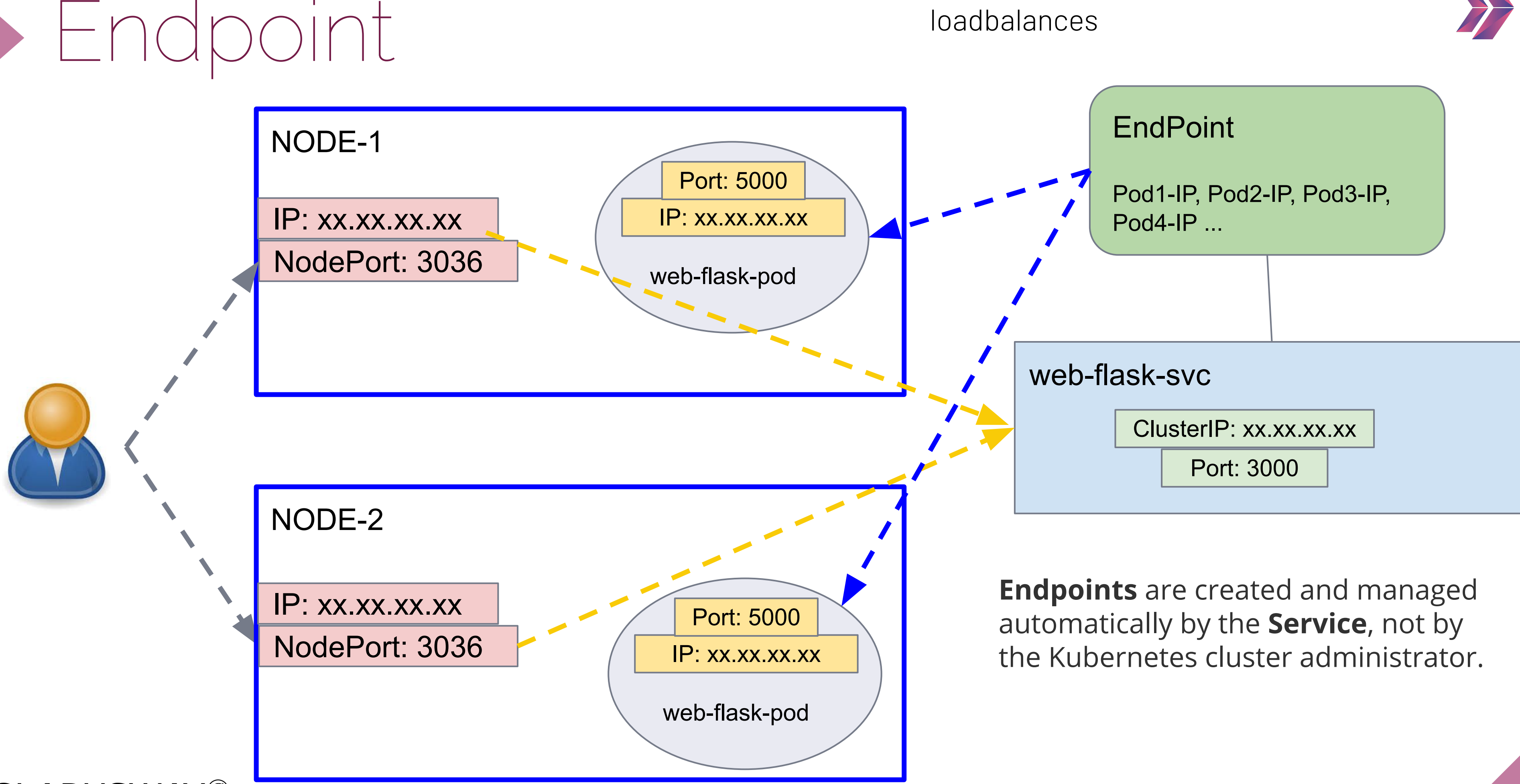


```yaml
apiVersion: v1
kind: Service
metadata:
 name: web-flask-svc
 labels:
   app: web-flask
spec:
 type: ClusterIP
 ports:
 - port: 3000
   targetPort: 5000
 selector:
   app: web-flask
```

# NodePort


NODE
IP: xx.xx.xx.xx
NodePort: 30480
web-flask-svc
ClusterIP: xx.xx.xx.xx
Port: 3000
Port: 5000
IP: xx.xx.xx.xx
web-flask-pod
Port: 5000
IP: xx.xx.xx.xx
web-flask-pod
Port: 5000
IP: xx.xx.xx.xx
web-flask-pod

# Endpoint



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

# THANKS!

## Any questions?

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