Learning Objectives

By the end of this chapter, you should be able to:

- Explain Kubernetes services.
- Expose an application.
- Discuss the service types available.
- Start a local proxy.
- Use the cluster DNS.

SERVICES

Overview

As touched on previously, the Kubernetes architecture is built on the concept of transient, decoupled objects connected together. Services are the agents which connect Pods together, or provide access outside of the cluster, with the idea that any particular Pod could be terminated and rebuilt. Typically using Labels, the refreshed Pod is connected and the microservice continues to provide the expected resource via an **Endpoint** object. Google has been working on Extensible Service Proxy (ESP), based off the nginx HTTP reverse proxy server, to provide a more flexible and powerful object than Endpoints, but ESP has not been adopted much outside of the Google App Engine or GKE environments.

There are several different service types, with the flexibility to add more, as necessary. Each service can be exposed internally or externally to the cluster. A service can also connect internal resources to an external resource, such as a third-party database.

The kube-proxy agent watches the Kubernetes API for new services and endpoints being created on each node. It opens random ports and listens for traffic to the **ClusterIP:Port**, and redirects the traffic to the randomly generated service endpoints.

Services provide automatic load-balancing, matching a label query. While there is no configuration of this option, there is the possibility of session affinity via IP. Also, a headless service, one without a fixed IP nor load-balancing, can be configured.

Unique IP addresses are assigned and configured via the etcd database, so that Services implement iptables to route traffic, but could leverage other technologies to provide access to resources in the future.

Service Update Pattern

Labels are used to determine which Pods should receive traffic from a service. As we have learned, labels can be dynamically updated for an object, which may affect which Pods continue to connect to a service.

The default update pattern is for a rolling deployment, where new Pods are added, with different versions of an application, and due to automatic load balancing, receive traffic along with previous versions of the application.

Should there be a difference in applications deployed, such that clients would have issues communicating with different versions, you may consider a more specific label for the deployment, which includes a version number. When the deployment creates a new replication controller for the update, the label would not match. Once the new Pods have been created, and perhaps allowed to fully initialize, we would edit the labels for which the Service connects. Traffic would shift to the new and ready version, minimizing client version confusion.

Accessing an Application with a Service

The basic step to access a new service is to use **kubectl**.

```
$ kubectl expose deployment/nginx --port=80 --type=NodePort



$ kubectl get svc
NAME         TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)        AGE
kubernetes   ClusterIP   10.0.0.1     <none>        443/TCP        18h
nginx        NodePort    10.0.0.112   <none>        80:31230/TCP   5s

$ kubectl get svc nginx -o yaml
apiVersion: v1
kind: Service
...
spec:
    clusterIP: 10.0.0.112
    ports:
    - nodePort: 31230
...
```

Open browser http://Public-IP:31230.

The kubectl expose command created a service for the nginx deployment. This service used port 80 and generated a random port on all the nodes. A particular port and targetPort can also be passed during object creation to avoid random values. The targetPort defaults to the port, but could be set to any value, including a string referring to a port on a backend Pod. Each Pod could have a different port, but traffic is still passed via the name. Switching traffic to a different port would maintain a client connection, while changing versions of software, for example.

The kubectl get svc command gave you a list of all the existing services, and we saw the nginx service, which was created with an internal cluster IP.

The range of cluster IPs and the range of ports used for the random NodePort are configurable in the API server startup options.

Services can also be used to point to a service in a different namespace, or even a resource outside the cluster, such as a legacy application not yet in Kubernetes.

Service Types

- ClusterIP

The ClusterIP service type is the default, and only provides access internally (except if manually creating an external endpoint). The range of ClusterIP used is defined via an API server startup option.

- NodePort

The NodePort type is great for debugging, or when a static IP address is necessary, such as opening a particular address through a firewall. The NodePort range is defined in the cluster configuration.

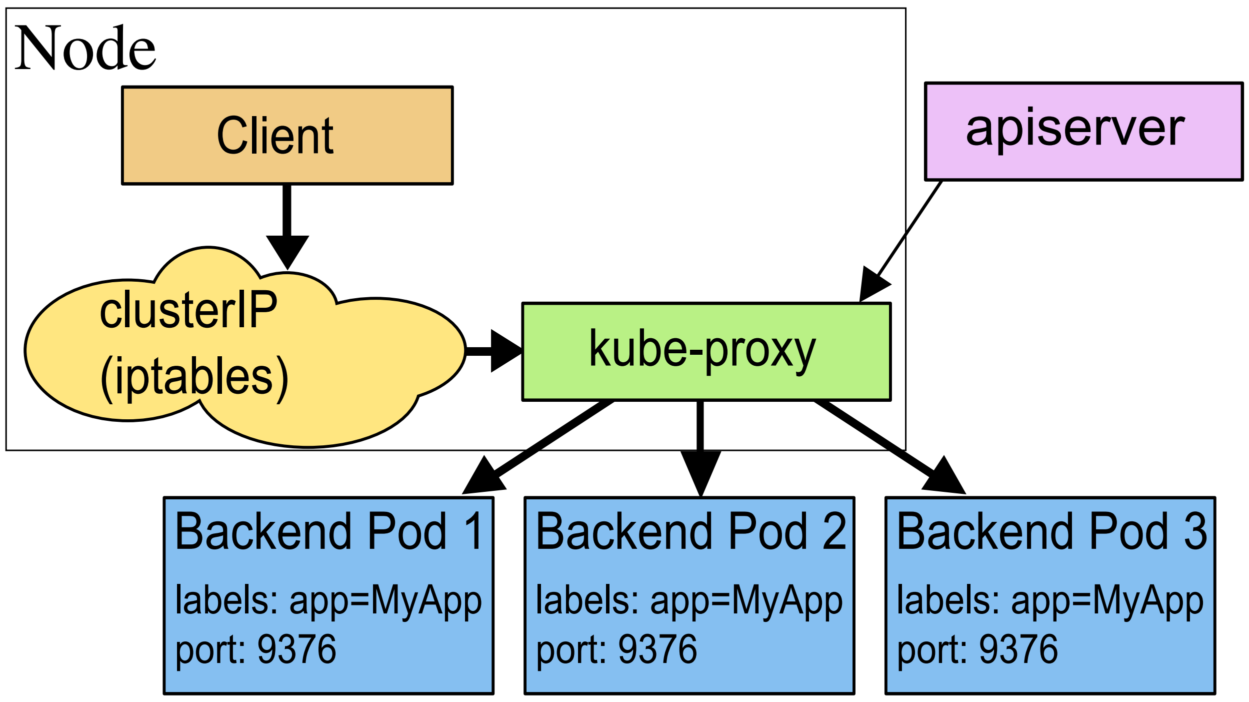
- LoadBalancer

The LoadBalancer service was created to pass requests to a cloud provider like GKE or AWS. Private cloud solutions also may implement this service type if there is a cloud provider plugin, such as with CloudStack and OpenStack. Even without a cloud provider, the address is made available to public traffic, and packets are spread among the Pods in the deployment automatically.

- ExternalName

A newer service is ExternalName, which is a bit different. It has no selectors, nor does it define ports or endpoints. It allows the return of an alias to an external service. The redirection happens at the DNS level, not via a proxy or forward. This object can be useful for services not yet brought into the Kubernetes cluster. A simple change of the type in the future would redirect traffic to the internal objects.

Services Diagram



Traffic from ClusterIP to Pod
Retrieved from the Kubernetes website

The kube-proxy running on cluster nodes watches the API server service resources. It presents a type of virtual IP address for services other than **ExternalName**. The mode for this process has changed over versions of Kubernetes.

In v1.0, services ran in userspace mode as TCP/UDP over IP or Layer 4. In the v1.1 release, the iptables proxy was added and became the default mode starting with v1.2.

In the iptables proxy mode, kube-proxy continues to monitor the API server for changes in Service and Endpoint objects, and updates rules for each object when created or removed. One limitation to the new mode is an inability to connect to a Pod should the original request fail, so it uses a Readiness Probe to ensure all containers are functional prior to connection. This mode allows for up to approximately 5000 nodes. Assuming multiple Services and Pods per node, this leads to a bottleneck in the kernel.

Another mode beginning in v1.9 is ipvs. While in beta, and expected to change, it works in the kernel space for greater speed, and allows for a configurable load-balancing algorithm, such as round-robin, shortest expected delay, least connection and several others. This can be helpful for large clusters, much past the previous 5000 node limitation. This mode assumes IPVS kernel modules are installed and running prior to kube-proxy.

The kube-proxy mode is configured via a flag sent during initialization, such as **mode=iptables** and could also be IPVS or userspace.

Local Proxy for Development

When developing an application or service, one quick way to check your service is to run a local proxy with **kubectl**. It will capture the shell, unless you place it in the background. When running, you can make calls to the Kubernetes API on localhost and also reach the ClusterIP services on their API URL. The IP and port where the proxy listens can be configured with command arguments.

Run a proxy:

```
$ kubectl proxy
Starting to serve on 127.0.0.1:8001
```

Next, to access a **ghost** service using the local proxy, we could use the following URL, for example, at **http://localhost:8001/api/v1/namespaces/default/services/ghost**.

If the service port has a name, the path will be **http://localhost:8001/api/v1/namespaces/default/services/ghost:**.

DNS

DNS has been provided as CoreDNS by default as of v1.13. The use of CoreDNS allows for a great amount of flexibility. Once the container starts, it will run a Server for the zones it has been configured to serve. Then, each server can load one or more plugin chains to provide other functionality.

The 30 or so in-tree plugins provide most common functionality, with an easy process to write and enable other plugins as necessary.

Common plugins can provide metrics for consumption by Prometheus, error logging, health reporting, and TLS to configure certificates for TLS and gRPC servers.

More can be found on the CoreDNS Plugins web page.

Verifying DNS Registration

To make sure that your DNS setup works well and that services get registered, the easiest way to do it is to run a pod in the cluster and exec in it to do a DNS lookup.

Create this sleeping pan **busybox** pod with the **kubectl create** command :

```
apiVersion: v1
kind: Pod
metadata:
    name: busybox
    namespace: default
spec:
    containers:
    - image: busybox
      name: busy
      command:
        - sleep
        - "3600"
```

Then, use **kubectl exec** to do your **nslookup** like so:

```
$ kubectl exec -ti busybox -- nslookup nginx
Server: 10.0.0.10
Address 1: 10.0.0.10
Name: nginx
Address 1: 10.0.0.112
```

You can see that the DNS name **nginx** (corresponding to the **nginx** service) is registered with the ClusterIP of the service.

Other steps, similar to any DNS troubleshooting, would be to check the **/etc/resolv.conf** file of the container:

```
$ kubectl exec busybox cat /etc/resolv.conf
```

Then, check the logs of each container in the **kube-dns** Pod. Look for log lines with **W** for warning, **E** for error and **F** for failure. Also check to make sure the DNS service is up and the DNS endpoints are exposed.