Unit 3

Exposing Applications using Services

Business Training

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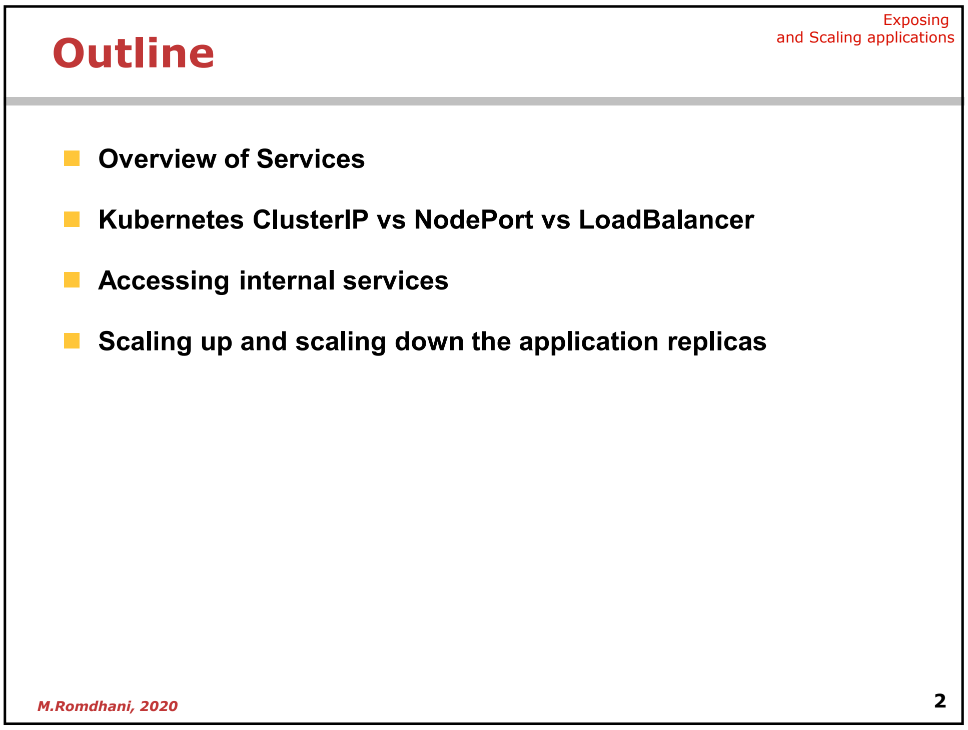

Outline

- Overview of Services
- Kubernetes ClusterIP vs NodePort vs LoadBalancer
- Accessing internal services
- Scaling up and scaling down the application replicas

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Overview of Services

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Kubernetes Networking Model

- **All containers within a pod can communicate with each other unimpeded.**
- **All Pods can communicate with all other Pods without NAT.**
- **All nodes can communicate with all Pods (and vice-versa) without NAT.**
- **The IP that a Pod sees itself as is the same IP that others see it as.**

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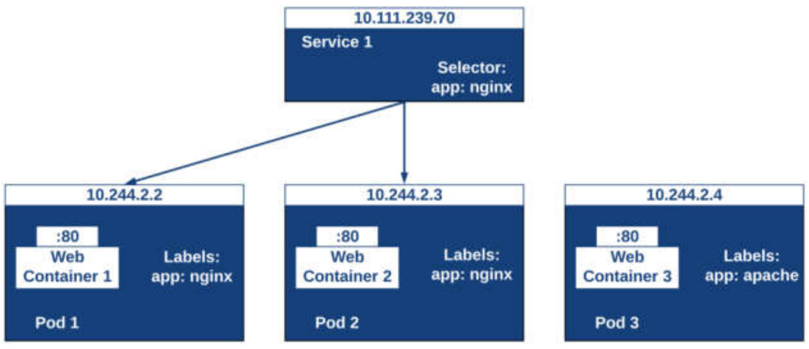
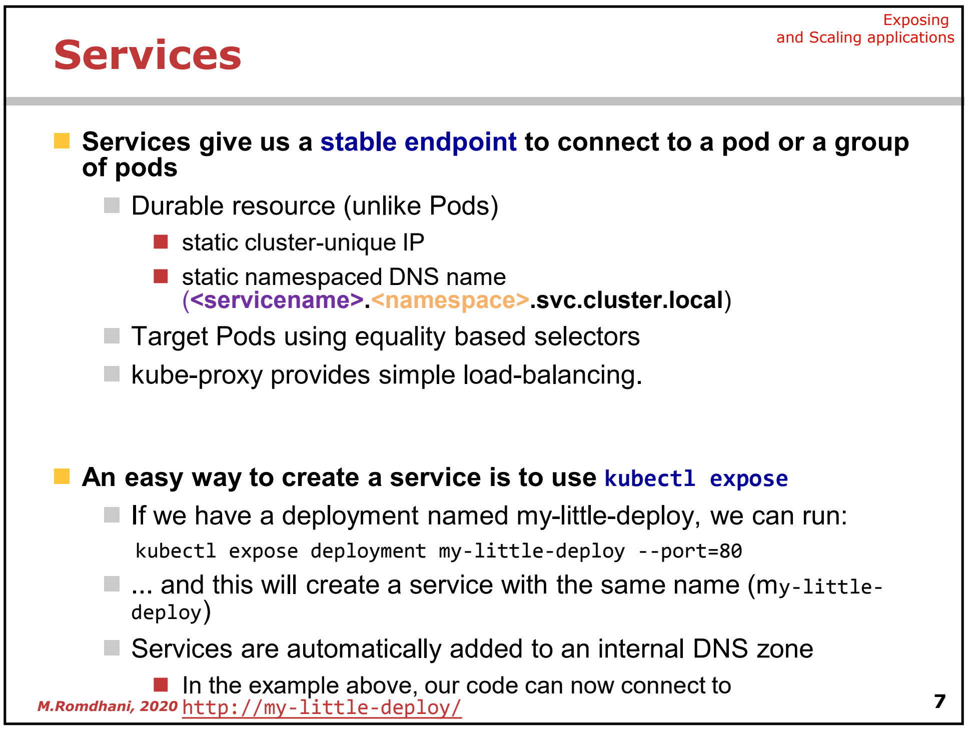
Fundamentals applied

- **Container-to-Container**
  - Containers within a pod exist within the same network namespace and share an IP.
  - Enables intrapod communication over localhost.
- **Pod-to-Pod**
  - Allocated cluster unique IP for the duration of its life cycle.
  - Pods themselves are fundamentally ephemeral
- **Pod-to-Service**
  - managed by **kube-proxy** and given a persistent cluster unique IP
  - exists beyond a Pod’s lifecycle.
- **External-to-Service**
  - Handled by k**ube-proxy**.
  - Works in cooperation with a cloud provider or other external entity (load balancer).

Exposing Pods

- **We might be asking how the service knows which pods it should be providing a front end for ?**
  - A Kubernetes Service can select the pods it is supposed to abstract through a **label** selector.
  - The two pods have labels named “app: nginx” and the Service has a label selector that is looking for those same labels.





Services

- **Services give us a stable endpoint to connect to a pod or a group of pods**
  - Durable resource (unlike Pods)
    - static cluster-unique IP
    - static namespaced DNS name (**<servicename>.<namespace>.svc.cluster.local**)
  - Target Pods using equality based selectors
  - kube-proxy provides simple load-balancing.
- **An easy way to create a service is to use `kubectl expose`**
  - If we have a deployment named my-little-deploy, we can run:

```
kubectl expose deployment my-little-deploy --port=80
```

  - ... and this will create a service with the same name (`my-little-deploy`)
  - Services are automatically added to an internal DNS zone
    - In the example above, our code can now connect to `http://my-little-deploy/`

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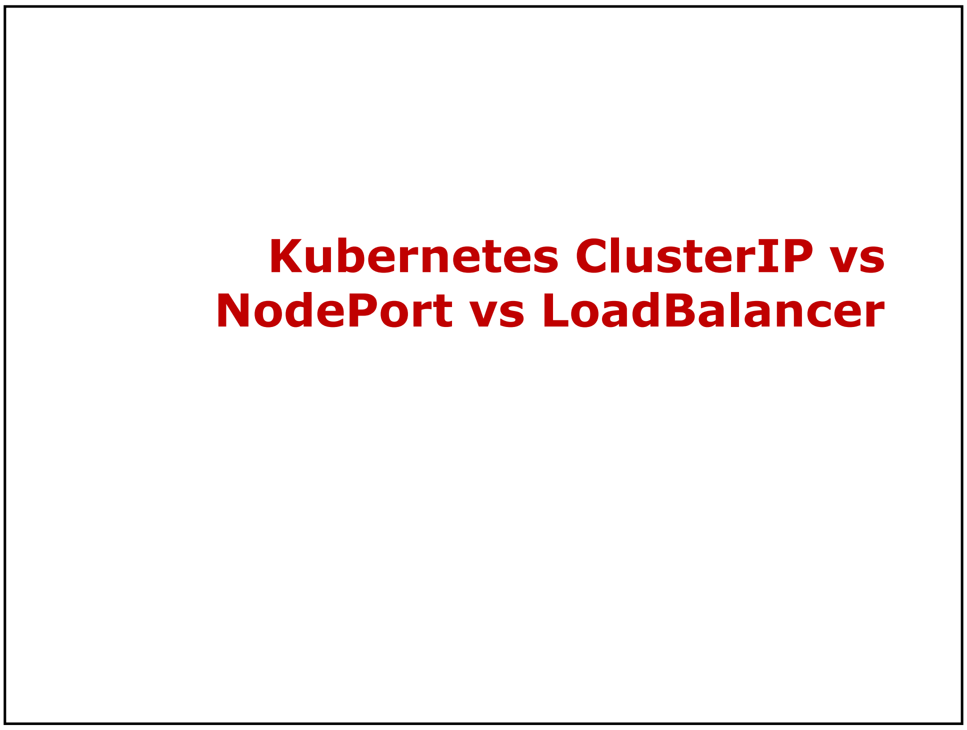

Kubernetes ClusterIP vs NodePort vs LoadBalancer

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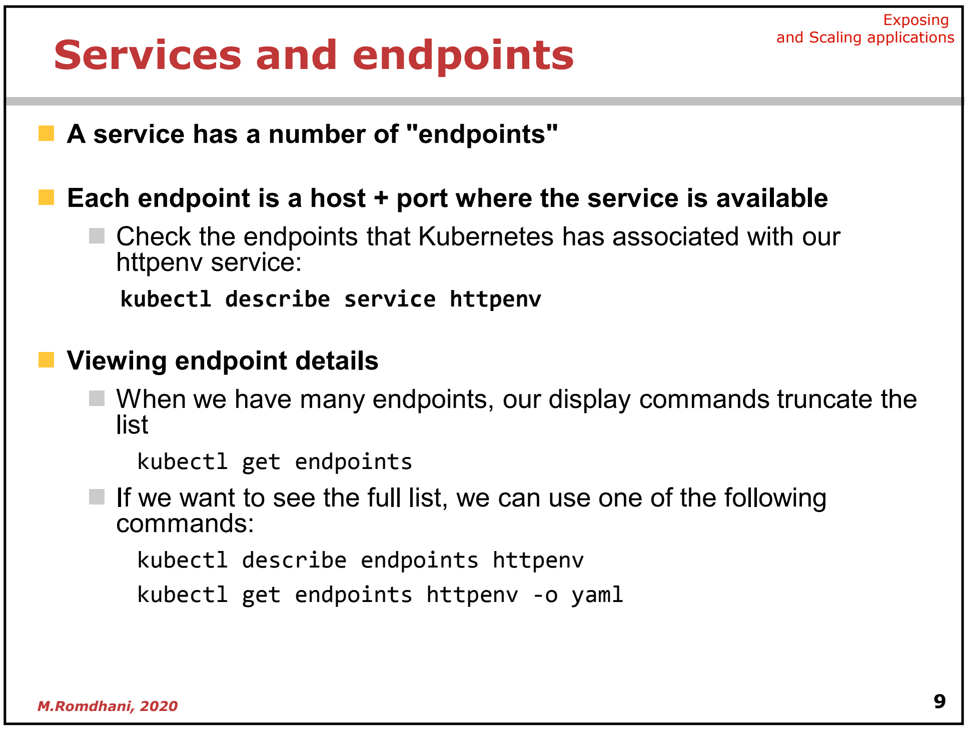


Services and endpoints

- **A service has a number of "endpoints"**
- **Each endpoint is a host + port where the service is available**
  - Check the endpoints that Kubernetes has associated with our httpenv service:

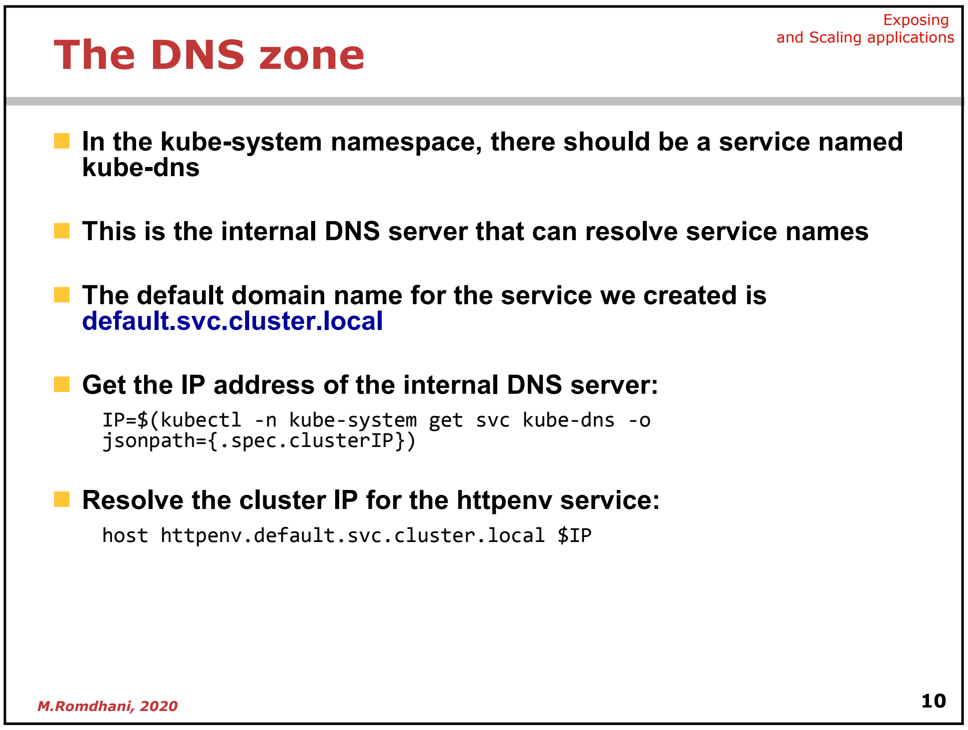
```
kubectl describe service httpenv
```

- **Viewing endpoint details**
  - When we have many endpoints, our display commands truncate the list

```
kubectl get endpoints
```

  - If we want to see the full list, we can use one of the following commands:

```
kubectl describe endpoints httpenv
kubectl get endpoints httpenv -o yaml
```



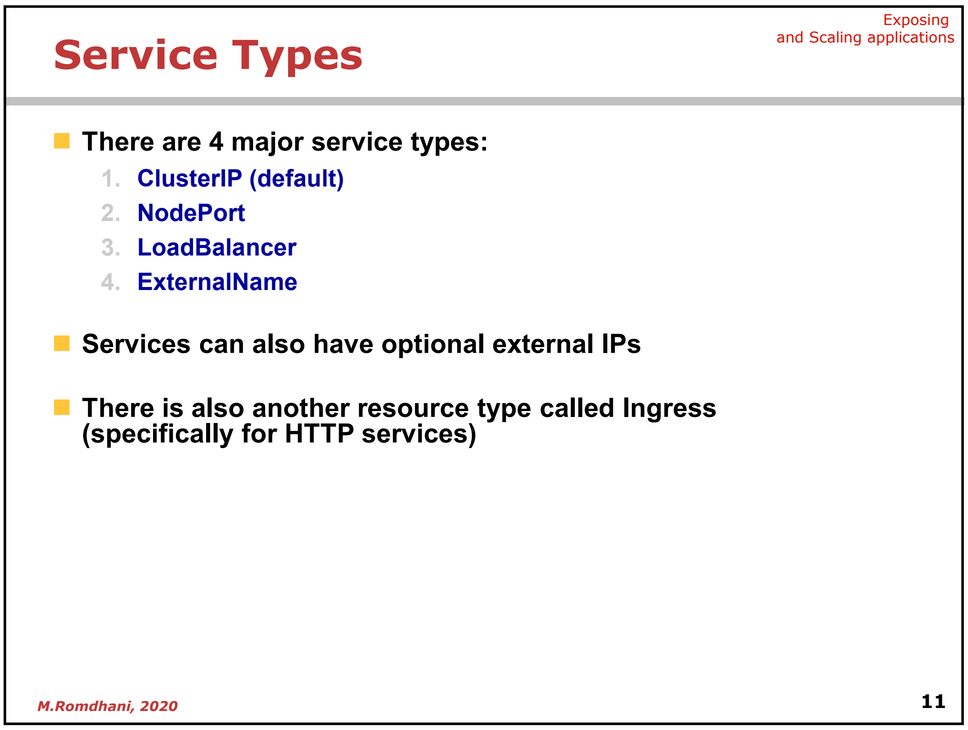
The DNS zone

- **In the kube-system namespace, there should be a service named kube-dns**
- **This is the internal DNS server that can resolve service names**
- **The default domain name for the service we created is default.svc.cluster.local**
- **Get the IP address of the internal DNS server:**

```
IP=$(kubectl -n kube-system get svc kube-dns -o
jsonpath={.spec.clusterIP})
```

- **Resolve the cluster IP for the httpenv service:**

```
host httpenv.default.svc.cluster.local $IP
```



Service Types

- There are 4 major service types:
  1. ClusterIP (default)
  2. NodePort
  3. LoadBalancer
  4. ExternalName
- Services can also have optional external IPs
- There is also another resource type called Ingress (specifically for HTTP services)

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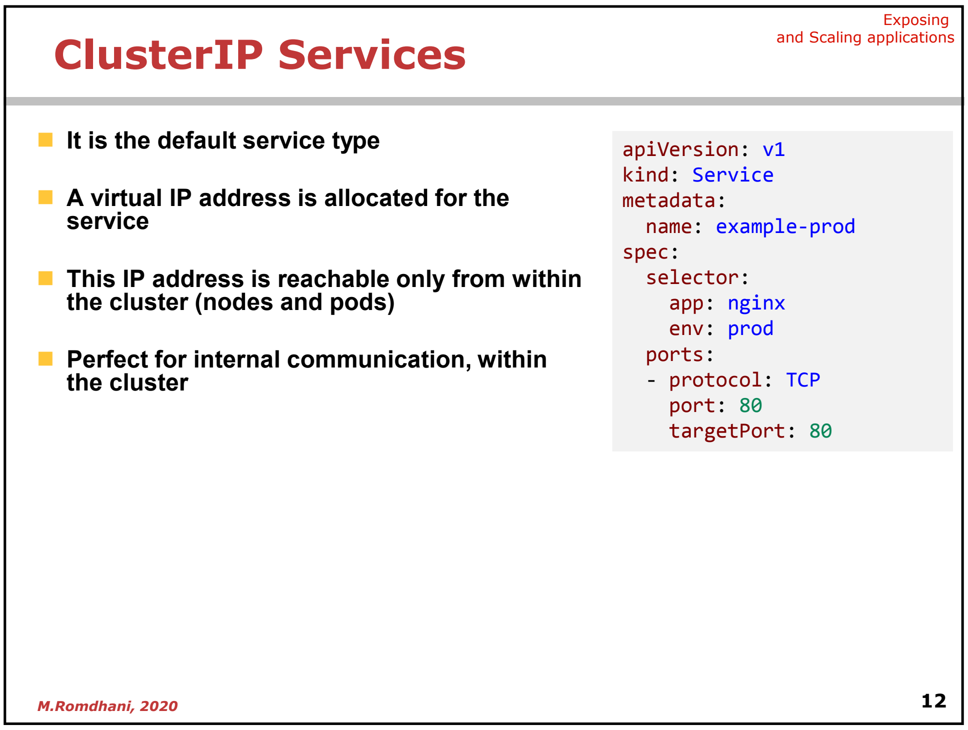

ClusterIP Services

- It is the default service type
- A virtual IP address is allocated for the service
- This IP address is reachable only from within the cluster (nodes and pods)
- Perfect for internal communication, within the cluster

```yaml
apiVersion: v1
kind: Service
metadata:
  name: example-prod
spec:
  selector:
    app: nginx
    env: prod
  ports:
  - protocol: TCP
    port: 80
    targetPort: 80
```

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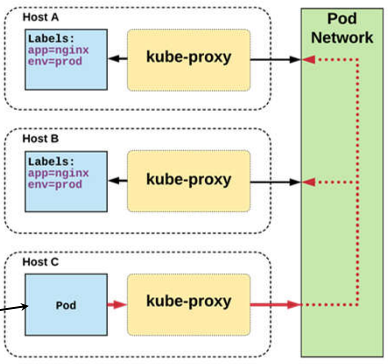
ClusterIP Services

```
Name:        example-prod
Selector:    app=nginx,env=prod
Type:        ClusterIP
IP:          10.96.28.176
Port:        <unset>  80/TCP
TargetPort:  80/TCP
Endpoints:   10.255.16.3:80,
             10.255.16.4:80
```

```
/ # nslookup example-prod.default.svc.cluster.local

Name:      example-prod.default.svc.cluster.local
Address 1: 10.96.28.176 example-prod.default.svc.cluster.local
```



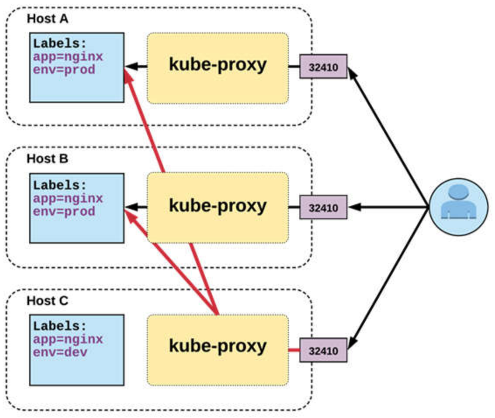
- The Pod on host C requests the service
  - It hits host iptables and it load-balances the connection between the endpoints residing on Hosts A, B

NodePort Services

- **NodePort services extend the ClusterIP service.**
  - Exposes a port on every node's IP.
- **Port can either be statically defined, or dynamically taken from a range between 30000-32767.**

```
apiVersion: v1
kind: Service
metadata:
  name: example-prod
spec:
  type: NodePort
  selector:
    app: nginx
    env: prod
  ports:
  - nodePort: 32410
    protocol: TCP
    port: 80
    targetPort: 80
```

NodePort Services



```
Name:       example-prod
Selector:   app=nginx,env=prod
Type:       NodePort
IP:         10.96.28.176
Port:       <unset>  80/TCP
TargetPort: 80/TCP
NodePort:   <unset>  32410/TCP
Endpoints:  10.255.16.3:80,
            10.255.16.4:80
```

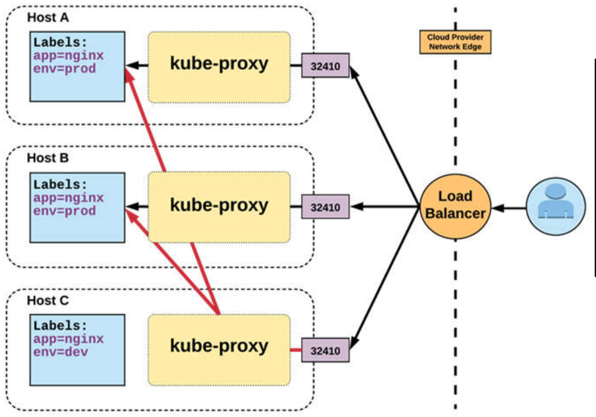
- User can hit any host in cluster on NodePort IP and get to service
- Does introduce extra hop if hitting a host without instance of the pod

LoadBalancer Services

- **LoadBalancer services extend NodePort.**
- **Works in conjunction with an external system to map a cluster external IP to the exposed service (typically a cloud load balancer, e.g. ELB on AWS, GLB on GCE ...)**

```
apiVersion: v1
kind: Service
metadata:
  name: example-prod
spec:
  type: LoadBalancer
  selector:
    app: nginx
    env: prod
  ports:
    protocol: TCP
    port: 80
    targetPort: 80
```

LoadBalancer Services



```
Name:        example-prod
Selector:    app=nginx,env=prod
Type:        LoadBalancer
IP:          10.96.28.176
LoadBalancer
Ingress:     172.17.18.43
Port:        <unset>  80/TCP
TargetPort:  80/TCP
NodePort:    <unset>  32410/TCP
Endpoints:   10.255.16.3:80,
             10.255.16.4:80
```

- Gets external IP from provider

ExternalName Services

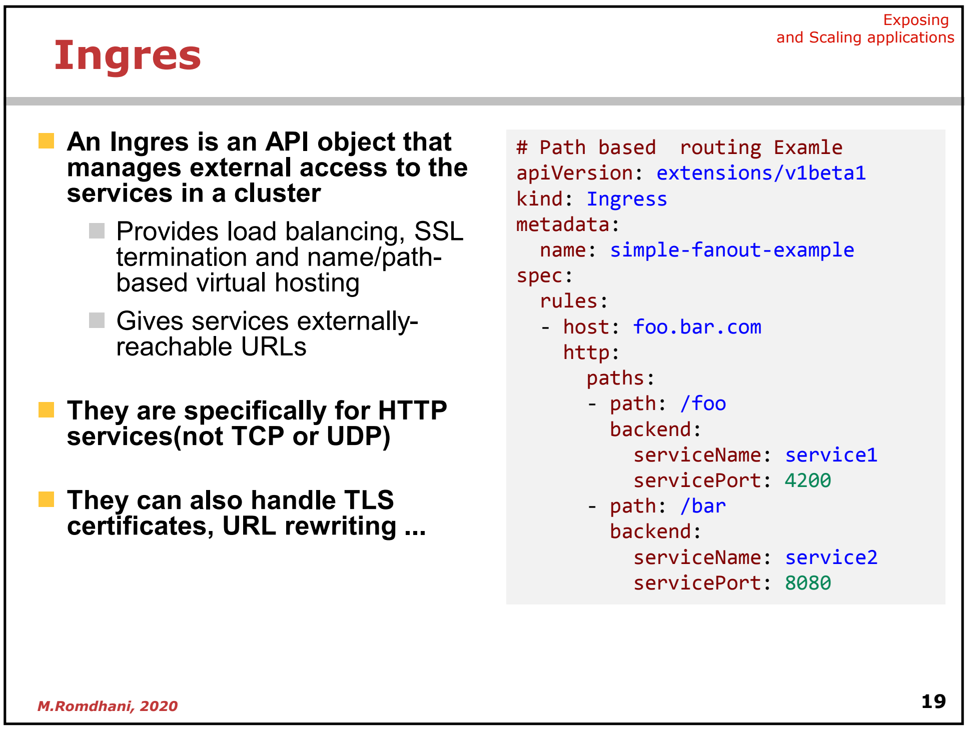
- **Services of type ExternalName are quite different**
- **No load balancer (internal or external) is created**
- **Only a DNS entry gets added to the DNS managed by Kubernetes**
- **That DNS entry will just be a CNAME to a provided record**
- **Example:**
  - Create a CNAME k8s pointing to kubernetes.io

```
kubectl create service externalname k8s
         --external-name kubernetes.io
```

  - Check the CNAME

```
nslookup k8s.default.svc.cluster.local
```

```
apiVersion: v1
kind: Service
metadata:
  name: example-prod
spec:
  type: LoadBalancer
  selector:
    app: nginx
    env: prod
  ports:
    protocol: TCP
    port: 80
    targetPort: 80
```



Ingres

- **An Ingres is an API object that manages external access to the services in a cluster**
  - Provides load balancing, SSL termination and name/path-based virtual hosting
  - Gives services externally-reachable URLs
- **They are specifically for HTTP services(not TCP or UDP)**
- **They can also handle TLS certificates, URL rewriting ...**

```
# Path based  routing Examle
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
  name: simple-fanout-example
spec:
  rules:
  - host: foo.bar.com
    http:
      paths:
      - path: /foo
        backend:
          serviceName: service1
          servicePort: 4200
      - path: /bar
        backend:
          serviceName: service2
          servicePort: 8080
```

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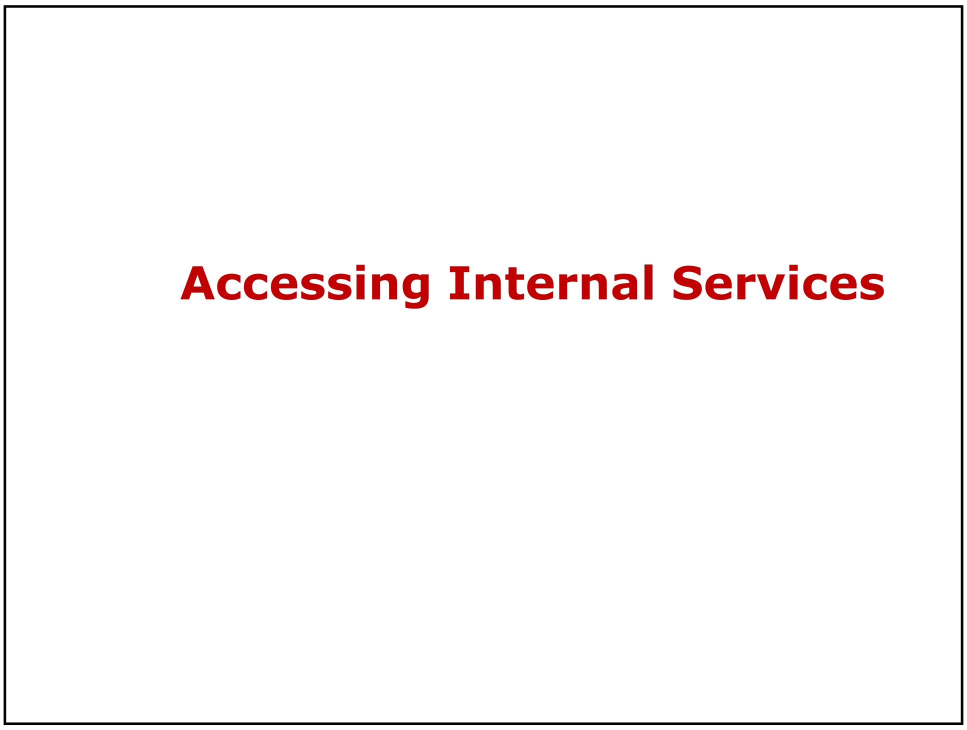

Accessing Internal Services

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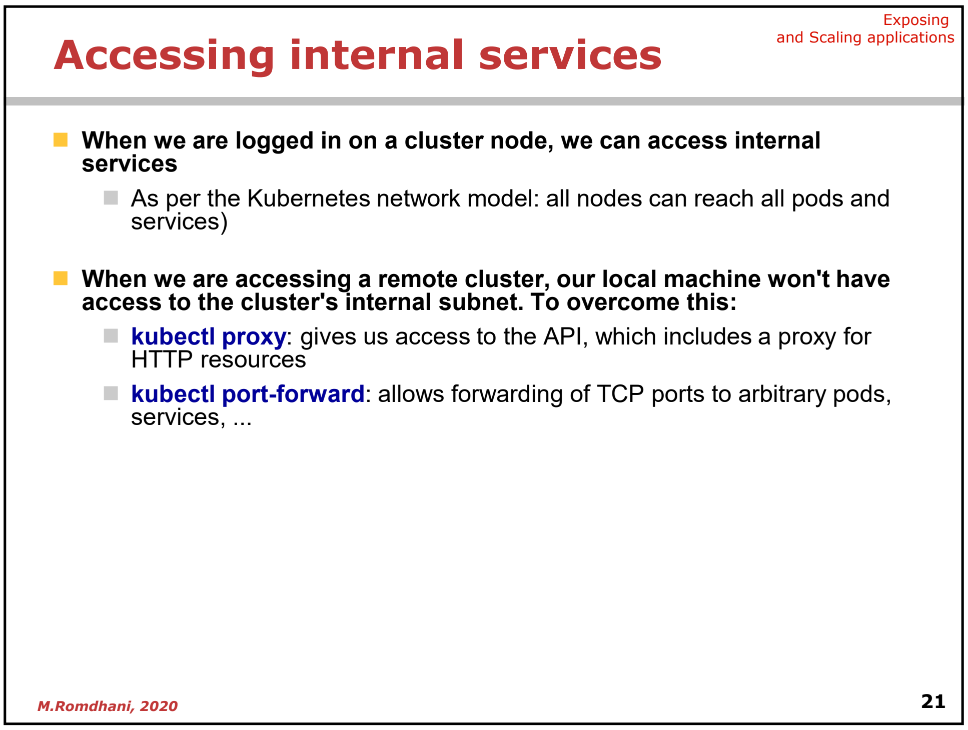
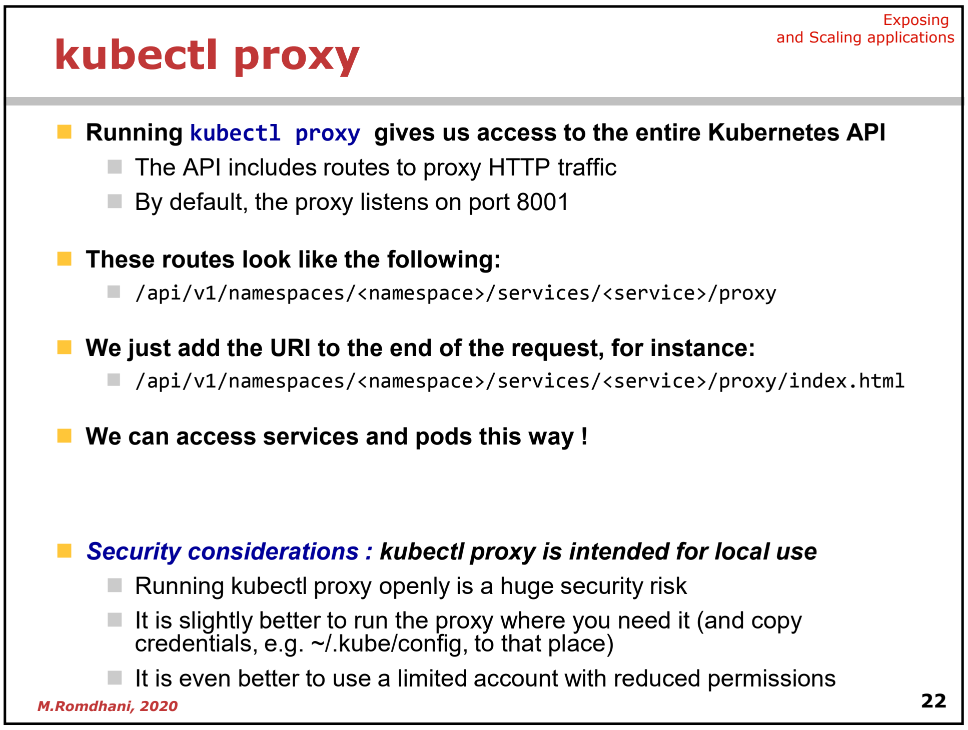


Accessing internal services

- **When we are logged in on a cluster node, we can access internal services**
  - As per the Kubernetes network model: all nodes can reach all pods and services)
- **When we are accessing a remote cluster, our local machine won't have access to the cluster's internal subnet. To overcome this:**
  - **kubectl proxy**: gives us access to the API, which includes a proxy for HTTP resources
  - **kubectl port-forward**: allows forwarding of TCP ports to arbitrary pods, services, ...



kubectl proxy

- **Running `kubectl proxy` gives us access to the entire Kubernetes API**
  - The API includes routes to proxy HTTP traffic
  - By default, the proxy listens on port 8001
- **These routes look like the following:**
  - `/api/v1/namespaces/<namespace>/services/<service>/proxy`
- **We just add the URI to the end of the request, for instance:**
  - `/api/v1/namespaces/<namespace>/services/<service>/proxy/index.html`
- **We can access services and pods this way !**
- ***Security considerations : kubectl proxy is intended for local use***
  - Running kubectl proxy openly is a huge security risk
  - It is slightly better to run the proxy where you need it (and copy credentials, e.g. ~/.kube/config, to that place)
  - It is even better to use a limited account with reduced permissions

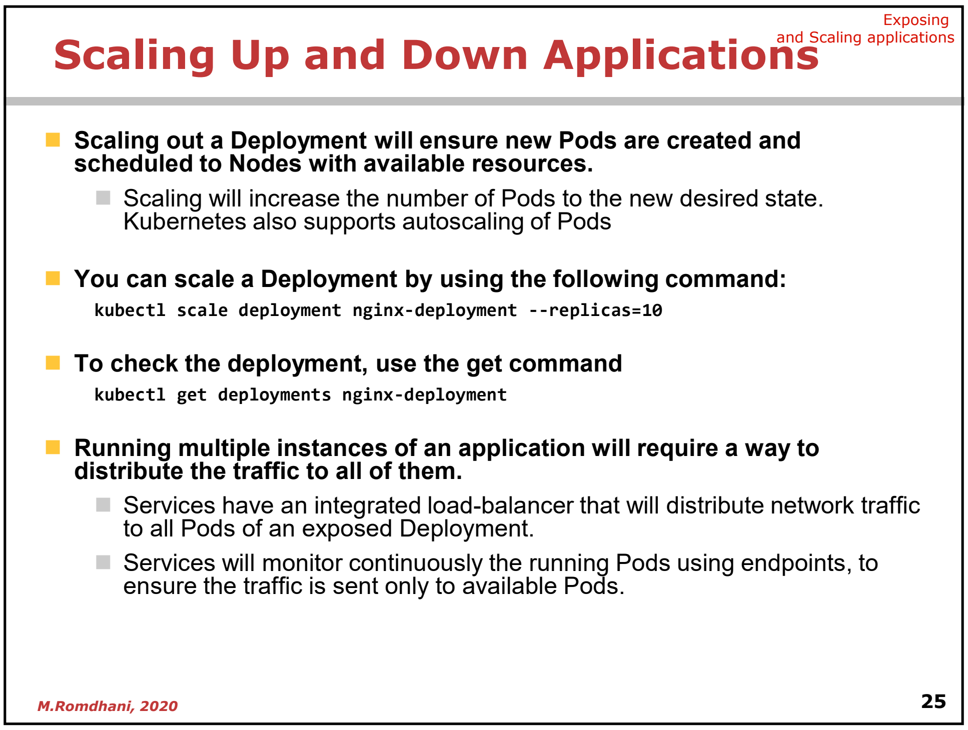
kubectl port-forward

- **What if we want to access a TCP service?**
  - We can use **kubectl port-forward** instead
  - It will create a TCP relay to forward connections to a specific port (of a pod, service, deployment...)
- **The syntax is:**

```
kubectl port-forward service/name_of_service local_port:remote_port
```

  - If only one port number is specified, it is used for both local and remote ports

Scaling up and scaling down the application replicas



Scaling Up and Down Applications

- **Scaling out a Deployment will ensure new Pods are created and scheduled to Nodes with available resources.**
  - Scaling will increase the number of Pods to the new desired state. Kubernetes also supports autoscaling of Pods
- **You can scale a Deployment by using the following command:**

```
kubectl scale deployment nginx-deployment --replicas=10
```

- **To check the deployment, use the get command**

```
kubectl get deployments nginx-deployment
```

- **Running multiple instances of an application will require a way to distribute the traffic to all of them.**
  - 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.

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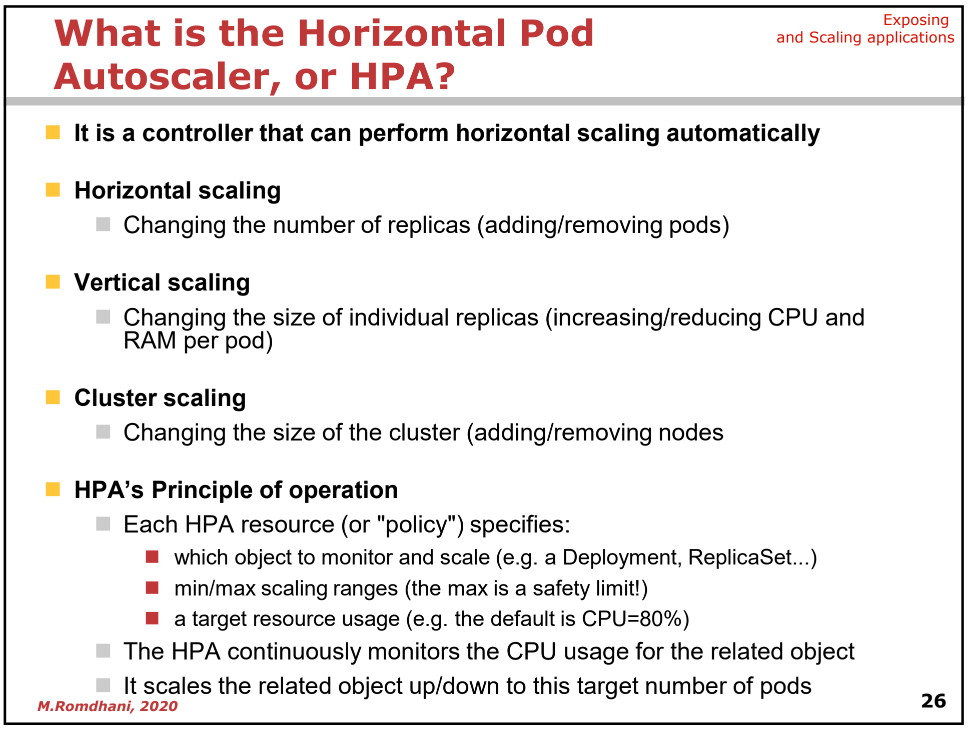

What is the Horizontal Pod Autoscaler, or HPA?

- **It is a controller that can perform horizontal scaling automatically**
- **Horizontal scaling**
  - Changing the number of replicas (adding/removing pods)
- **Vertical scaling**
  - Changing the size of individual replicas (increasing/reducing CPU and RAM per pod)
- **Cluster scaling**
  - Changing the size of the cluster (adding/removing nodes
- **HPA's Principle of operation**
  - Each HPA resource (or "policy") specifies:
    - which object to monitor and scale (e.g. a Deployment, ReplicaSet...)
    - min/max scaling ranges (the max is a safety limit!)
    - a target resource usage (e.g. the default is CPU=80%)
  - The HPA continuously monitors the CPU usage for the related object
  - It scales the related object up/down to this target number of pods

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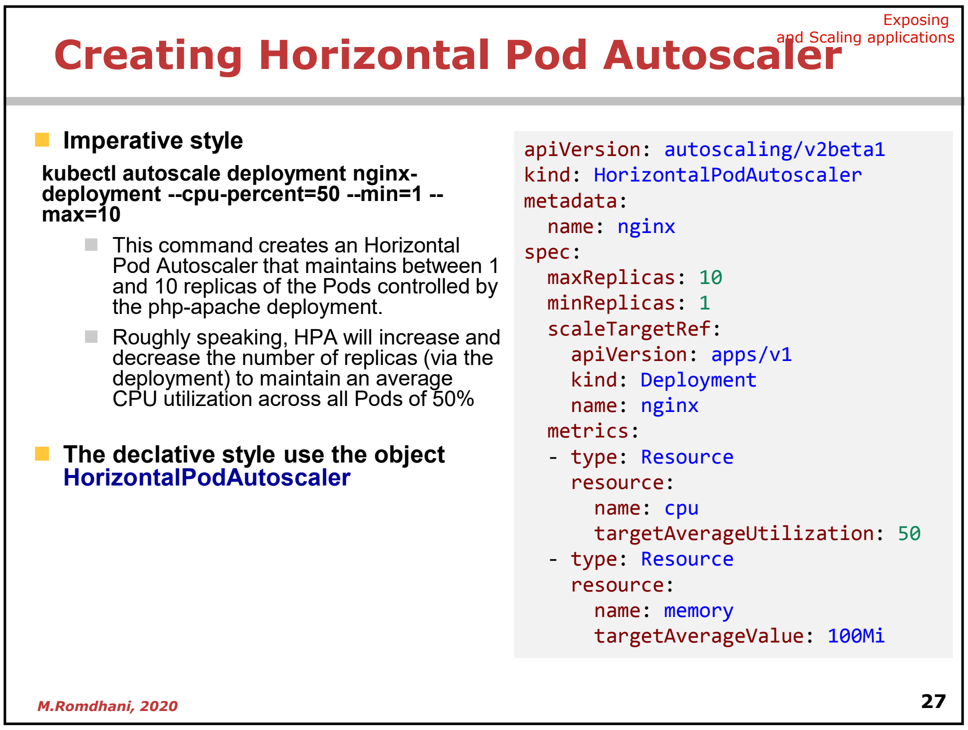

Creating Horizontal Pod Autoscaler

- **Imperative style**

  kubectl autoscale deployment nginx-deployment --cpu-percent=50 --min=1 --max=10

  - This command creates an Horizontal Pod Autoscaler that maintains between 1 and 10 replicas of the Pods controlled by the php-apache deployment.
  - Roughly speaking, HPA will increase and decrease the number of replicas (via the deployment) to maintain an average CPU utilization across all Pods of 50%

- **The declative style use the object HorizontalPodAutoscaler**

```
apiVersion: autoscaling/v2beta1
kind: HorizontalPodAutoscaler
metadata:
  name: nginx
spec:
  maxReplicas: 10
  minReplicas: 1
  scaleTargetRef:
    apiVersion: apps/v1
    kind: Deployment
    name: nginx
  metrics:
  - type: Resource
    resource:
      name: cpu
      targetAverageUtilization: 50
  - type: Resource
    resource:
      name: memory
      targetAverageValue: 100Mi
```