

Kemp Ingress Controller for Kubernetes

Feature Description

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Table of Contents

1 Introduction **5**

2 Prerequisites **6**

2.1 AWS EKS Setup Steps 6

3 Install the LoadMaster Ingress Controller **9**

4 Enable LoadMaster to Kubernetes Integration **11**

5 Service Mode and Ingress Mode **13**

5.1 Service Mode 14

5.1.1 How Service Mode Works 16

5.1.2 When to Use Service Mode 16

5.1.3 Configure Service Mode 17

5.1.3.1 Configure a LoadMaster Virtual Service 17

5.1.3.2 Configure the Kubernetes Service 17

5.1.3.3 Verify the Application 18

5.2 Ingress Mode 19

5.2.1 How Ingress Mode Works 20

5.2.2 When to Use Ingress Mode 21

5.2.3 Configure Ingress Mode 21

5.2.3.1 Create a Kubernetes Ingress Controller 21

5.2.3.2 Verify the Application 22

5.2.4 Additional Annotations for Ingress Mode 23

6 Ensuring Connectivity from the LoadMaster to Pods **27**

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6.1 Overlay Networks 27
6.2 How to Check if an Overlay Network is in Use 27
6.3 LoadMaster to Pod Connectivity 28
6.4 Adding Routes 28
6.4.1 Calico 29
7 Creation and Deletion of Objects 31
8 LoadMaster Ingress Logs 33
9 API Commands 34
9.1 Upload a Kube Config File 34
9.2 Delete the Kube Config File 34
9.3 List the Contexts in the Kube Config File 34
9.4 Check the Operations Mode 34
9.5 Set the Operations Mode 34
9.6 Check the Namespace being Watched 35
9.7 Set the Namespace to Watch 35
9.8 Check the Watch Timeout 35
9.9 Set the Watch Timeout 35
9.10 Restart the Ingress Controller 35
Last Updated Date 36

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1 Introduction

The Kemp Ingress Controller for Kubernetes enables a Kemp LoadMaster Virtual Service to be used to publish access to Kubernetes applications. This enables application server pools in published Virtual Services to dynamically update when Pods running on a Kubernetes platform are added or removed from a proxied service object. This provides a convenient way for managing the connection between the Load Balancer and Container network for connections into Kubernetes (commonly referred to as North-South Traffic).

As LoadMaster operates outside of Kubernetes, the Kemp Ingress Controller provides a convenient way for managing end points for either Containerized or Monolithic Applications or a combination of both through the same device.

You first need to install the Ingress Controller on the LoadMaster. Once installed, you can enable this functionality in Service or Ingress mode.

This functionality provides the following capabilities:

- Automated mapping of Kubernetes Service or Ingress object configurations to LoadMaster Virtual Services and SubVSs
- Support for mapping Kubernetes annotations to Virtual Service attributes
- Automated addition and deletion of Real Servers as a result of changes in Kubernetes (for example, scale up or scale down operations)

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2 Prerequisites

Some prerequisites that must be in place before configuring the Kemp Ingress Controller functionality for Kubernetes are listed below:

- At least one licensed and running LoadMaster instance
- A Kube config file with the necessary permissions to read configuration using the Kubernetes Application Programming Interface (API)
- Network access between the LoadMaster and the Kubernetes API server
- Details of the namespace for which objects are defined
- The LoadMaster must be able to route to the Pod CIDR networks within the relevant Kubernetes Clusters and the Cluster Nodes. This may require additional routes to be created. For further details on how to do this, refer to the **Ensuring Connectivity from the LoadMaster to Pods** section.

The Kemp Ingress Controller is currently confirmed to be supported on the following platforms:

- Cloud:
    - Kubernetes running in Azure (Azure Kubernetes Service (AKS))
    - Kubernetes running in Amazon Web Services (AWS) Elastic Kubernetes Service (EKS). For setup steps that you must perform if using AWS EKS, refer to the **AWS EKS Setup Steps** section.
    - Kubernetes running in Rancher Kubernetes Management Platform
- On-prem Linux: Kubernetes running on Linux Operating System (OS)

2.1 AWS EKS Setup Steps

If you intend to use the Kemp Ingress Controller for Kubernetes in the AWS EKS platform, there are some setup steps that you must perform:

1. Install the AWS Command Line Interface (CLI) 2.0:

   curl "https://awscli.amazonaws.com/awscli-exe-linux-x86_64.zip" -o "awscliv2.zip"

   unzip awscliv2.zip

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sudo ./aws/install

2. Install kubectl:

curl -o kubectl https://amazon-eks.s3.us-west-2.amazonaws.com/1.18.9/2020-11-02/bin/linux/amd64/kubectl

3. Install eksctl:

curl --silent --location "https://github.com/weaveworks/eksctl/releases/latest/download/eksctl_$(uname -s)_amd64.tar.gz" | tar xz -C /tmp

sudo mv /tmp/eksctl /usr/local/bin

eksctl version

> The AWS user must have permissions to create an EKS cluster. There must also be available resources to create one Virtual Private Cloud (VPC).

4. Run the command to create the cluster:

eksctl create cluster --name=eksctl --region=us-east-1 --ssh-public-key=aws_eks_ted.pub --nodes=4 --node-type=m5.large

> The above command takes approximately 5 to 10 minutes to execute. Upon successful execution, it creates one VPC, four subnets, and three security groups.

5. After creating the cluster, create the LoadMaster on AWS with one public interface (subnet) of eksctl and a security group with **All** traffic allowed.

LoadMaster security group rules: For example, launch-wizard-58

Type	Protocol	Port range
All traffic	All	All

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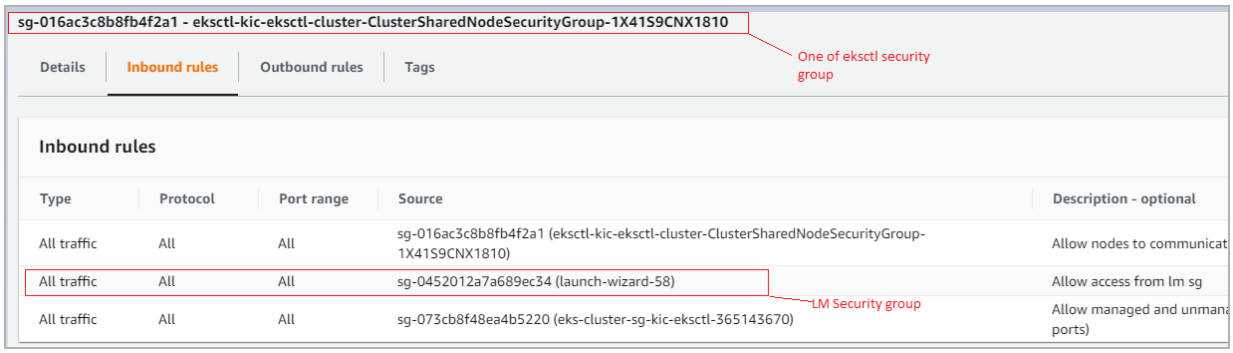

6. Then, add the LoadMaster security group (created above) to all the security groups created by eksctl to ensure communication and to not be restricted by ports, protocols, and so on. The screenshot above shows an example of the eksctl security group.

7. License the LoadMaster, install the addons and upload the Kubeconfig file.

8. Create the configuration on eksctl and health checking should then work.

For further details, refer to the following AWS User Guide: Getting started with Amazon EKS - AWS Management Console and AWS CLI.

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3 Install the LoadMaster Ingress Controller

The Ingress Controller is not installed on the LoadMaster by default. You can easily install it by following these steps:

1. In the LoadMaster User Interface (UI), go to **Virtual Services > Kubernetes Settings**.
2. Click **Install**.
3. Wait for the installation to complete and click **OK** on the confirmation message.
4. Reboot the LoadMaster to activate all required add-ons - **System Configuration > System Administration > System Reboot > Reboot**.

After rebooting, you can use the **Kubernetes Settings** configuration page to enable the LoadMaster Kubernetes integration.

> For LoadMasters deployed in AWS or Azure in a High Availability Pair, please ensure that the add-ons are installed on both devices.

> LoadMaster users (apart from the default admin **bal** user) must be assigned the **All Permissions** option in their user permissions to be permitted access to modify Kubernetes settings in the LoadMaster.

Manual add-on installation

If the LoadMaster is deployed to a location where connectivity to Kemp infrastructure is not available, you can install the Kemp Ingress Controller by following the below steps:

1. Download the required add-ons. Go to https://support.kemptechnologies.com/hc/en-us/sections/200409933-Other-Downloads and select the **Kemp Ingress Contoller**. Here you can download the required add-on files.

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2. On LoadMaster, navigate to **System Configuration>System Administration>Update Software**.
3. Under the **Install new Addon Package** menu add each file and verification file and click **Install Addon Package**.
4. Reboot the LoadMaster to activate all required add-ons, navigate to **System Configuration > System Administration > System Reboot > Reboot**.

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4 Enable LoadMaster to Kubernetes Integration

To enable LoadMaster to Kubernetes communication, the LoadMaster must have Kubernetes API access. To enable this, follow the steps below in the LoadMaster UI:

1. In the main menu, go to **Virtual Services > Kubernetes Settings**.
2. Click **Choose File**.
3. Browse to and select your **Kube Config** file.

   This allows the LoadMaster to communicate with Kubernetes.

   The default location for the Kube Config file is ~/.kube/config, for example, if you are using the Azure Cloud Shell you can access this using **/home/<YourName>/.kube/config** using the **Download File** option at the top of the Cloud Shell window.

   If using Minikube, it is recommended to embed the certificates used for authentication inside the kubeconfig file. This can be done with the following command in Minikube:
   minikube config set embed-certs true

   If the backup of one LoadMaster is restored to another LoadMaster, it is recommended to upload the **Kube Config** file separately to the restored LoadMaster.
4. Click **Install**.
5. Once the **Kube Config** file is successfully installed, some information is populated in the **Contexts** section.

   The **Name**, **Cluster**, and **User** are shown.
6. Select the relevant **K8S Operations Mode**.

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> For further details on each mode, including instructions on how to configure each mode in Kubernetes, refer to the **Service Mode and Ingress Mode** section.

7. Select the **Namespace to Watch**.

> All namespaces are watched if this field is unset.

8. Optional: Set the **Ingress Watch Timeout** in seconds.

> This is the Ingress Controller watch timeout. Valid values range from 30 - 900.

When configured correctly, details on the Kubernetes **Nodes** and relevant objects (Ingress Objects with an ingress class specification of "kempLB" and Service Objects labelled "kempLB:Enabled") are shown at the bottom of the screen.

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5 Service Mode and Ingress Mode

The Kemp Ingress Controller supports two modes of operation:

- Service Mode: In this mode, the LoadMaster configuration is driven through configuration of Service Objects in Kubernetes.
- Ingress Mode: In this mode, the LoadMaster configuration is driven through configuration of the Ingress Object in Kubernetes.

For further details on each mode, refer to the sections below.

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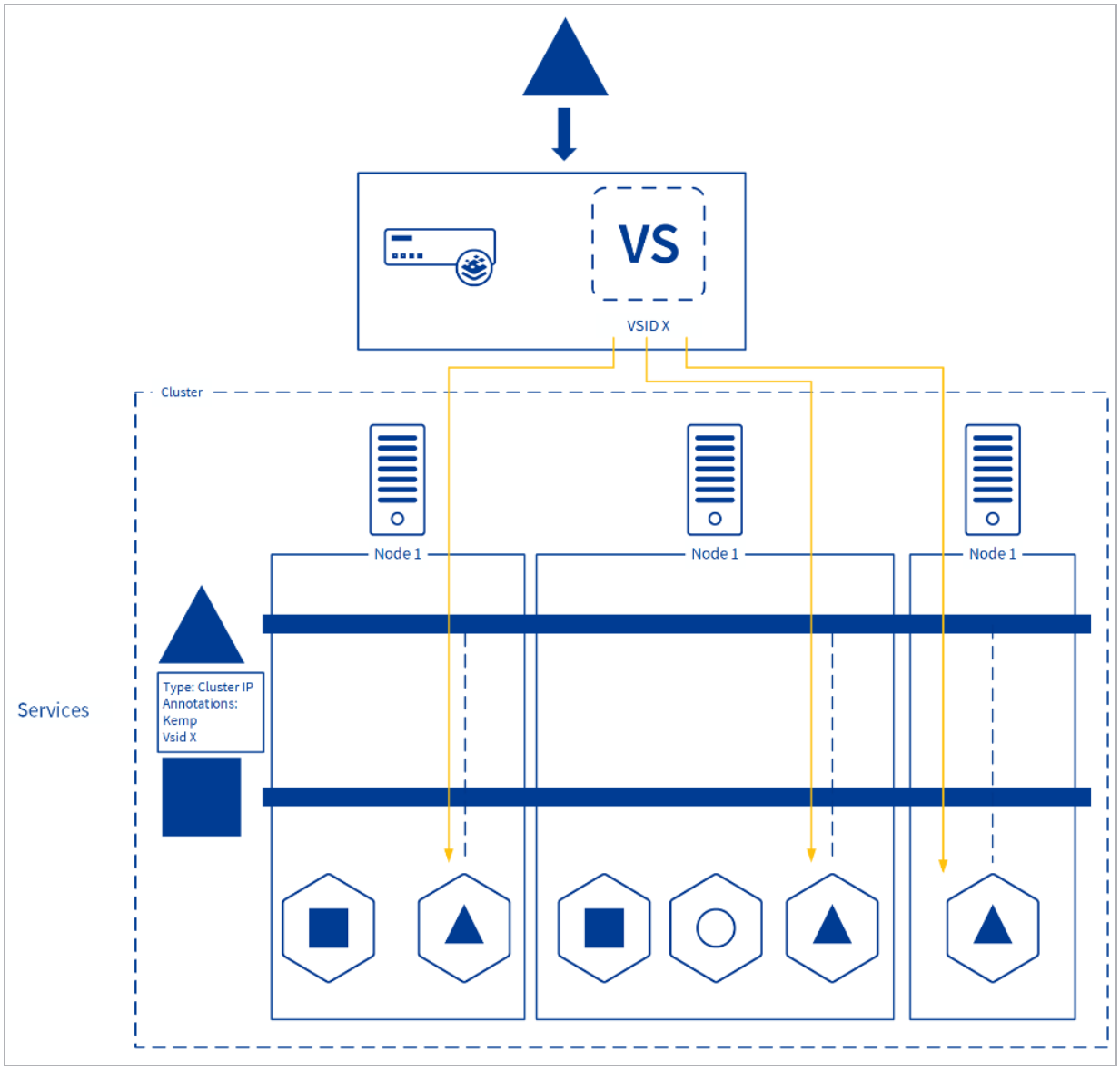
5.1 Service Mode



Service mode is an operating mode developed by Kemp to meet the needs of Network Operations and Application Developers to work together more seamlessly despite different tool-chains and working practices. This is done by enabling the Network Operations team to create dedicated Virtual Services that can be provided to Application Developers operating in Kubernetes. By dynamically updating based on the state of the defined application in Kubernetes this allows for dynamic application publishing without exposing full access to the LoadMaster.

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Service mode allows you to expose a service on the Kubernetes cluster that is not available to access externally by tagging the service with a Virtual Service ID. The LoadMaster makes API calls to determine what pods are linked to the service and then adds the appropriate Real Servers to the Virtual Service.

The advantages and disadvantages of service mode are listed below.

Advantages:

- Efficient routing of traffic to pods
- Eliminates unnecessary East-West traffic
- LoadMaster changes are restricted to the specific Virtual Service defined

Disadvantages:

- May need additional routes to pods defined
- The pod network must not overlap with network IPs
- Nodes must be on the same subnet as the LoadMaster
- A single Virtual Service per Kubernetes Service is required

To enable Service Mode, a Kubernetes service is annotated as being "KempLB enabled" along with a Virtual Service reference (typically the Virtual Service ID) to link it to a Virtual Service on the LoadMaster. The LoadMaster monitors the configuration and if it matches an existing Virtual Service, the appropriate Real Servers are created to route traffic into the service pods. In this mode, the Virtual Service must pre-exist and no new Virtual Service is created. If the service scales, more Real Servers will be added.

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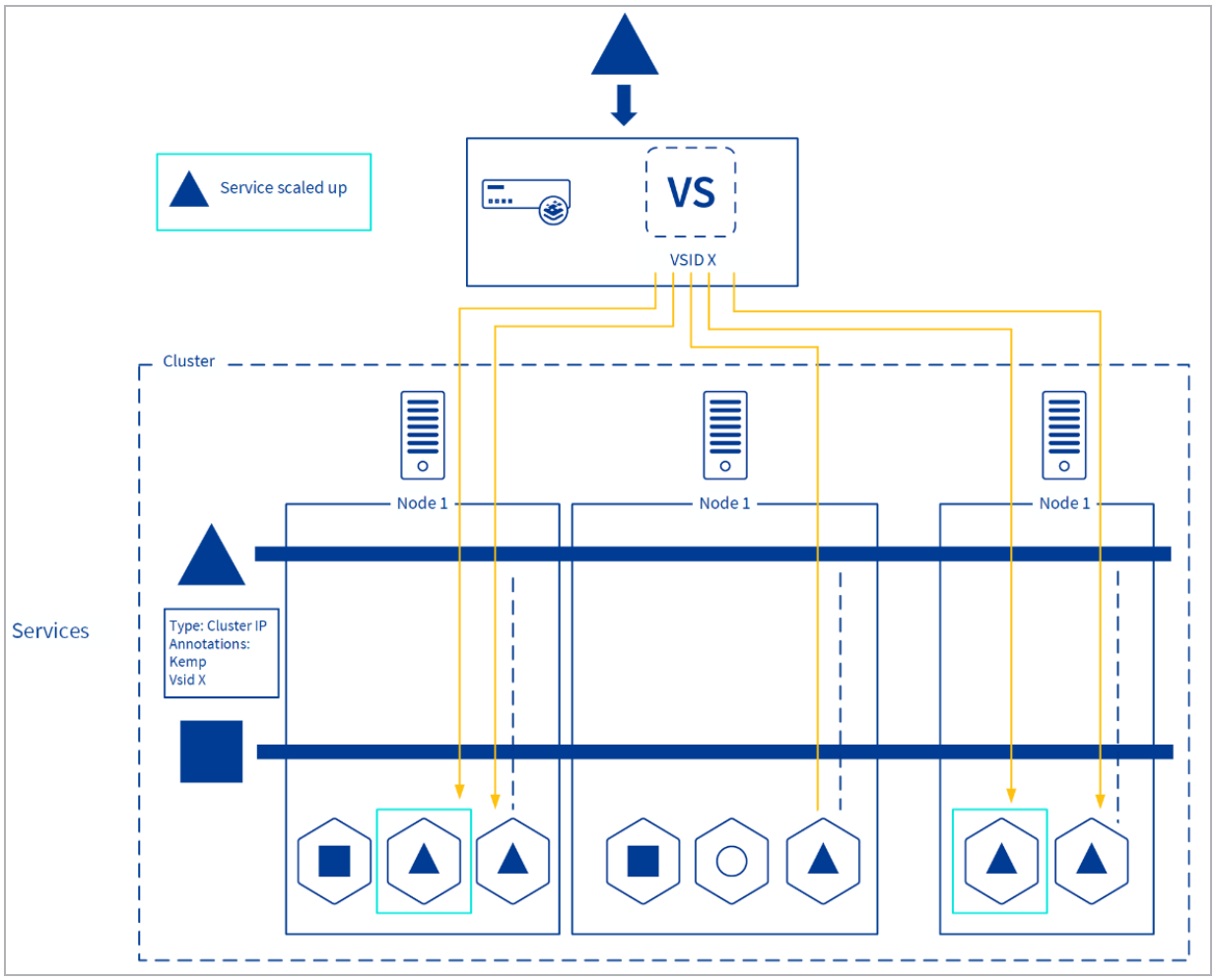

To illustrate the operation of service mode, if the number of pods scales up from three to five, for example, the Virtual Service updates automatically and will have five Real Servers.

5.1.1 How Service Mode Works

In Service Mode, a Virtual Service is created on the LoadMaster and details of this (for example VSID) is provided to the Application Developers (or persons configuring Kubernetes). When publishing a Kubernetes Service it is labeled as kempLB-enabled and associated with the Virtual Service (for example, through the VSID). The LoadMaster automatically detects this and configures itself to match the Service configuration defined in Kubernetes by adding the appropriate Real Servers. This Virtual Service then dynamically changes when pods are added/created/destroyed.

5.1.2 When to Use Service Mode

Service Mode is suitable if you are a:

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- NetOps Team without knowledge or access of the Kubernetes infrastructure
- NetOps Team who uses a different deployment and configuration management toolchain than their AppDev Teams
- Managed Service Provider operating shared Kubernetes and Network infrastructure while their customers self-manage their Kubernetes-based applications

5.1.3 Configure Service Mode

Refer to the sections below for instructions on how to configure service mode.

5.1.3.1 Configure a LoadMaster Virtual Service

You must configure a Virtual Service:

1. In the LoadMaster UI, go to **Virtual Services > Add New**.
2. Expand the **Real Servers** section.
3. Ensure the **Real Server Check Method** is set to **HTTP Protocol**.
4. Select **GET** as the **HTTP Method**.
5. Do not modify any of the other default settings.
6. Take note of the Virtual Service **Id** number.

> The Virtual Service **Id** number is available at the top of the Virtual Service modify screen. This is needed to connect your Kubernetes service to the LoadMaster Virtual Service.

5.1.3.2 Configure the Kubernetes Service

Follow the steps below to link an existing service in Kubernetes to the LoadMaster Virtual Service:

1. Modify the relevant YAML file.
2. Add the following label:

   kempLB: Enabled

3. Add the following annotation:

   "vsid":"<VirtualServiceID>"

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> Throughout this document, angular brackets (**< >**) indicate a value that is variable that you must configure appropriately based on your environment.

4. In the Kubernetes Shell, apply the following configuration:

   kubectl apply -f <Filename>.yaml

5. In the Kubernetes Shell, run the following command to see the service details:

   kubectl describe service <Name>

Here is an example of a YAML file:

```
apiVersion: v1
kind: Service
metadata:
       name: <Name>
       labels:
              kempLB: Enabled
       annotations:
              "vsid": "<VirtualServiceID>"
spec:
       type: ClusterIP
       ports:
              - port: <VirtualServicePort>
       selector:
              app: <ApplicationSelector>
```

5.1.3.3 Verify the Application

The LoadMaster should have picked up that a Kubernetes service has been labeled as **kempLB=Enabled** and configured the LoadMaster Virtual Service with matching VSID with Real Servers corresponding to Kubernetes Services pods. To verify this, follow the steps below:

1. In the LoadMaster UI, go to **Virtual Services > View/Modify Services**.

   > You should see the status as up/green and a Real Server matching the IP address of your Kubernetes pod.

2. Navigate to the Virtual Service IP address in your browser.

   > You should be able to open the appropriate application.

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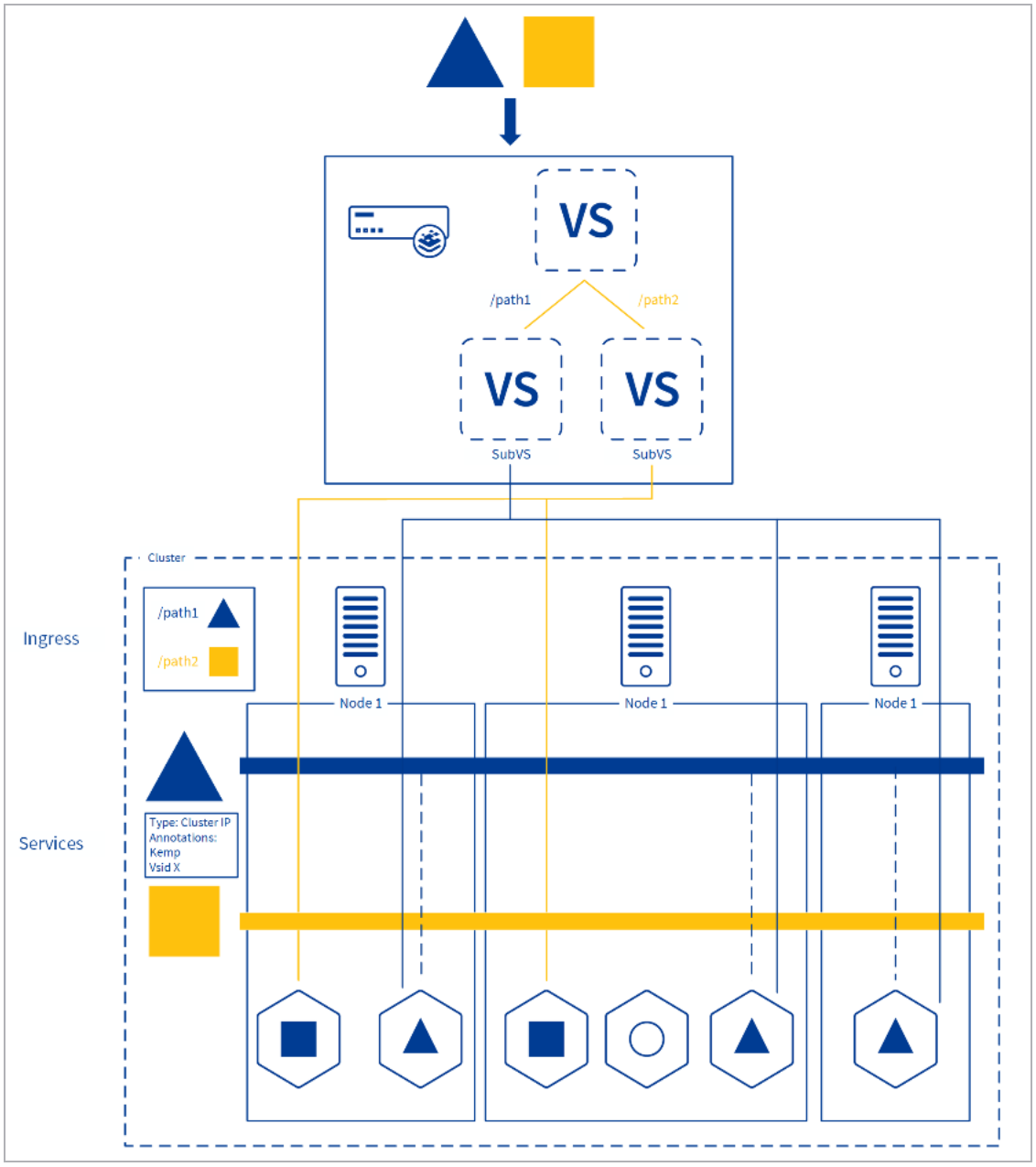
If you deploy more replicas of the service, these should also appear as Real Servers in the LoadMaster Virtual Service. In your Kubernetes Shell, run the following command to see this work:

kubectl scale --replicas=2 deployment/<Application>

5.2 Ingress Mode



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Ingress Mode is designed to allow DevOps Teams to use the LoadMaster as an Ingress Controller for their Kubernetes Clusters in place of containerized ingress controllers.

Ingress mode allows you to define the ingress with an ingress controller. The LoadMaster creates one Virtual Service with one or more SubVSs. Any Virtual Services created by Kubernetes are labelled as **L7+K8S** in the **Layer** column on the **View/Modify Services** screen.

Each SubVS maps to the corresponding service in Kubernetes as defined by the ingress object rules. This means you do not need a separate Virtual Service for each service. The one Virtual Service performs routing based on the path and/or host as defined. If a new pod is added, a new Real Server gets automatically added to the relevant SubVS.

In Ingress Mode, ingress IP address and port numbers are defined in the Kubernetes Ingress Object in addition to attributes used to route specific traffic to particular service pods. In this mode, the Virtual Service is created based on the information defined (if appropriate values are used). If more traffic paths and services are added, these are updated on the Virtual Service with each service typically represented as a SubVS. If a service scales, more Real Servers are added.

Ingress Mode is the standard Kubernetes Ingress Controller operating mode designed for cross-functional teams operating purely through the Kubernetes API.

The advantages and disadvantages of ingress mode are listed below.

Advantages:

- Efficient routing of traffic to pods
- Eliminates unnecessary East-West traffic
- Single Virtual Service for multiple services
- No need for double load balancing
- Kubernetes endpoints can be administered along with monolithic load-balanced services

Disadvantages:

- May need routes to pods defined
- Pod network must not overlap with network IP addresses
- Nodes must be on the same subnet as the LoadMaster

5.2.1 How Ingress Mode Works

The Kubernetes API defines an 'Ingress Controller' object which allows DevOps Teams to publish their Services to external systems and users.

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Ingress Mode allows DevOps Teams to define a new class of Ingress Controller utilizing the LoadMaster which automatically detects and matches the configuration as defined in Kubernetes.

The LoadMaster detects when Services Endpoints (that is, Kubernetes Pods) are added or removed and ensures the LoadMaster SubVS Real Servers are updated accordingly.

5.2.2 When to Use Ingress Mode

Ingress Mode is designed and recommended if you are a:

- Cross-functional DevOps Team who own and operate both the network and Kubernetes infrastructure in addition to the applications
- NetOps Team with knowledge of and access to the Kubernetes infrastructure
- NetOps Team who use the same deployment toolchain and processes as their AppDev Teams
- Managed Service Provider operating shared Kubernetes and Network infrastructure in addition to managing their customers' Kubernetes-based applications

5.2.3 Configure Ingress Mode

Refer to the sections below for instructions on how to configure ingress mode.

5.2.3.1 Create a Kubernetes Ingress Controller

You must define a Kubernetes Ingress Object that stores the configuration that the LoadMaster requires. Here is an example YAML file:

```
apiVersion: extensions/v1beta1
kind: Ingress
metadata:
       name: kemp-ingress
       annotations:
               "kubernetes.io/ingress.class": "kempLB"
               "kemp.ax/vsip": "<VirtualServiceAddress>"
               "kemp.ax/vsport": "<VirtualServicePort>"
               "kemp.ax/vsprot": "<tcp/udp>"
spec:
       rules:
       - host: <HostAddress1>
       http:
               paths:
                       - path: </Path1>
                               backend:
                                       serviceName: <ServiceName1>
```


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```
                                        servicePort: <ServicePort1>
    - host: <HostAddress2>
            http:
                    paths:
                            - path: </Path2>
                                    backend:
                                            serviceName: <ServiceName2>
                                            servicePort: <ServicePort2>
```

In your Kubernetes Shell session, run:

kubectl apply -f <Filename>.yaml

In your Kubernetes Shell session, run the following command to see the ingress details:

kubectl describe ingress <Name>

5.2.3.2 Verify the Application

The LoadMaster should have picked up that a Kubernetes ingress controller has been published and configured a new Virtual Service (if necessary) and the required SubVS(s) for each Kubernetes Services pod. To verify this, follow the steps below:

1. In the LoadMaster UI, go to **Virtual Services > View/Modify Services**.

   You should see the status as up/green and a SubVS. If you click the Virtual Service IP address it should expand to show the SubVS with a Real Server matching the IP address of your Kubernetes pod.

2. Modify the hosts file of your client system to resolve an address to the Virtual Service IP address.

3. Navigate to this address in your browser. This should open the application. By using different hostnames or paths you should be able to access the different services as defined in the Ingress Rules.

4. If you deploy more replicas of the service, these should also appear as Real Servers in the LoadMaster SubVS. To do this, in your Cloud Shell run:

   kubectl scale --replicas=2 deployment/<Application>

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5.2.4 Additional Annotations for Ingress Mode

In addition to defining Virtual Service attributes for creation (for example, Virtual Service IP addresses and port), an Ingress object may also be used to define other attributes. Below is a table of attributes supported. For further details on each attribute, refer to the RESTful API Interface Description.

ingress attr	lmapi attr
addvia	AddVia
alertthresh	AlertThreshold
allowhttp2	AllowHTTP2
altaddress	AltAddress
cache	Cache
cachepercent	CachePercent
certfile	CertFile
checkhost	CheckHost
checkport	CheckPort
checkurl	CheckUrl
checkuse1.1	CheckUse1.1
ciphers	Ciphers
cipherset	CipherSet
clientcert	ClientCert
compress	Compress
copyhdrfrom	CopyHdrFrom
copyhdrto	CopyHdrTo
defaultgw	DefaultGW
enable	Enable
enhealthchecks	EnhancedHealthChecks

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ingress attr	lmapi attr
errorcode	ErrorCode
errorurl	ErrorUrl
espenabled	EspEnabled
extraports	ExtraPorts
followvsid	FollowVSID
forcel7	ForceL7
idletime	Idletime
inauthmode	InputAuthMode
locbindaddr	LocalBindAddrs
machlen	MatchLen
multiconnect	MultiConnect
needhostname	NeedHostName
non_local	non_local
ocspverify	OCSPVerify
outauthmode	OutputAuthMode
persist	persist
perstout	PersistTimeout
portfollow	PortFollow
preprec	PreProcPrecedence
preprecpos	PreProcPrecedencePos
qos	QoS
querytag	QueryTag
reqprec	RequestPrecedence
reqprecpos	RequestPrecedencePos

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ingress attr	lmapi attr
reqrules	RequestRules
respprec	ResponsePrecedence
resprecpos	ResponsePrecedencePos
resprules	ResponseRules
rsminimum	RsMinimum
rsnihostname	ReverseSNIHostname
shed	Schedule
sechdropt	SecurityHeaderOptions
serverinit	ServerInit
sslaccel	SSLAcceleration
sslreencrypt	SSLReencrypt
sslreverse	SSLReverse
sslrewrite	SSLRewrite
standbyaddr	StandbyAddr
standbyport	StandbyPort
starttlsmode	StartTLSMode
subnetorig	SubnetOriginating
sslaccel	SSLAcceleration
tlstype	TLSType
transparent	Transparent
useforsnatt	UseforSnatt
verify	Verify
vsaddr	VSAddress
vsip	VSAddress

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ingress attr	lmapi attr
vsname	NickName
vsport	Protocol
vstype	VStype

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6 Ensuring Connectivity from the LoadMaster to Pods

When running Kubernetes there are multiple options for the configuration of how pods can communicate. Kubernetes requirements are that pods on a node can communicate with all pods on all nodes without Network Address Translation (NAT). Agents on a node (for example, system daemons, kubelet) can communicate with all pods on that node and pods in the host network of a node can communicate with all pods on all nodes without NAT. For further details, refer to the following Kubernetes page: Cluster Networking.

There are a number of ways to implement these and it varies based on the Container Network Interface (CNI) plugins used, cloud provider integrations, or any Border Gateway Protocol (BGP) peering with the physical network in use.

If the pods are routable from outside the network there is no requirement for outbound Secure Network Address Translation (SNAT) and pods can be accessed directly without using Kubernetes Services. The disadvantages are that the IP addresses used must be reserved for pod use.

6.1 Overlay Networks

An overlay network allows network devices to communicate across an underlying network (referred to as the underlay) without the underlay network having any knowledge of the devices connected to the overlay network.

There are a number of common overlay network types that can be used such as Flannel Calico and Weave Net. Typically, when using an overlay network, pods are assigned with an address from a set of addresses assigned to the overlay network and this is different from the Host Network in which the Node's IP addresses are from.

In most cases when using an overlay network, it is typical that pods are not routable.

6.2 How to Check if an Overlay Network is in Use

If you are unsure, the simplest way to check if an overlay network is used and pods are not routable is to view the pod IP addresses and compare to the IP addresses of the nodes. If these are on a different network space then routes must be added.

For example:

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```
[root@master-node ~]# kubectl get nodes -o wide
NAME STATUS ROLES AGE VERSION INTERNAL-IP EXTERNAL-IP OS-IMAGE KERNEL-VERSION
CONTAINER-RUNTIME
master-node Ready master 46d v1.19.2 10.1.151.30 <none> CentOS Linux 7 (Core) 3.10.0-
1127.19.1.el7.x86_64 docker://19.3.13
node-1 Ready <none> 46d v1.19.2 10.1.151.31 <none> CentOS Linux 7 (Core) 3.10.0-
1127.19.1.el7.x86_64 docker://19.3.13
node-2 Ready <none> 46d v1.19.2 10.1.151.32 <none> CentOS Linux 7 (Core) 3.10.0-
1127.19.1.el7.x86_64 docker://19.3.13
[root@master-node ~]#
[root@master-node ~]# kubectl get pods -o wide
NAME READY STATUS RESTARTS AGE IP NODE NOMINATED NODE READINESS GATES
azure-vote-back-59d587dbb7-x297k 1/1 Running 1 3d 192.168.84.150 node-1 <none> <none>
azurefront-5f47b44b9b-nhdwb 1/1 Running 1 3d 192.168.247.14 node-2 <none> <none>
frontend-6c6d6dfd4d-6xzpd 1/1 Running 1 3d 192.168.247.2 node-2 <none> <none>
frontend-6c6d6dfd4d-g26cb 1/1 Running 1 3d 192.168.247.1 node-2 <none> <none>
frontend-6c6d6dfd4d-qbbsv 1/1 Running 1 3d 192.168.84.155 node-1 <none> <none>
redis-master-f46ff57fd-jjhwx 1/1 Running 1 3d 192.168.84.153 node-1 <none> <none>
redis-slave-bbc7f655d-5xnkk 1/1 Running 1 3d 192.168.84.156 node-1 <none> <none>
redis-slave-bbc7f655d-n9vgh 1/1 Running 1 3d 192.168.247.12 node-2 <none> <none>
```

In the above example, it is clear that the PODs are on a different network to the nodes.

6.3 LoadMaster to Pod Connectivity

When using Kemp Ingress Controller for Kubernetes, because the LoadMaster operates outside the Kubernetes Cluster, when it receives traffic it needs a mechanism to route to the correct pods. This means there must be network connectivity between the LoadMaster and the pods. The simplest way to achieve this is to manually create the necessary routes. It is important to note that to do this the LoadMaster must have an interface in the same network as the Kubernetes Hosts.

6.4 Adding Routes

To see what routes are necessary the following Kubernetes commands can be used.

For most CNIs the following can be used:

```
kubectl get nodes -o jsonpath="{range .items[*]}{'Destination: '}
{.spec.podCIDR}{'\t'}{'Gateway: '}{.status.addresses[0].address}{'\n'}{end}"
```


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For example:

```
[root@master-node ~]# kubectl get nodes -o jsonpath="{range .items[*]}
{'Destination: '}{.spec.podCIDR}{'\t'}{'Gateway: '}{.status.addresses
[0].address}{'\n'}{end}"
Destination: 192.168.0.0/24 Gateway: 10.1.151.30
Destination: 192.168.1.0/24 Gateway: 10.1.151.31
Destination: 192.168.2.0/24 Gateway: 10.1.151.32
```

The above command tells us what routes are needed on the LoadMaster and you can add these routes in the LoadMaster UI by going to **System Configuration > Network Setup > Additional Routes**.

Destination	Gateway
192.168.0.0/24	10.1.151.30
192.168.1.0/24	10.1.151.31
192.168.2.0/24	10.1.151.32

6.4.1 Calico

If Calico is being used for the overlay network, the commands to use are a little different.

```
kubectl get nodes -o jsonpath="{range .items[*]}{'Destination: }
{.metadata.annotations.projectcalico\.org/IPv4IPIPTunnelAddr}{'\tGateway: '}
{.metadata.annotations.projectcalico\.org/IPv4Address}{'\n'}"
kubectl get IPpool -o jsonpath="{range .items[*]}{'Destination Mask: /'}
{.spec.blockSize}{'\n'}"
```

For example:

```
[root@master-node ~]# kubectl get nodes -o jsonpath="{range .items[*]}
{'Destination: '}
{.metadata.annotations.projectcalico\.org/IPv4IPIPTunnelAddr}{'\tGateway: '}
{.metadata.annotations.projectcalico\.org/IPv4Address}{'\n'}"
Destination: 192.168.77.128 Gateway: 10.1.151.30/24
Destination: 192.168.84.128 Gateway: 10.1.151.31/24
Destination: 192.168.247.0 Gateway: 10.1.151.32/24
Destination: Gateway:
```

> The above does not provide the netmask to use for the Destination Address Space. By default, Calico uses /26 but this can be verified using the following command.

```
[root@master-node ~]# kubectl get IPpool -o jsonpath="{range .items[*]}
{'Destination Mask: /'}{.spec.blockSize}{'\n'}"
```


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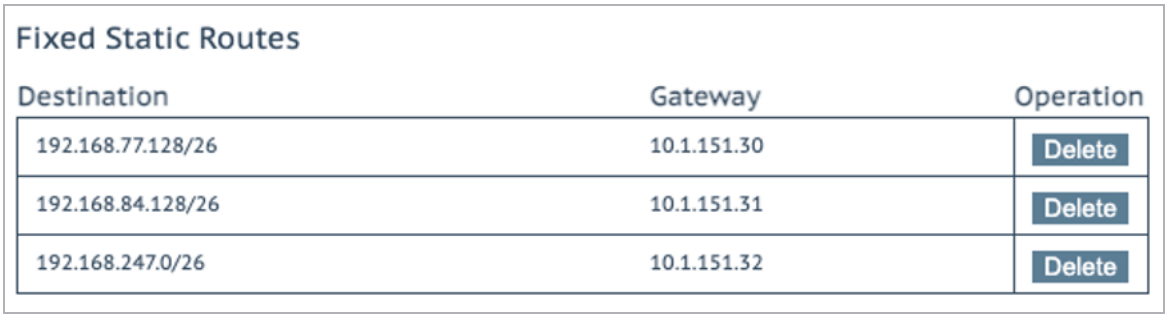
```
Destination Mask: /26
Destination Mask: /
[root@master-node ~]#
```



Routes to add to the LoadMaster (in **System Configuration > Network Setup > Additional Routes**):

Destination	Gateway
192.168.77.128/26	10.1.151.30
192.168.84.128/26	10.1.151.31
192.168.247.0/26	10.1.151.32

The subnet mask defaults to /26 for Calico.

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7 Creation and Deletion of Objects

When using the Kemp Ingress Controller for Kubernetes it is important to understand the expected behaviour with regard to deletion and creation of Virtual Services and Real Servers on the LoadMaster.

'Desired State' is one of the core principles of Kubernetes, whereby a desired configuration is defined and the Kubernetes Controller monitors this and implements any changes required to meet the desired state (for example creating/destroying pods in the cluster). When using the Kemp Ingress Controller for Kubernetes, the LoadMaster operates in a similar manner. The LoadMaster periodically monitors the desired state of how traffic should reach services and updates the configuration (if needed) to reflect this.

It is important to understand some expected behaviour when using the Kemp Ingress Controller for Kubernetes in the two modes of operation:

- Service Mode: In this mode, a service may be annotated with attributes to link it to an existing Virtual Service (typically the Virtual Service ID) on the LoadMaster. The LoadMaster monitors the configuration and if it matches an existing Virtual Service, the appropriate Real Servers are created to route traffic into the service pods. In this mode the Virtual Service must pre-exist and no new Virtual Services are created. If the service scales, more Real Servers are added.
  If Real Servers are manually deleted on the LoadMaster, the service definition will still map to an existing Virtual Service and will simply re-add these Real Servers. However, If a Virtual Service is deleted, the service will no longer have a valid Virtual Service defined in the Service configuration and no Virtual Service will be recreated.
  You can delete a Virtual Service using the LoadMaster (along with removing the Virtual Service ID on the Service) but when removing a Real Server this should be done using Kubernetes pod scaling.
- Ingress Mode: In Ingress Mode, the LoadMaster uses the Ingress Object created in Kubernetes. This defines ingress IP:Port numbers in addition to other attributes used to route to particular services. In this mode the Virtual Service itself is created based on the information defined here (if appropriate values are used). If more traffic paths and services are added, these are updated on the Virtual Service with each service typically represented as a SubVS. If any one service scales, more Real Servers are added.
  If the Virtual Service or Real Server is deleted on the LoadMaster, this results in the Virtual

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Service/Real Server being recreated as long as the Ingress object still exists in Kubernetes which defined these as a desired state.
When deleting a Virtual Service, you should do this using the Kubernetes Ingress Object and when adding/removing Real Servers this should be done using Kubernetes pod scaling.

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8 LoadMaster Ingress Logs

You can access the Kemp Ingress Controller logs by going to **System Configuration > Logging Options > Extended Log Files**. There are two log types:

- **Ingress Controller Logs**
- **Ingress Resource Watcher Logs**

The ingress logs are only shown when:

- The LoadMaster ingress controller is installed, and;
- Ingress logs exist

The following information can be seen in the logs:

- Issues connecting with Kubernetes
- Virtual Services created by Kemp Ingress Controller
- Changes made as a result of scaling
- Configuration changes
- Unrecognized Virtual Service IDs
- Incorrect YAML configuration

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9 API Commands

This section provides details about the LoadMaster RESTful API commands you can use to configure the Kubernetes Ingress Controller functionality.

9.1 Upload a Kube Config File

To upload a Kube config file to the LoadMaster, run the **addlmingressk8sconf** as a cURL command. For example:

```
curl -X POST --data-binary "@<KubeConfigFilename>" -k
https://<Username>:<Password>@<LoadMasterIPAddress>/access/addlmingressk8sconf
```

9.2 Delete the Kube Config File

To delete the existing Kube config file from the LoadMaster, run the **dellmingressk8sconf** command. For example:

```
/access/dellmingressk8sconf
```

9.3 List the Contexts in the Kube Config File

To list the contexts in the Kube config file that is installed on the LoadMaster, run the **showlmingressk8sconf** command. For example:

```
/access/showlmingressk8sconf
```

9.4 Check the Operations Mode

To check what **Operations Mode** is currently selected, run the **getlmingressmode** command. For example:

```
/access/getlmingressmode
```

9.5 Set the Operations Mode

To set the **Operations Mode**, run the **setlmingressmode** command. For example:

```
/access/setlmingressmode?mode=<Service/Ingress>
```


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9.6 Check the Namespace being Watched

To check what namespace is currently being watched, run the **getlmingressnamespace** command. For example:

/access/getlmingressnamespace

9.7 Set the Namespace to Watch

To set the **Namespace to Watch**, run the **setlmingressnamespace** command. For example:

/access/setlmingressnamespace?namespace=<Namespace>

9.8 Check the Watch Timeout

To check the current **LMingress Watch Timeout** (in seconds), run the **getlmingresswatchtimeout** command. For example:

/access/getlmingresswatchtimeout

9.9 Set the Watch Timeout

To set the **LMingress Watch Timeout** (in seconds), run the **setlmingresswatchtimeout** command. For example:

/access/setlmingresswatchtimeout?watchtimeout=<TimeoutInSeconds>

9.10 Restart the Ingress Controller

To restart the LoadMaster Ingress Controller, run the **restartlmingress** command. For example:

/access/restartlmingress

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