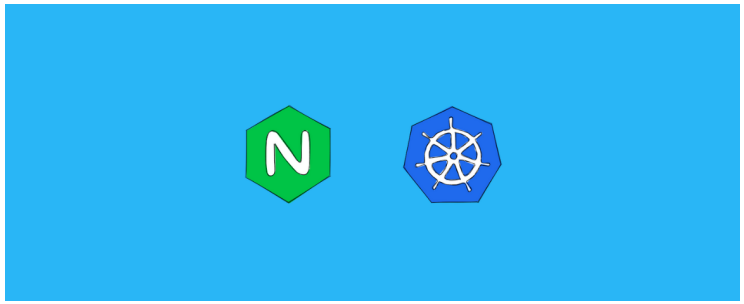
K — KUBERNETES

How to Setup Nginx Ingress Controller On Kubernetes – Detailed Guide

by **Bibin Wilson** · March 3, 2022



In this comprehensive ingress guide, you will learn how to **setup Nginx ingress controller** on Kubernetes and configure ingress using DNS.

If you want to understand how Kubernetes ingress work, read my Kubernetes Ingress Tutorial. for beginners. I have explained all the core ingress concepts including how an ingress object works with an ingress controller.

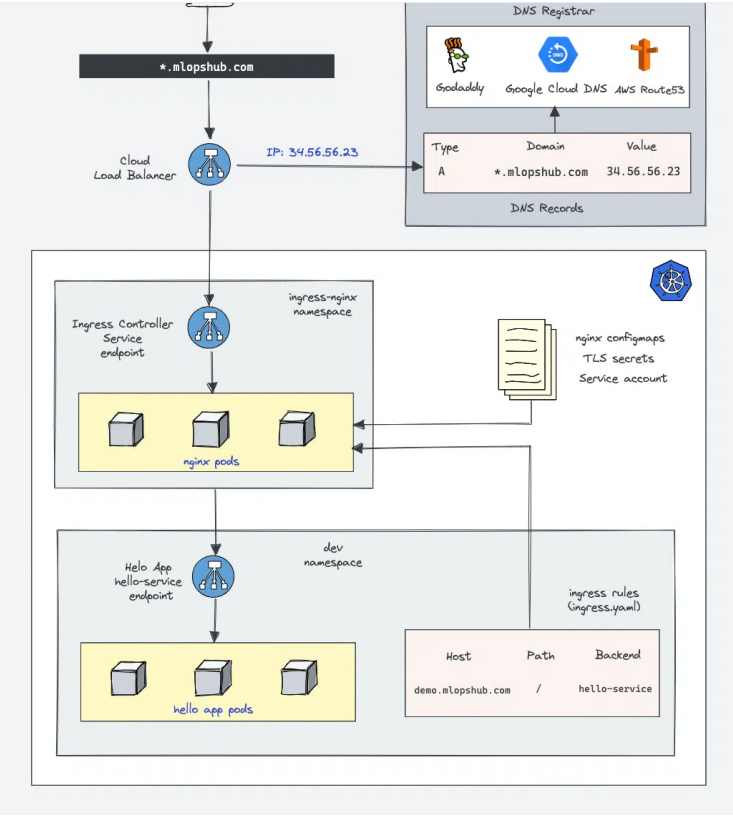
There are two Nginx ingress controllers.

1. Nginx ingress controller by kubernetes community
2. Nginx ingress controller by Nginx Inc

Ingress & Nginx Ingress controller Architecture

Here is a high-level architecture of Kubernetes ingress using the Nginx ingress controller. In this guide, we will learn by building the setup in the architecture.

(**Note**: Click the image to view in high resolution)



Prerequisites

1. A Kuberntes cluster
2. kubectl utility installed and authenticated to kubernetes cluster.
3. Admin access to kubernetes cluster.
4. A valid domain to point to ingress controller Load Balancer

If you are on google cloud, assign admin permissions to your account to enable cluster roles.

```
ACCOUNT=$(gcloud info --format='value(config.account)')
kubectl create clusterrolebinding owner-cluster-admin-
binding \
    --clusterrole cluster-admin \
    --user $ACCOUNT
```

Nginx Ingress Controller Kubernetes Manifests

All the kubernetes manifests used in this tutorial are hosted on the Github repository. Clone it and use it for deployment. These manifests are taken from the official Nginx community repo.

```
git clone https://github.com/scriptcamp/nginx-ingress-
controller.git
```

First, we will understand all the associated Kubernetes objects by **deploying Nginx controllers using YAML manifests**. Once we have the understanding, we will **deploy it using the Helm chart**.

Also, here is the one-liner to deploy all the objects.


```
/provider/cloud/deploy.yaml
```

Note: If you want to understand all the Nginx ingress controllers objects and how they relate to each other, I suggest you create objects individually from the repo. Once you know how it works, you can use a single manifest or a helm chart to deploy it.

Deploy Nginx Ingress Controller With Manifests

We need to deploy the following objects to have a **working Nginx controller**.

1. `ingress-nginx` namespace
2. Service account/Roles/ClusterRoles for **Nginx admission controller**
3. Validating webhook Configuration
4. Jobs to create/update Webhook CA bundles
5. Service account/Roles/ClusterRoles of **Nginx controller deployment**
6. Nginx controller configmap

- Ingress controller deployment

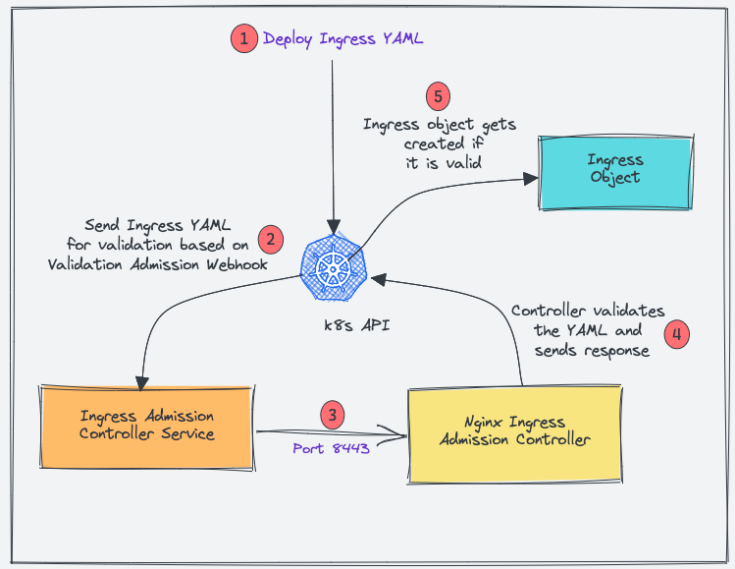
Note: You can create all the manifests yourself or use the Github repo. However, I highly suggest you go through every manifest and understand what you are deploying.

Need for Admission Controller & Validating Webhook

Kubernetes Admission Controller is a small piece of code to validate or update Kubernetes objects before creating them. In this case, it's an **admission controller to validate the ingress objects**. In this case, the Admission Controller code is part of the Nginx controller which listens on port `8443` .

We can deploy ingress objects with the wrong configuration without an admission controller. However, it breaks all the ingress rules associated with the ingress controller.

With the admission controller in place, we can ensure that the ingress object we create has configurations and doesn't break routing rules.



1. When you deploy a ingress YAML, the Validation admission intercepts the request.
2. Kubernetes API then sends the ingress object to the validation admission controller service endpoint based on admission webhook endpoints.
3. Service sends the request to the nginx deployment on port 8443 for validating the ingress object.
4. The admission controller then sends response to the k8s API.
5. If its is a valid response, the API will create the ingress object.

Create a Namespace

We will deploy all the Nginx controller objects in the `ingress-nginx` namespace.

Let's create the namespace.

```
kubectl create ns ingress-nginx
```

Create Admission Controller Roles & Service Account

We need a Role and ClusterRole with required permissions and bind to `ingress-nginx-admission` service account.

Create a file named `admission-service-account.yaml` and copy the following contents.

```
---
apiVersion: v1
kind: ServiceAccount
metadata:
  labels:
    app.kubernetes.io/component: admission-webhook
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-admission
  namespace: ingress-nginx
```



```
metadata:
  annotations:
    app.kubernetes.io/component: admission-webhook
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-admission
  namespace: ingress-nginx
rules:
- apiGroups:
  - ""
  resources:
  - secrets
  verbs:
  - get
  - create

---
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  labels:
    app.kubernetes.io/component: admission-webhook
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-admission
  namespace: ingress-nginx
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: ingress-nginx-admission
subjects:
- kind: ServiceAccount
  name: ingress-nginx-admission
  namespace: ingress-nginx


---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  labels:
    app.kubernetes.io/component: admission-webhook
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-admission
```

```
  resources:
  - validatingwebhookconfigurations
  verbs:
  - get
  - update

---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  labels:
    app.kubernetes.io/component: admission-webhook
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-admission
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: ingress-nginx-admission
subjects:
- kind: ServiceAccount
  name: ingress-nginx-admission
  namespace: ingress-nginx
```

Deploy the manifest.

```
kubectl apply -f admission-service-account.yaml
```

Create Validating Webhook Configuration

Create a file named `validating-webhook.yaml` and copy the following contents.

```
---
apiVersion: admissionregistration.k8s.io/v1
kind: ValidatingWebhookConfiguration
```



```
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-admission
webhooks:
- admissionReviewVersions:
  - v1
  clientConfig:
    service:
      name: ingress-nginx-controller-admission
      namespace: ingress-nginx
      path: /networking/v1/ingresses
  failurePolicy: Fail
  matchPolicy: Equivalent
  name: validate.nginx.ingress.kubernetes.io
  rules:
  - apiGroups:
    - networking.k8s.io
    apiVersions:
    - v1
    operations:
    - CREATE
    - UPDATE
    resources:
    - ingresses
  sideEffects: None
```

Create the `ValidatingWebhookConfiguration`

```
kubectl apply -f validating-webhook.yaml
```

Deploy Jobs To Update Webhook Certificates

The `ValidatingWebhookConfiguration` works only over HTTPS. So it needs a CA bundle.

We use kube-webhook-certgen to generate a CA cert bundle with

The second job patches the `ValidatingWebhookConfiguration` object with the CA bundle.

Create a file named `jobs.yaml` and copy the following contents.

```
---
apiVersion: batch/v1
kind: Job
metadata:
  labels:
    app.kubernetes.io/component: controller
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-admission-create
  namespace: ingress-nginx
spec:
  template:
    metadata:
      labels:
        app.kubernetes.io/component: controller
        app.kubernetes.io/instance: ingress-nginx
        app.kubernetes.io/name: ingress-nginx
      name: ingress-nginx-admission-create
    spec:
      containers:
      - args:
        - create
        - --host=ingress-nginx-controller-admission,ingress-
nginx-controller-admission.$(POD_NAMESPACE).svc
        - --namespace=$(POD_NAMESPACE)
        - --secret-name=ingress-nginx-admission
        env:
        - name: POD_NAMESPACE
          valueFrom:
            fieldRef:
              fieldPath: metadata.namespace
        image: k8s.gcr.io/ingress-nginx/kube-webhook-
certgen:v1.1.1
```



```
          allowPrivilegeEscalation: false
      nodeSelector:
        kubernetes.io/os: linux
      restartPolicy: OnFailure
      securityContext:
        runAsNonRoot: true
        runAsUser: 2000
      serviceAccountName: ingress-nginx-admission
---
apiVersion: batch/v1
kind: Job
metadata:
  labels:
    app.kubernetes.io/component: admission-webhook
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-admission-patch
  namespace: ingress-nginx
spec:
  template:
    metadata:
      labels:
        app.kubernetes.io/component: admission-webhook
        app.kubernetes.io/instance: ingress-nginx
        app.kubernetes.io/name: ingress-nginx
      name: ingress-nginx-admission-patch
    spec:
      containers:
      - args:
        - patch
        - --webhook-name=ingress-nginx-admission
        - --namespace=$(POD_NAMESPACE)
        - --patch-mutating=false
        - --secret-name=ingress-nginx-admission
        - --patch-failure-policy=Fail
        env:
        - name: POD_NAMESPACE
          valueFrom:
            fieldRef:
              fieldPath: metadata.namespace
        image: k8s.gcr.io/ingress-nginx/kube-webhook-
certgen:v1.1.1
        imagePullPolicy: IfNotPresent
        name: patch
        securityContext:
```

```
      restartPolicy: OnFailure
      securityContext:
        runAsNonRoot: true
        runAsUser: 2000
      serviceAccountName: ingress-nginx-admission
```

Once the jobs are executed, you can describe the `ValidatingWebhookConfigurationand` , you will see the patched bundle.

```
kubectl describe ValidatingWebhookConfiguration ingress-
nginx-admission
```

Create Ingress Controller Roles & Service Account

Create a file named `ingress-service-account.yaml` and copy the following contents.

```
---
apiVersion: v1
kind: ServiceAccount
metadata:
  labels:
    app.kubernetes.io/component: admission-webhook
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx
  namespace: ingress-nginx

---
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
```



```
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx
  namespace: ingress-nginx
rules:
- apiGroups:
  - ""
  resources:
  - namespaces
  verbs:
  - get
- apiGroups:
  - ""
  resources:
  - configmaps
  - pods
  - secrets
  - endpoints
  verbs:
  - get
  - list
  - watch
- apiGroups:
  - ""
  resources:
  - services
  verbs:
  - get
  - list
  - watch
- apiGroups:
  - networking.k8s.io
  resources:
  - ingresses
  verbs:
  - get
  - list
  - watch
- apiGroups:
  - networking.k8s.io
  resources:
  - ingresses/status
  verbs:
  - update
- apiGroups:
  - networking.k8s.io
```

```
  - get
  - list
  - watch
- apiGroups:
  - ""
  resourceNames:
  - ingress-controller-leader
  resources:
  - configmaps
  verbs:
  - get
  - update
- apiGroups:
  - ""
  resources:
  - configmaps
  verbs:
  - create
- apiGroups:
  - ""
  resources:
  - events
  verbs:
  - create
  - patch

---
apiVersion: rbac.authorization.k8s.io/v1
kind: RoleBinding
metadata:
  labels:
    app.kubernetes.io/component: controller
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx
  namespace: ingress-nginx
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: ingress-nginx
subjects:
- kind: ServiceAccount
  name: ingress-nginx
  namespace: ingress-nginx
```



```
metadata:
  labels:
    app.kubernetes.io/component: controller
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx
rules:
- apiGroups:
  - ""
  resources:
  - configmaps
  - endpoints
  - nodes
  - pods
  - secrets
  - namespaces
  verbs:
  - list
  - watch
- apiGroups:
  - ""
  resources:
  - nodes
  verbs:
  - get
- apiGroups:
  - ""
  resources:
  - services
  verbs:
  - get
  - list
  - watch
- apiGroups:
  - networking.k8s.io
  resources:
  - ingresses
  verbs:
  - get
  - list
  - watch
- apiGroups:
  - ""
  resources:
  - events
```

```
  - apiGroups:
    - networking.k8s.io
    resources:
    - ingresses/status
    verbs:
    - update
  - apiGroups:
    - networking.k8s.io
    resources:
    - ingressclasses
    verbs:
    - get
    - list
    - watch

---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRoleBinding
metadata:
  labels:
    app.kubernetes.io/component: controller
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: ClusterRole
  name: ingress-nginx
subjects:
- kind: ServiceAccount
  name: ingress-nginx
  namespace: ingress-nginx
```

Deploy the manifest.

```
kubectl apply -f ingress-service-account.yaml
```

Create Configmap

settings. Please refer to the official community documentation for all the supported configurations.

Create a file named `configmap.yaml` and copy the following contents.

```
---
apiVersion: v1
data:
  allow-snippet-annotations: "true"
kind: ConfigMap
metadata:
  labels:
    app.kubernetes.io/component: controller
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-controller
  namespace: ingress-nginx
```

Create the configmap.

```
kubectl apply -f configmap.yaml
```

Create Ingress Controller & Admission Controller Services

Create a file named `services.yaml` and copy the following contents.

```
---
apiVersion: v1
kind: Service
```

```
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-controller
  namespace: ingress-nginx
spec:
  externalTrafficPolicy: Local
  ipFamilies:
  - IPv4
  ipFamilyPolicy: SingleStack
  ports:
  - appProtocol: http
    name: http
    port: 80
    protocol: TCP
    targetPort: http
  - appProtocol: https
    name: https
    port: 443
    protocol: TCP
    targetPort: https
  selector:
    app.kubernetes.io/component: controller
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  type: LoadBalancer
---
apiVersion: v1
kind: Service
metadata:
  labels:
    app.kubernetes.io/component: controller
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
  name: ingress-nginx-controller-admission
  namespace: ingress-nginx
spec:
  ports:
  - appProtocol: https
    name: https-webhook
    port: 443
    targetPort: webhook
  selector:
    app.kubernetes.io/component: controller
    app.kubernetes.io/instance: ingress-nginx
    app.kubernetes.io/name: ingress-nginx
```


Create the services.

```
kubectl apply -f services.yaml
```

`ingress-nginx-controller` creates a Loadbalancer in the respective cloud platform you are deploying.

You can get the load balancer IP/DNS using the following command.

```
kubectl --namespace ingress-nginx get services -o wide -w
ingress-nginx-controller
```

> **Note**: For each cloud provider there are specific annotations you can use to map static IP address and other configs to the Loadbalancer. Check out GCP annotations here and AWS annoatations here.

Create Ingress Controller Deployment

Create a file named `deployment.yaml` and copy the following contents.

```
---
```

```
    labels:
      app.kubernetes.io/component: controller
      app.kubernetes.io/instance: ingress-nginx
      app.kubernetes.io/name: ingress-nginx
    name: ingress-nginx-controller
    namespace: ingress-nginx
spec:
    minReadySeconds: 0
    revisionHistoryLimit: 10
    selector:
      matchLabels:
        app.kubernetes.io/component: controller
        app.kubernetes.io/instance: ingress-nginx
        app.kubernetes.io/name: ingress-nginx
    template:
      metadata:
        labels:
          app.kubernetes.io/component: controller
          app.kubernetes.io/instance: ingress-nginx
          app.kubernetes.io/name: ingress-nginx
      spec:
        containers:
        - args:
          - /nginx-ingress-controller
          - --publish-service=$(POD_NAMESPACE)/ingress-nginx-
controller
          - --election-id=ingress-controller-leader
          - --controller-class=k8s.io/ingress-nginx
          - --configmap=$(POD_NAMESPACE)/ingress-nginx-
controller
          - --validating-webhook=:8443
          - --validating-webhook-certificate=/usr/local
/certificates/cert
          - --validating-webhook-key=/usr/local
/certificates/key
          env:
          - name: POD_NAME
            valueFrom:
              fieldRef:
                fieldPath: metadata.name
          - name: POD_NAMESPACE
            valueFrom:
              fieldRef:
                fieldPath: metadata.namespace
          - name: LD_PRELOAD
```



```
        lifecycle:
          preStop:
            exec:
              command:
              - /wait-shutdown
        livenessProbe:
          failureThreshold: 5
          httpGet:
            path: /healthz
            port: 10254
            scheme: HTTP
          initialDelaySeconds: 10
          periodSeconds: 10
          successThreshold: 1
          timeoutSeconds: 1
        name: controller
        ports:
        - containerPort: 80
          name: http
          protocol: TCP
        - containerPort: 443
          name: https
          protocol: TCP
        - containerPort: 8443
          name: webhook
          protocol: TCP
        readinessProbe:
          failureThreshold: 3
          httpGet:
            path: /healthz
            port: 10254
            scheme: HTTP
          initialDelaySeconds: 10
          periodSeconds: 10
          successThreshold: 1
          timeoutSeconds: 1
        resources:
          requests:
            cpu: 100m
            memory: 90Mi
        securityContext:
          allowPrivilegeEscalation: true
          capabilities:
            add:
            - NET_BIND_SERVICE
```

```
        volumeMounts:
        - mountPath: /usr/local/certificates/
          name: webhook-cert
          readOnly: true
      dnsPolicy: ClusterFirst
      nodeSelector:
        kubernetes.io/os: linux
      serviceAccountName: ingress-nginx
      terminationGracePeriodSeconds: 300
      volumes:
      - name: webhook-cert
        secret:
          secretName: ingress-nginx-admission
```

Create the deployment.

```
kubectl apply -f deployment.yaml
```

To ensure that deployment is working, check the pod status.

```
kubectl get pods -n ingress-nginx
```

Nginx Ingress Controller Helm Deployment

If you are a Helm user, you can deploy the ingress controller using the community helm chart. `ValidatingWebhookConfiguration` is disabled by default in `values.yaml` .

Deploy the helm chart. It will create the namespace `ingress-nginx`


```
helm upgrade --install ingress-nginx ingress-nginx \
  --repo https://kubernetes.github.io/ingress-nginx \
  --namespace ingress-nginx --create-namespace
```

Verify the helm release.

```
helm list -n ingress-nginx
```

To clean up the resources, uninstall the release.

```
helm uninstall ingress-nginx -n ingress-nginx
```

Map a Domain Name To Ingress Loadbalancer IP

The primary goal of Ingress is to **receive external traffic to services running on Kubernetes**. Ideally in projects, a DNS would be mapped to the ingress controller Loadbalancer IP.

This can be done via the **respective DNS provider with the domain name you own**.

> **Info**: For internet-facing apps, it will be public DNS pointing to the public IP of the load balancer. If it's an

mapped to a private load balancer IP.

Single DNS Mapping

You can map a single domain directly as an **A record to the load balancer IP**. Using this you can have only one domain for the ingress controller and multiple path-based traffic routing.

For example,

```
www.example.com --> Loadbalancer IP
```

You can also have path-based routing using this model.

Few examples,

```
http://www.example.com/app1
http://www.example.com/app2
http://www.example.com/app1/api
http://www.example.com/app2/api
```

Wildcard DNS Mapping

If you **map a wildcard DNS to the load balancer**, you can have dynamic DNS endpoints through ingress.

controller will take care of routing it to the required service endpoint.

For example, check the following two mappings.

```
*.example.com --> Loadbalancer IP
*.apps.example.com --> Loadbalancer IP
```

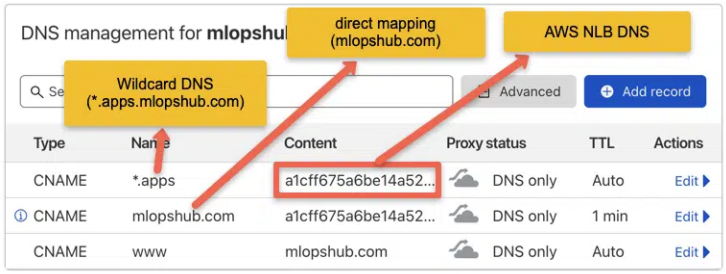
This way you can have multiple **dynamic subdomains through a single ingress controller** and each DNS can have its own path-based routing.

Few examples,

```
#URL one

http://demo1.example.com/api
http://demo1.example.com/api/v1
http://demo1.example.com/api/v2

#app specific urls

http://grafana.apps.example.com
http://prometheus.apps.example.com

#URL two

http://demo2.apps.example.com/api
http://demo2.apps.example.com/api/v1
http://demo2.apps.example.com/api/v2
```

For demo purposes, I have **mapped a wildcard DNS to the LoadBalancer IP**. Based on your DNS provider, you can add the DNS

The following image shows the DNS records I used for this blog demo. **I used EKS** so instead of Loadnbalacer IP, I have a **DNS of network load balancer endpoint which will be a CNAME**. In the case of GKE, you will get an IP and in that case, you need to create an A record.



Deploy a Demo Application

For testing ingress, we will deploy a demo application and add a ClusterIp service to it. This application will be accessible only within the cluster without ingress.

Step 1: create a namespace named dev

```
kubectl create namespace dev
```

Step 2: Create a file named `hello-app.yaml`

Step 3: Copy the following contents and save the file.


```
metadata:
  name: hello-app
  namespace: dev
spec:
  selector:
    matchLabels:
      app: hello
  replicas: 3
  template:
    metadata:
      labels:
        app: hello
    spec:
      containers:
      - name: hello
        image: "gcr.io/google-samples/hello-app:2.0"
```

Step 4: Create the deployment using kubectl

```
kubectl create -f hello-app.yaml
```

Check the deployment status.

```
kubectl get deployments -n dev
```

Step 5: Create a file named `hello-app-service.yaml`

Step 6: Copy the following contents and save the file.

```
apiVersion: v1
kind: Service
metadata:
  name: hello-service
  namespace: dev
```

```
  type: ClusterIP
  selector:
    app: hello
  ports:
  - port: 80
    targetPort: 8080
    protocol: TCP
```

Step 7: Create the service using kubectl.

```
kubectl create -f hello-app-service.yaml
```

Create Ingress Object for Application

Now let's create an ingress object to access our hello app using a DNS. An ingress object is nothing but a setup of routing rules.

If you are wondering how the ingress object is connected to the Nginx controller, the ingress controller pod connects to the Ingress API to check for rules and it updates its `nginx.conf` accordingly.

Since I have wildcard DNS mapped (`*.apps.mlopshub.com`) with the DNS provider, I will use `demo.apps.mlopshub.com` to point to the hello app service.

Step 1: Create a file named `ingress.yaml`

Replace `demo.apps.mlopshub.com` with your domain name. Also, we are creating this ingress object in the `dev` namespace as the hello app is running in the `dev` namespace.

```
apiVersion: networking.k8s.io/v1
kind: Ingress
metadata:
  name: test-ingress
  namespace: dev
spec:
  ingressClassName: nginx
  rules:
  - host: "demo.apps.mlopshub.com"
    http:
      paths:
        - pathType: Prefix
          path: "/"
          backend:
            service:
              name: hello-service
              port:
                number: 80
```

Step 3: Describe created ingress object created to check the configurations.

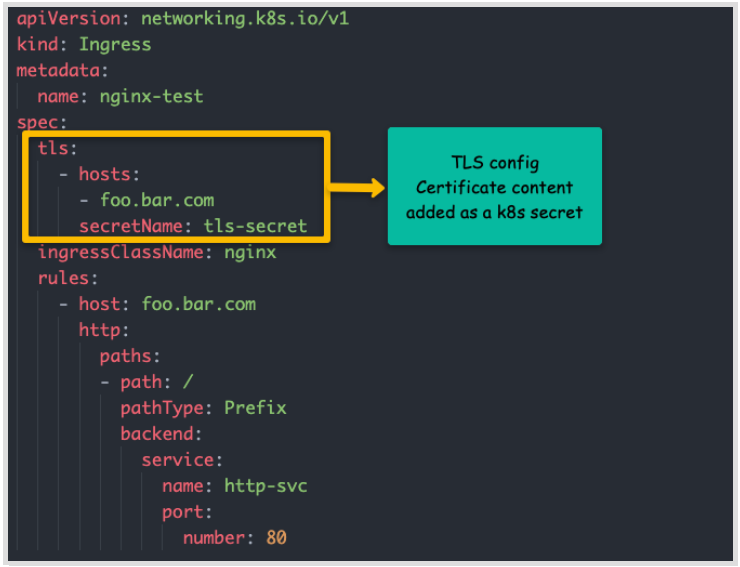
```
kubectl describe ingress  -n dev
```

Now if I try to access `demo.apps.mlopshub.com` domain, I will be able to access the hello app as shown below. (You should replace it with your domain name)

TLS With Nginx Ingress

You can configure TLS certificates with each ingress object. The TLS gets terminated at the ingress controller level.

The following image shows the ingress TLS config. The TLS certificate needs to be added as a secret object.



I have written a detailed article on Ingress TLS configuration.

Conclusion

In this article, we have learned how to setup Nginx ingress controller.

It is very easy to get started. However, for project implementation ensure that you got through all Nginx configurations and **tune them according to the requirements**.

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