



# Red Hat Service Interconnect 1.5

## Examples

Application network tutorials with Skupper CLI and YAML



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Application network tutorials with Skupper CLI and YAML

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## Abstract

Red Hat Service Interconnect is a Red Hat build of the open source Skupper project. This Skupper documentation is reproduced for reference.

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# CHAPTER 1. INTRODUCTION TO EXAMPLES

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## CHAPTER 2. SKUPPER HELLO WORLD

A minimal HTTP application deployed across Kubernetes clusters using Skupper

This example is part of a [suite of examples](#) showing the different ways you can use Skupper to connect services across cloud providers, data centers, and edge sites.

### Overview

This example is a very simple multi-service HTTP application deployed across Kubernetes clusters using Skupper.

It contains two services:

- A backend service that exposes an `/api/hello` endpoint. It returns greetings of the form **Hi, <your-name>. I am <my-name> (<pod-name>).**
- A frontend service that sends greetings to the backend and fetches new greetings in response.

With Skupper, you can place the backend in one cluster and the frontend in another and maintain connectivity between the two services without exposing the backend to the public internet.

### Prerequisites

- The **kubect**l command-line tool, version 1.15 or later ([installation guide](#))
- Access to at least one Kubernetes cluster, from [any provider you choose](#)

### Procedure

- [Install the Skupper command-line tool](#)
- [Set up your clusters](#)
- [Deploy the frontend and backend](#)
- [Create your sites](#)
- [Link your sites](#)
- [Expose the backend](#)
- [Access the frontend](#)

1. Install the Skupper command-line tool

This example uses the Skupper command-line tool to deploy Skupper. You need to install the **skupper** command only once for each development environment.

See the [Installation](#) for details about installing the CLI. For configured systems, use the following command:

```
sudo dnf install skupper-cli
```

2. Set up your clusters

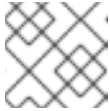
Skupper is designed for use with multiple Kubernetes clusters. The **skupper** and **kubect**l commands use your [kubeconfig](#) and current context to select the cluster and namespace where they operate.



Your kubeconfig is stored in a file in your home directory. The **skupper** and **kubectl** commands use the **KUBECONFIG** environment variable to locate it.

A single kubeconfig supports only one active context per user. Since you will be using multiple contexts at once in this exercise, you need to create distinct kubeconfigs.

For each namespace, open a new terminal window. In each terminal, set the **KUBECONFIG** environment variable to a different path and log in to your cluster. Then create the namespace you wish to use and set the namespace on your current context.



#### NOTE

The login procedure varies by provider. See the documentation for yours:

- [Amazon Elastic Kubernetes Service \(EKS\)](#)
- [Azure Kubernetes Service \(AKS\)](#)
- [Google Kubernetes Engine \(GKE\)](#)
- [IBM Kubernetes Service](#)
- [OpenShift](#)

#### West:

```
export KUBECONFIG=~/.kube/config-west
# Enter your provider-specific login command
kubectl create namespace west
kubectl config set-context --current --namespace west
```

#### East:

```
export KUBECONFIG=~/.kube/config-east
# Enter your provider-specific login command
kubectl create namespace east
kubectl config set-context --current --namespace east
```

### 3. Deploy the frontend and backend

This example runs the frontend and the backend in separate Kubernetes namespaces, on different clusters.

Use **kubectl create deployment** to deploy the frontend in West and the backend in East.

#### West:

```
kubectl create deployment frontend --image quay.io/skupper/hello-world-frontend
```

#### East:

```
kubectl create deployment backend --image quay.io/skupper/hello-world-backend --
replicas 3
```

### 4. Create your sites

A `Skupper_site` is a location where components of your application are running. Sites are linked together to form a network for your application. In Kubernetes, a site is associated with a namespace.

For each namespace, use **skupper init** to create a site. This deploys the Skupper router and controller. Then use **skupper status** to see the outcome.

#### West:

```
skupper init
skupper status
```

Sample output:

```
$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace 'west'. Use 'skupper status' to get more
information.

$ skupper status
Skupper is enabled for namespace "west". It is not connected to any other sites. It has no
exposed services.
```

#### East:

```
skupper init
skupper status
```

Sample output:

```
$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace 'east'. Use 'skupper status' to get more
information.

$ skupper status
Skupper is enabled for namespace "east". It is not connected to any other sites. It has no
exposed services.
```

As you move through the steps below, you can use **skupper status** at any time to check your progress.

#### 5. Link your sites

A `Skupper_link` is a channel for communication between two sites. Links serve as a transport for application connections and requests.

Creating a link requires use of two **skupper** commands in conjunction, **skupper token create** and **skupper link create**.

The **skupper token create** command generates a secret token that signifies permission to create a link. The token also carries the link details. Then, in a remote site, The **skupper link create** command uses the token to create a link to the site that generated it.

**NOTE**

The link token is truly a `_secret`. Anyone who has the token can link to your site. Make sure that only those you trust have access to it.

First, use **skupper token create** in West to generate the token. Then, use **skupper link create** in East to link the sites.

**West:**

```
skupper token create ~/secret.token
```

Sample output:

```
$ skupper token create ~/secret.token
Token written to ~/secret.token
```

**East:**

```
skupper link create ~/secret.token
```

Sample output:

```
$ skupper link create ~/secret.token
Site configured to link to https://10.105.193.154:8081/ed9c37f6-d78a-11ec-a8c7-
04421a4c5042 (name=link1)
Check the status of the link using 'skupper link status'.
```

If your terminal sessions are on different machines, you may need to use **scp** or a similar tool to transfer the token securely. By default, tokens expire after a single use or 15 minutes after creation.

## 6. Expose the backend

We now have our sites linked to form a Skupper network, but no services are exposed on it. Skupper uses the **skupper expose** command to select a service from one site for exposure in all the linked sites.

Use **skupper expose** to expose the backend service in East to the frontend in West.

**East:**

```
skupper expose deployment/backend --port 8080
```

Sample output:

```
$ skupper expose deployment/backend --port 8080
deployment backend exposed as backend
```

## 7. Access the frontend

In order to use and test the application, we need external access to the frontend.

Use **kubectl port-forward** to make the frontend available at **localhost:8080**.

**West:**

```
kubectl port-forward deployment/frontend 8080:8080
```

You can now access the web interface by navigating to <http://localhost:8080> in your browser.

## CHAPTER 3. ACCESSING ACTIVEMQ USING SKUPPER

Use public cloud resources to process data from a private message broker

This example is part of a [suite of examples](#) showing the different ways you can use Skupper to connect services across cloud providers, data centers, and edge sites.

### Overview

This example is a simple messaging application that shows how you can use Skupper to access an ActiveMQ broker at a remote site without exposing it to the public internet.

It contains two services:

- An ActiveMQ broker running in a private data center. The broker has a queue named "notifications".
- An AMQP client running in the public cloud. It sends 10 messages to "notifications" and then receives them back.

For the broker, this example uses the [Apache ActiveMQ Artemis](#) image from [ArtemisCloud.io](#). The client is a simple [Quarkus](#) application.

The example uses two Kubernetes namespaces, "private" and "public", to represent the private data center and public cloud.

Prerequisites

- The **kubectl** command-line tool, version 1.15 or later ([installation guide](#))
- Access to at least one Kubernetes cluster, from [any provider you choose](#)

### Procedure

- [Install the Skupper command-line tool](#)
- [Set up your namespaces](#)
- [Deploy the message broker](#)
- [Create your sites](#)
- [Link your sites](#)
- [Expose the message broker](#)
- [Run the client](#)

1. Install the Skupper command-line tool

This example uses the Skupper command-line tool to deploy Skupper. You need to install the **skupper** command only once for each development environment.

See the [Installation](#) for details about installing the CLI. For configured systems, use the following command:

```
sudo dnf install skupper-cli
```

## 2. Set up your namespaces

Skupper is designed for use with multiple Kubernetes namespaces, usually on different clusters. The **skupper** and **kubectl** commands use your [kubeconfig](#) and current context to select the namespace where they operate.

Your kubeconfig is stored in a file in your home directory. The **skupper** and **kubectl** commands use the **KUBECONFIG** environment variable to locate it.

A single kubeconfig supports only one active context per user. Since you will be using multiple contexts at once in this exercise, you need to create distinct kubeconfigs.

For each namespace, open a new terminal window. In each terminal, set the **KUBECONFIG** environment variable to a different path and log in to your cluster. Then create the namespace you wish to use and set the namespace on your current context.



### NOTE

The login procedure varies by provider. See the documentation for yours:

- [Amazon Elastic Kubernetes Service \(EKS\)](#)
- [Azure Kubernetes Service \(AKS\)](#)
- [Google Kubernetes Engine \(GKE\)](#)
- [IBM Kubernetes Service](#)
- [OpenShift](#)

#### Public:

```
export KUBECONFIG=~/.kube/config-public
# Enter your provider-specific login command
kubectl create namespace public
kubectl config set-context --current --namespace public
```

#### Private:

```
export KUBECONFIG=~/.kube/config-private
# Enter your provider-specific login command
kubectl create namespace private
kubectl config set-context --current --namespace private
```

## 3. Deploy the message broker

In Private, use the **kubectl apply** command to install the broker.

#### Private:

```
kubectl apply -f server
```

Sample output:

```
$ kubectl apply -f server
deployment.apps/broker created
```

#### 4. Create your sites

A Skupper \_site is a location where components of your application are running. Sites are linked together to form a network for your application. In Kubernetes, a site is associated with a namespace.

For each namespace, use **skupper init** to create a site. This deploys the Skupper router and controller. Then use **skupper status** to see the outcome.

##### Public:

```
skupper init
skupper status
```

Sample output:

```
$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace 'public'. Use 'skupper status' to get more
information.

$ skupper status
Skupper is enabled for namespace "public". It is not connected to any other sites. It has
no exposed services.
```

##### Private:

```
skupper init
skupper status
```

Sample output:

```
$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace 'private'. Use 'skupper status' to get more
information.

$ skupper status
Skupper is enabled for namespace "private". It is not connected to any other sites. It has
no exposed services.
```

As you move through the steps below, you can use **skupper status** at any time to check your progress.

#### 5. Link your sites

A Skupper \_link is a channel for communication between two sites. Links serve as a transport for application connections and requests.

Creating a link requires use of two **skupper** commands in conjunction, **skupper token create** and **skupper link create**.

The **skupper token create** command generates a secret token that signifies permission to create a link. The token also carries the link details. Then, in a remote site, The **skupper link create** command uses the token to create a link to the site that generated it.

**NOTE**

The link token is truly a `_secret`. Anyone who has the token can link to your site. Make sure that only those you trust have access to it.

First, use **skupper token create** in site `Public` to generate the token. Then, use **skupper link create** in site `Private` to link the sites.

**Public:**

```
skupper token create ~/secret.token
```

Sample output:

```
$ skupper token create ~/secret.token
Token written to ~/secret.token
```

**Private:**

```
skupper link create ~/secret.token
```

Sample output:

```
$ skupper link create ~/secret.token
Site configured to link to https://10.105.193.154:8081/ed9c37f6-d78a-11ec-a8c7-
04421a4c5042 (name=link1)
Check the status of the link using 'skupper link status'.
```

If your terminal sessions are on different machines, you may need to use **scp** or a similar tool to transfer the token securely. By default, tokens expire after a single use or 15 minutes after creation.

## 6. Expose the message broker

In `Private`, use **skupper expose** to expose the broker on the Skupper network.

Then, in `Public`, use **kubectl get service/broker** to check that the service appears after a moment.

**Private:**

```
skupper expose deployment/broker --port 5672
```

Sample output:

```
$ skupper expose deployment/broker --port 5672
deployment broker exposed as broker
```

**Public:**

```
kubectl get service/broker
```

Sample output:



```
$ kubectl get service/broker
NAME      TYPE      CLUSTER-IP   EXTERNAL-IP  PORT(S)  AGE
broker   ClusterIP 10.100.58.95 <none>      5672/TCP 2s
```

## 7. Run the client

In Public, use **kubectl run** to run the client.

### Public:

```
kubectl run client --attach --rm --restart Never --image quay.io/skupper/activemq-example-client --env SERVER=broker
```

Sample output:

```
$ kubectl run client --attach --rm --restart Never --image quay.io/skupper/activemq-example-client --env SERVER=broker

-----
--/ __ V/// _ | / _ V//_/// _ /
-//_///_// _ | / , _ / < / // ^ \
--\ _ \ \ _ _ // | / / | / / | \ _ _ / / /
2022-05-27 11:19:07,149 INFO [io.sma.rea.mes.amqp] (main) SRMSG16201: AMQP
broker configured to broker:5672 for channel incoming-messages
2022-05-27 11:19:07,170 INFO [io.sma.rea.mes.amqp] (main) SRMSG16201: AMQP
broker configured to broker:5672 for channel outgoing-messages
2022-05-27 11:19:07,198 INFO [io.sma.rea.mes.amqp] (main) SRMSG16212:
Establishing connection with AMQP broker
2022-05-27 11:19:07,212 INFO [io.sma.rea.mes.amqp] (main) SRMSG16212:
Establishing connection with AMQP broker
2022-05-27 11:19:07,215 INFO [io.quarkus] (main) client 1.0.0-SNAPSHOT on JVM
(powerd by Quarkus 2.9.2.Final) started in 0.397s.
2022-05-27 11:19:07,215 INFO [io.quarkus] (main) Profile prod activated.
2022-05-27 11:19:07,215 INFO [io.quarkus] (main) Installed features: [cdi, smallrye-
context-propagation, smallrye-reactive-messaging, smallrye-reactive-messaging-amqp,
vertx]
Sent message 1
Sent message 2
Sent message 3
Sent message 4
Sent message 5
Sent message 6
Sent message 7
Sent message 8
Sent message 9
Sent message 10
2022-05-27 11:19:07,434 INFO [io.sma.rea.mes.amqp] (vert.x-eventloop-thread-0)
SRMSG16213: Connection with AMQP broker established
2022-05-27 11:19:07,442 INFO [io.sma.rea.mes.amqp] (vert.x-eventloop-thread-0)
SRMSG16213: Connection with AMQP broker established
2022-05-27 11:19:07,468 INFO [io.sma.rea.mes.amqp] (vert.x-eventloop-thread-0)
SRMSG16203: AMQP Receiver listening address notifications
Received message 1
Received message 2
Received message 3
Received message 4
Received message 5
```

Received message 6  
Received message 7  
Received message 8  
Received message 9  
Received message 10  
Result: OK

## CHAPTER 4. SKUPPER CAMEL INTEGRATION EXAMPLE

Twitter, Telegram and PostgreSQL integration routes deployed across Kubernetes clusters using Skupper

This example is part of a [suite of examples](#) showing the different ways you can use Skupper to connect services across cloud providers, data centers, and edge sites.

### Overview

In this example we can see how to integrate different Camel integration routers that can be deployed across multiple Kubernetes clusters using Skupper.

The main idea of this project is to show a Camel integration deployed in a public cluster which searches tweets that contain the word 'skupper'. Those results are sent to a private cluster that has a database deployed. A third public cluster will ping the database and send new results to a Telegram channel.

In order to run this example you will need to create a Telegram channel and a Twitter Account to use its credentials.

It contains the following components:

- A Twitter Camel integration that searches in the Twitter feed for results containing the word **skupper** (public).
- A PostgreSQL Camel sink that receives the data from the Twitter Camel router and sends it to the database (public).
- A PostgreSQL database that contains the results (private).
- A Telegram Camel integration that polls the database and sends the results to a Telegram channel (public).

### Prerequisites

- The **kubectl** command-line tool, version 1.15 or later ([\[installation guide\]](#)[\[install-kubectl\]](#))
- The **skupper** command-line tool, the latest version ([\[installation guide\]](#)[\[install-skupper\]](#))
- Access to at least one Kubernetes cluster, from any provider you choose
- **Kamel** installation to deploy the Camel integrations per namespace.

```
kamel install
```

- A **Twitter Developer Account** in order to use the Twitter API (you need to add the credentials in **config.properties** file)
- Create a **Telegram Bot** and Channel to publish messages (you need to add the credentials in **config.properties** file)

### Procedure

- [Configure separate console sessions](#)
- [Access your clusters](#)

- [Set up your namespaces](#)
- [Install Skupper in your namespaces](#)
- [Check the status of your namespaces](#)
- [Link your namespaces](#)
- [Deploy and expose the database in the private cluster](#)
- [Create the table to store the tweets](#)
- [Deploy Twitter Camel Integration in the public cluster](#)
- [Deploy Telegram Camel integration in the public cluster](#)
- [Test the application](#)

1. Configure separate console sessions

Skupper is designed for use with multiple namespaces, typically on different clusters. The **skupper** command uses your [kubeconfig](#) and current context to select the namespace where it operates.

Your kubeconfig is stored in a file in your home directory. The **skupper** and **kubectl** commands use the **KUBECONFIG** environment variable to locate it.

A single kubeconfig supports only one active context per user. Since you will be using multiple contexts at once in this exercise, you need to create distinct kubeconfigs.

Start a console session for each of your namespaces. Set the **KUBECONFIG** environment variable to a different path in each session.

Console for `_private1`:

```
export KUBECONFIG=~/.kube/config-private1
```

Console for `_public1`:

```
export KUBECONFIG=~/.kube/config-public1
```

Console for `_public2`:

```
export KUBECONFIG=~/.kube/config-public2
```

2. Access your clusters

The methods for accessing your clusters vary by Kubernetes provider. Find the instructions for your chosen providers and use them to authenticate and configure access for each console session. See the following links for more information:

- [Amazon Elastic Kubernetes Service \(EKS\)](#)
- [Azure Kubernetes Service \(AKS\)](#)
- [Google Kubernetes Engine \(GKE\)](#)
- [IBM Kubernetes Service](#)

- [OpenShift](#)
  - [More providers](#)
3. Set up your namespaces  
Use **kubectl create namespace** to create the namespaces you wish to use (or use existing namespaces). Use **kubectl config set-context** to set the current namespace for each session.

Console for `_private1`:

```
kubectl create namespace private1
kubectl config set-context --current --namespace private1
```

Console for `_public1`:

```
kubectl create namespace public1
kubectl config set-context --current --namespace public1
```

Console for `_public2`:

```
kubectl create namespace public2
kubectl config set-context --current --namespace public2
```

4. Install Skupper in your namespaces  
The **skupper init** command installs the Skupper router and service controller in the current namespace. Run the **skupper init** command in each namespace.

Console for `_private1`:

```
skupper init
```

Console for `_public1`:

```
skupper init
```

Console for `_public2`:

```
skupper init
```

5. Check the status of your namespaces  
Use **skupper status** in each console to check that Skupper is installed.

Console for `_private1`:

```
skupper status
```

Console for `_public1`:

```
skupper status
```

Console for `_public2`:

-

```
skupper status
```

You should see output like this for each namespace:

```
Skupper is enabled for namespace "<namespace>" in interior mode. It is not connected
to any other sites. It has no exposed services.
The site console url is: http://<address>:8080
The credentials for internal console-auth mode are held in secret: 'skupper-console-
users'
```

As you move through the steps below, you can use **skupper status** at any time to check your progress.

## 6. Link your namespaces

Creating a link requires use of two **skupper** commands in conjunction, **skupper token create** and **skupper link create**.

The **skupper token create** command generates a secret token that signifies permission to create a link. The token also carries the link details. Then, in a remote namespace, The **skupper link create** command uses the token to create a link to the namespace that generated it.



### NOTE

The link token is truly a `_secret`. Anyone who has the token can link to your namespace. Make sure that only those you trust have access to it.

First, use **skupper token create** in one namespace to generate the token. Then, use **skupper link create** in the other to create a link.

Console for `_public1`:

```
skupper token create ~/public1.token --uses 2
```

Console for `_public2`:

```
skupper link create ~/public1.token
skupper link status --wait 30
skupper token create ~/public2.token
```

Console for `_private1`:

```
skupper link create ~/public1.token
skupper link create ~/public2.token
skupper link status --wait 30
```

If your console sessions are on different machines, you may need to use **scp** or a similar tool to transfer the token.

## 7. Deploy and expose the database in the private cluster

Use **kubectl apply** to deploy the database in **private1**. Then expose the deployment.

Console for `_private1`:

```
-
```

```
kubectl create -f src/main/resources/database/postgres-svc.yaml
skupper expose deployment postgres --address postgres --port 5432 -n private1
```

8. Create the table to store the tweets  
Console for `_private1`:

```
kubectl run pg-shell -i --tty --image quay.io/skupper/simple-pg --
env="PGUSER=postgresadmin" --env="PGPASSWORD=admin123" --
env="PGHOST=$(kubectl get service postgres -o=jsonpath='{.spec.clusterIP}')" -- bash
psql --dbname=postgresdb
CREATE EXTENSION IF NOT EXISTS "uuid-ossp";
CREATE TABLE tw_feedback (id uuid DEFAULT uuid_generate_v4 (),sigthning
VARCHAR(255),created TIMESTAMP default CURRENTTIMESTAMP,PRIMARY
KEY(id));
```

9. Deploy Twitter Camel Integration in the public cluster  
First, we need to deploy the **TwitterRoute** component in Kubernetes by using `kamel`. This component will poll Twitter every 5000 ms for tweets that include the word **skupper**. Subsequently, it will send the results to the **postgresql-sink**, that should be installed in the same cluster as well. The kamelet sink will insert the results in the PostgreSQL database.

Console for `_public1`:

```
src/main/resources/scripts/setUpPublic1Cluster.sh
```

10. Deploy Telegram Camel integration in the public cluster  
In this step we will install the secret in Kubernetes that contains the database credentials, in order to be used by the **TelegramRoute** component. After that we will deploy **TelegramRoute** using `kamel` in the Kubernetes cluster. This component will poll the database every 3 seconds and gather the results inserted during the last 3 seconds.

Console for `_public2`:

```
src/main/resources/scripts/setUpPublic2Cluster.sh
```

11. Test the application  
To be able to see the whole flow at work, you need to post a tweet containing the word **skupper** and after that you will see a new message in the Telegram channel with the title **New feedback about Skupper**

Console for `_private1`:

```
kubectl attach pg-shell -c pg-shell -i -t
psql --dbname=postgresdb
SELECT * FROM twfeedback;
```

Sample output:

```
id          | sigthning | created
-----+-----+-----
95655229-747a-4787-8133-923ef0a1b2ca | Testing skupper | 2022-03-10
19:35:08.412542
```

Console for \_public1:

```
kamel logs twitter-route
```

Sample output:

```
"[1] 2022-03-10 19:35:08,397 INFO [postgresql-sink-1] (Camel (camel-1) thread #0 -  
twitter-search://skupper) Testing skupper"
```



## CHAPTER 5. ACCESSING AN FTP SERVER USING SKUPPER

Securely connect to an FTP server on a remote Kubernetes cluster

This example is part of a [suite of examples](#) showing the different ways you can use Skupper to connect services across cloud providers, data centers, and edge sites.

### Overview

This example shows you how you can use Skupper to connect an FTP client on one Kubernetes cluster to an FTP server on another.

It demonstrates use of Skupper with multi-port services such as FTP. It uses FTP in passive mode (which is more typical these days) and a [restricted port range](#) that simplifies Skupper configuration.

### Prerequisites

- The **kubect**l command-line tool, version 1.15 or later ([installation guide](#))
- Access to at least one Kubernetes cluster, from [any provider you choose](#)

### Procedure

- [Install the Skupper command-line tool](#)
- [Set up your namespaces](#)
- [Deploy the FTP server](#)
- [Create your sites](#)
- [Link your sites](#)
- [Expose the FTP server](#)
- [Run the FTP client](#)

1. Install the Skupper command-line tool

This example uses the Skupper command-line tool to deploy Skupper. You need to install the **skupper** command only once for each development environment.

See the [Installation](#) for details about installing the CLI. For configured systems, use the following command:

```
sudo dnf install skupper-cli
```

2. Set up your namespaces

Skupper is designed for use with multiple Kubernetes namespaces, usually on different clusters. The **skupper** and **kubect**l commands use your [kubeconfig](#) and current context to select the namespace where they operate.

Your kubeconfig is stored in a file in your home directory. The **skupper** and **kubect**l commands use the **KUBECONFIG** environment variable to locate it.

A single kubeconfig supports only one active context per user. Since you will be using multiple contexts at once in this exercise, you need to create distinct kubeconfigs.

For each namespace, open a new terminal window. In each terminal, set the **KUBECONFIG** environment variable to a different path and log in to your cluster. Then create the namespace you wish to use and set the namespace on your current context.



#### NOTE

The login procedure varies by provider. See the documentation for yours:

- [Amazon Elastic Kubernetes Service \(EKS\)](#)
- [Azure Kubernetes Service \(AKS\)](#)
- [Google Kubernetes Engine \(GKE\)](#)
- [IBM Kubernetes Service](#)
- [OpenShift](#)

#### Public:

```
export KUBECONFIG=~/.kube/config-public
# Enter your provider-specific login command
kubectl create namespace public
kubectl config set-context --current --namespace public
```

#### Private:

```
export KUBECONFIG=~/.kube/config-private
# Enter your provider-specific login command
kubectl create namespace private
kubectl config set-context --current --namespace private
```

### 3. Deploy the FTP server

In Private, use **kubectl apply** to deploy the FTP server.

#### Private:

```
kubectl apply -f server
```

Sample output:

```
$ kubectl apply -f server
deployment.apps/ftp-server created
```

### 4. Create your sites

A Skupper `_site` is a location where components of your application are running. Sites are linked together to form a network for your application. In Kubernetes, a site is associated with a namespace.

For each namespace, use **skupper init** to create a site. This deploys the Skupper router and controller. Then use **skupper status** to see the outcome.

#### Public:

```
skupper init
skupper status
```

Sample output:

```
$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace 'public'. Use 'skupper status' to get more
information.

$ skupper status
Skupper is enabled for namespace "public". It is not connected to any other sites. It has
no exposed services.
```

**Private:**

```
skupper init
skupper status
```

Sample output:

```
$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace 'private'. Use 'skupper status' to get more
information.

$ skupper status
Skupper is enabled for namespace "private". It is not connected to any other sites. It has
no exposed services.
```

As you move through the steps below, you can use **skupper status** at any time to check your progress.

## 5. Link your sites

A Skupper `_link` is a channel for communication between two sites. Links serve as a transport for application connections and requests.

Creating a link requires use of two **skupper** commands in conjunction, **skupper token create** and **skupper link create**.

The **skupper token create** command generates a secret token that signifies permission to create a link. The token also carries the link details. Then, in a remote site, The **skupper link create** command uses the token to create a link to the site that generated it.



### NOTE

The link token is truly a `_secret`. Anyone who has the token can link to your site. Make sure that only those you trust have access to it.

First, use **skupper token create** in site Public to generate the token. Then, use **skupper link create** in site Private to link the sites.

**Public:**

```
skupper token create ~/secret.token
```

Sample output:

```
$ skupper token create ~/secret.token
Token written to ~/secret.token
```

**Private:**

```
skupper link create ~/secret.token
```

Sample output:

```
$ skupper link create ~/secret.token
Site configured to link to https://10.105.193.154:8081/ed9c37f6-d78a-11ec-a8c7-
04421a4c5042 (name=link1)
Check the status of the link using 'skupper link status'.
```

If your terminal sessions are on different machines, you may need to use **scp** or a similar tool to transfer the token securely. By default, tokens expire after a single use or 15 minutes after creation.

## 6. Expose the FTP server

In Private, use **skupper expose** to expose the FTP server on all linked sites.

**Private:**

```
skupper expose deployment/ftp-server --port 21100 --port 21
```

Sample output:

```
$ skupper expose deployment/ftp-server --port 21100 --port 21
deployment ftp-server exposed as ftp-server
```

## 7. Run the FTP client

In Public, use **kubectl run** and the **curl** image to perform FTP put and get operations.

**Public:**

```
echo "Hello!" | kubectl run ftp-client --stdin --rm --image=docker.io/curlimages/curl --
restart=Never -- -s -T - ftp://example:example@ftp-server/greeting
kubectl run ftp-client --attach --rm --image=docker.io/curlimages/curl --restart=Never -- -
s ftp://example:example@ftp-server/greeting
```

Sample output:

```
$ echo "Hello!" | kubectl run ftp-client --stdin --rm --image=docker.io/curlimages/curl --
restart=Never -- -s -T - ftp://example:example@ftp-server/greeting
pod "ftp-client" deleted

$ kubectl run ftp-client --attach --rm --image=docker.io/curlimages/curl --restart=Never --
```

```
-s ftp://example:example@ftp-server/greeting  
Hello!  
pod "ftp-client" deleted
```

## CHAPTER 6. IPERF

Perform real-time network throughput measurements while using iPerf3

This example is part of a [suite of examples](#) showing the different ways you can use Skupper to connect services across cloud providers, data centers, and edge sites.

### Overview

This tutorial demonstrates how to perform real-time network throughput measurements across Kubernetes using the iperf3 tool. In this tutorial you:

- deploy iperf3 in three separate clusters
- run iperf3 client test instances

### Prerequisites

- The **kubectl** command-line tool, version 1.15 or later ([\[installation guide\]](#)[\[install-kubectl\]](#))
- Access to three clusters to observe performance. As an example, the three clusters might consist of:
  - A private cloud cluster running on your local machine (**private1**)
  - Two public cloud clusters running in public cloud providers (**public1** and **public2**)

### Procedure

- [Install the Skupper command-line tool](#)
- [Configure separate console sessions](#)
- [Access your clusters](#)
- [Set up your namespaces](#)
- [Install Skupper in your namespaces](#)
- [Check the status of your namespaces](#)
- [Link your namespaces](#)
- [Deploy the iperf3 servers](#)
- [Expose iperf3 from each namespace](#)
- [Run benchmark tests across the clusters](#)

1. Install the Skupper command-line tool

The **skupper** command-line tool is the entrypoint for installing and configuring Skupper. You need to install the **skupper** command only once for each development environment.

See the [Installation](#) for details about installing the CLI. For configured systems, use the following command:

```
sudo dnf install skupper-cli
```

For Windows and other installation options, see [Installing Skupper](#).

## 2. Configure separate console sessions

Skupper is designed for use with multiple namespaces, usually on different clusters. The **skupper** and **kubectl** commands use your [kubeconfig](#) and current context to select the namespace where they operate.

Your kubeconfig is stored in a file in your home directory. The **skupper** and **kubectl** commands use the **KUBECONFIG** environment variable to locate it.

A single kubeconfig supports only one active context per user. Since you will be using multiple contexts at once in this exercise, you need to create distinct kubeconfigs.

Start a console session for each of your namespaces. Set the **KUBECONFIG** environment variable to a different path in each session.

### Console for public1:

```
export KUBECONFIG=~/.kube/config-public1
```

### Console for public2:

```
export KUBECONFIG=~/.kube/config-public2
```

### Console for private1:

```
export KUBECONFIG=~/.kube/config-private1
```

## 3. Access your clusters

The procedure for accessing a Kubernetes cluster varies by provider. [Find the instructions for your chosen provider](#) and use them to authenticate and configure access for each console session.

## 4. Set up your namespaces

Use **kubectl create namespace** to create the namespaces you wish to use (or use existing namespaces). Use **kubectl config set-context** to set the current namespace for each session.

### Console for public1:

```
kubectl create namespace public1
kubectl config set-context --current --namespace public1
```

### Console for public2:

```
kubectl create namespace public2
kubectl config set-context --current --namespace public2
```

### Console for private1:

```
kubectl create namespace private1
kubectl config set-context --current --namespace private1
```

## 5. Install Skupper in your namespaces

The **skupper init** command installs the Skupper router and controller in the current namespace. Run the **skupper init** command in each namespace.

**Console for public1:**

```
skupper init --enable-console --enable-flow-collector
```

**Console for public2:**

```
skupper init
```

**Console for private1:**

```
skupper init
```

Sample output:

```
$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace '<namespace>'. Use 'skupper status' to get more
information.
```

6. Check the status of your namespaces  
Use **skupper status** in each console to check that Skupper is installed.

**Console for public1:**

```
skupper status
```

**Console for public2:**

```
skupper status
```

**Console for private1:**

```
skupper status
```

Sample output:

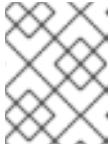
```
Skupper is enabled for namespace "<namespace>" in interior mode. It is connected to 1
other site. It has 1 exposed service.
The site console url is: <console-url>
The credentials for internal console-auth mode are held in secret: 'skupper-console-
users'
```

As you move through the steps below, you can use **skupper status** at any time to check your progress.

7. Link your namespaces  
Creating a link requires use of two **skupper** commands in conjunction, **skupper token create** and **skupper link create**.



The **skupper token create** command generates a secret token that signifies permission to create a link. The token also carries the link details. Then, in a remote namespace, The **skupper link create** command uses the token to create a link to the namespace that generated it.



#### NOTE

The link token is truly a `_secret`. Anyone who has the token can link to your namespace. Make sure that only those you trust have access to it.

First, use **skupper token create** in one namespace to generate the token. Then, use **skupper link create** in the other to create a link.

#### Console for public1:

```
skupper token create ~/private1-to-public1-token.yaml
skupper token create ~/public2-to-public1-token.yaml
```

#### Console for public2:

```
skupper token create ~/private1-to-public2-token.yaml
skupper link create ~/public2-to-public1-token.yaml
skupper link status --wait 60
```

#### Console for private1:

```
skupper link create ~/private1-to-public1-token.yaml
skupper link create ~/private1-to-public2-token.yaml
skupper link status --wait 60
```

If your console sessions are on different machines, you may need to use **scp** or a similar tool to transfer the token securely. By default, tokens expire after a single use or 15 minutes after creation.

8. Deploy the iperf3 servers  
After creating the application router network, deploy **iperf3** in each namespace.

#### Console for private1:

```
kubectl apply -f deployment-iperf3-a.yaml
```

#### Console for public1:

```
kubectl apply -f deployment-iperf3-b.yaml
```

#### Console for public2:

```
kubectl apply -f deployment-iperf3-c.yaml
```

9. Expose iperf3 from each namespace  
We have established connectivity between the namespaces and deployed **iperf3**. Before we can test performance, we need access to the **iperf3** from each namespace.

**Console for private1:**

```
skupper expose deployment/iperf3-server-a --port 5201
```

**Console for public1:**

```
skupper expose deployment/iperf3-server-b --port 5201
```

**Console for public2:**

```
skupper expose deployment/iperf3-server-c --port 5201
```

## 10. Run benchmark tests across the clusters

After deploying the iperf3 servers into the private and public cloud clusters, the virtual application network enables communications even though they are running in separate clusters.

**Console for private1:**

```
kubectl exec $(kubectl get pod -l application=iperf3-server-a -
o=jsonpath='{.items[0].metadata.name}') -- iperf3 -c iperf3-server-a
kubectl exec $(kubectl get pod -l application=iperf3-server-a -
o=jsonpath='{.items[0].metadata.name}') -- iperf3 -c iperf3-server-b
kubectl exec $(kubectl get pod -l application=iperf3-server-a -
o=jsonpath='{.items[0].metadata.name}') -- iperf3 -c iperf3-server-c
```

**Console for public1:**

```
kubectl exec $(kubectl get pod -l application=iperf3-server-b -
o=jsonpath='{.items[0].metadata.name}') -- iperf3 -c iperf3-server-a
kubectl exec $(kubectl get pod -l application=iperf3-server-b -
o=jsonpath='{.items[0].metadata.name}') -- iperf3 -c iperf3-server-b
kubectl exec $(kubectl get pod -l application=iperf3-server-b -
o=jsonpath='{.items[0].metadata.name}') -- iperf3 -c iperf3-server-c
```

**Console for public2:**

```
kubectl exec $(kubectl get pod -l application=iperf3-server-c -
o=jsonpath='{.items[0].metadata.name}') -- iperf3 -c iperf3-server-a
kubectl exec $(kubectl get pod -l application=iperf3-server-c -
o=jsonpath='{.items[0].metadata.name}') -- iperf3 -c iperf3-server-b
kubectl exec $(kubectl get pod -l application=iperf3-server-c -
o=jsonpath='{.items[0].metadata.name}') -- iperf3 -c iperf3-server-c
```

## CHAPTER 7. ACCESSING KAFKA USING SKUPPER

Use public cloud resources to process data from a private Kafka cluster

This example is part of a [suite of examples](#) showing the different ways you can use Skupper to connect services across cloud providers, data centers, and edge sites.

### Overview

This example is a simple Kafka application that shows how you can use Skupper to access a Kafka cluster at a remote site without exposing it to the public internet.

It contains two services:

- A Kafka cluster named "cluster1" running in a private data center. The cluster has a topic named "topic1".
- A Kafka client running in the public cloud. It sends 10 messages to "topic1" and then receives them back.

To set up the Kafka cluster, this example uses the Kubernetes operator from the [Strimzi](#) project. The Kafka client is a Java application built using [Quarkus](#).

The example uses two Kubernetes namespaces, "private" and "public", to represent the private data center and public cloud.

Prerequisites

- The **kubect**l command-line tool, version 1.15 or later ([installation guide](#))
- Access to at least one Kubernetes cluster, from [any provider you choose](#)

### Procedure

- [Install the Skupper command-line tool](#)
- [Set up your namespaces](#)
- [Deploy the Kafka cluster](#)
- [Create your sites](#)
- [Link your sites](#)
- [Expose the Kafka cluster](#)
- [Run the client](#)

1. Install the Skupper command-line tool

This example uses the Skupper command-line tool to deploy Skupper. You need to install the **skupper** command only once for each development environment.

See the [Installation](#) for details about installing the CLI. For configured systems, use the following command:

```
sudo dnf install skupper-cli
```

## 2. Set up your namespaces

Skupper is designed for use with multiple Kubernetes namespaces, usually on different clusters. The **skupper** and **kubectl** commands use your [kubeconfig](#) and current context to select the namespace where they operate.

Your kubeconfig is stored in a file in your home directory. The **skupper** and **kubectl** commands use the **KUBECONFIG** environment variable to locate it.

A single kubeconfig supports only one active context per user. Since you will be using multiple contexts at once in this exercise, you need to create distinct kubeconfigs.

For each namespace, open a new terminal window. In each terminal, set the **KUBECONFIG** environment variable to a different path and log in to your cluster. Then create the namespace you wish to use and set the namespace on your current context.



### NOTE

The login procedure varies by provider. See the documentation for yours:

- [Amazon Elastic Kubernetes Service \(EKS\)](#)
- [Azure Kubernetes Service \(AKS\)](#)
- [Google Kubernetes Engine \(GKE\)](#)
- [IBM Kubernetes Service](#)
- [OpenShift](#)

#### Public:

```
export KUBECONFIG=~/.kube/config-public
# Enter your provider-specific login command
kubectl create namespace public
kubectl config set-context --current --namespace public
```

#### Private:

```
export KUBECONFIG=~/.kube/config-private
# Enter your provider-specific login command
kubectl create namespace private
kubectl config set-context --current --namespace private
```

## 3. Deploy the Kafka cluster

In Private, use the **kubectl create** and **kubectl apply** commands with the listed YAML files to install the operator and deploy the cluster and topic.

#### Private:

```
kubectl create -f server/strimzi.yaml
kubectl apply -f server/cluster1.yaml
kubectl wait --for condition=ready --timeout 900s kafka/cluster1
```

Sample output:

```

$ kubectl create -f server/strimzi.yaml
customresourcedefinition.apiextensions.k8s.io/kafkas.kafka.strimzi.io created
rolebinding.rbac.authorization.k8s.io/strimzi-cluster-operator-entity-operator-delegation
created
clusterrolebinding.rbac.authorization.k8s.io/strimzi-cluster-operator created
rolebinding.rbac.authorization.k8s.io/strimzi-cluster-operator-topic-operator-delegation
created
customresourcedefinition.apiextensions.k8s.io/kafkausers.kafka.strimzi.io created
customresourcedefinition.apiextensions.k8s.io/kafkarebalances.kafka.strimzi.io created
deployment.apps/strimzi-cluster-operator created
customresourcedefinition.apiextensions.k8s.io/kafkamirrmaker2s.kafka.strimzi.io
created
clusterrole.rbac.authorization.k8s.io/strimzi-entity-operator created
clusterrole.rbac.authorization.k8s.io/strimzi-cluster-operator-global created
clusterrolebinding.rbac.authorization.k8s.io/strimzi-cluster-operator-kafka-broker-
delegation created
rolebinding.rbac.authorization.k8s.io/strimzi-cluster-operator created
clusterrole.rbac.authorization.k8s.io/strimzi-cluster-operator-namespaced created
clusterrole.rbac.authorization.k8s.io/strimzi-topic-operator created
clusterrolebinding.rbac.authorization.k8s.io/strimzi-cluster-operator-kafka-client-
delegation created
clusterrole.rbac.authorization.k8s.io/strimzi-kafka-client created
serviceaccount/strimzi-cluster-operator created
clusterrole.rbac.authorization.k8s.io/strimzi-kafka-broker created
customresourcedefinition.apiextensions.k8s.io/kafkatopics.kafka.strimzi.io created
customresourcedefinition.apiextensions.k8s.io/kafkabridges.kafka.strimzi.io created
customresourcedefinition.apiextensions.k8s.io/kafkaconnectors.kafka.strimzi.io created
customresourcedefinition.apiextensions.k8s.io/kafkaconnects2is.kafka.strimzi.io created
customresourcedefinition.apiextensions.k8s.io/kafkaconnects.kafka.strimzi.io created
customresourcedefinition.apiextensions.k8s.io/kafkamirrmakers.kafka.strimzi.io
created
configmap/strimzi-cluster-operator created

$ kubectl apply -f server/cluster1.yaml
kafka.kafka.strimzi.io/cluster1 created
kafkatopic.kafka.strimzi.io/topic1 created

$ kubectl wait --for condition=ready --timeout 900s kafka/cluster1
kafka.kafka.strimzi.io/cluster1 condition met

```

**NOTE:**

By default, the Kafka bootstrap server returns broker addresses that include the Kubernetes namespace in their domain name. When, as in this example, the Kafka client is running in a namespace with a different name from that of the Kafka cluster, this prevents the client from resolving the Kafka brokers.

To make the Kafka brokers reachable, set the **advertisedHost** property of each broker to a domain name that the Kafka client can resolve at the remote site. In this example, this is achieved with the following listener configuration:

```

spec:
  kafka:
    listeners:
      - name: plain
        port: 9092

```

```

type: internal
tls: false
configuration:
  brokers:
    - broker: 0
      advertisedHost: cluster1-kafka-0.cluster1-kafka-brokers

```

See [Advertised addresses for brokers](#) for more information.

#### 4. Create your sites

A Skupper `_site` is a location where components of your application are running. Sites are linked together to form a network for your application. In Kubernetes, a site is associated with a namespace.

For each namespace, use **skupper init** to create a site. This deploys the Skupper router and controller. Then use **skupper status** to see the outcome.

##### Public:

```

skupper init
skupper status

```

Sample output:

```

$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace 'public'. Use 'skupper status' to get more
information.

$ skupper status
Skupper is enabled for namespace "public". It is not connected to any other sites. It has
no exposed services.

```

##### Private:

```

skupper init
skupper status

```

Sample output:

```

$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace 'private'. Use 'skupper status' to get more
information.

$ skupper status
Skupper is enabled for namespace "private". It is not connected to any other sites. It has
no exposed services.

```

As you move through the steps below, you can use **skupper status** at any time to check your progress.

#### 5. Link your sites

A Skupper `_link` is a channel for communication between two sites. Links serve as a transport for application connections and requests.

Creating a link requires use of two **skupper** commands in conjunction, **skupper token create** and **skupper link create**.

The **skupper token create** command generates a secret token that signifies permission to create a link. The token also carries the link details. Then, in a remote site, The **skupper link create** command uses the token to create a link to the site that generated it.



#### NOTE

The link token is truly a `_secret`. Anyone who has the token can link to your site. Make sure that only those you trust have access to it.

First, use **skupper token create** in site Public to generate the token. Then, use **skupper link create** in site Private to link the sites.

#### Public:

```
skupper token create ~/secret.token
```

Sample output:

```
$ skupper token create ~/secret.token
Token written to ~/secret.token
```

#### Private:

```
skupper link create ~/secret.token
```

Sample output:

```
$ skupper link create ~/secret.token
Site configured to link to https://10.105.193.154:8081/ed9c37f6-d78a-11ec-a8c7-
04421a4c5042 (name=link1)
Check the status of the link using 'skupper link status'.
```

If your terminal sessions are on different machines, you may need to use **scp** or a similar tool to transfer the token securely. By default, tokens expire after a single use or 15 minutes after creation.

#### 6. Expose the Kafka cluster

In Private, use **skupper expose** with the **--headless** option to expose the Kafka cluster as a headless service on the Skupper network.

Then, in Public, use the **kubectl get service** command to check that the **cluster1-kafka-brokers** service appears after a moment.

#### Private:

```
skupper expose statefulset/cluster1-kafka --headless --port 9092
```

Sample output:

```
$ skupper expose statefulset/cluster1-kafka --headless --port 9092
statefulset cluster1-kafka exposed as cluster1-kafka-brokers
```

**Public:**

```
kubectl get service/cluster1-kafka-brokers
```

Sample output:

```
$ kubectl get service/cluster1-kafka-brokers
NAME                TYPE        CLUSTER-IP   EXTERNAL-IP   PORT(S)    AGE
cluster1-kafka-brokers ClusterIP   None         <none>        9092/TCP   2s
```

#### 7. Run the client

Use the **kubectl run** command to execute the client program in Public.

**Public:**

```
kubectl run client --attach --rm --restart Never --image quay.io/skupper/kafka-example-
client --env BOOTSTRAPSERVERS=cluster1-kafka-brokers:9092
```

Sample output:

```
$ kubectl run client --attach --rm --restart Never --image quay.io/skupper/kafka-example-
client --env BOOTSTRAPSERVERS=cluster1-kafka-brokers:9092
[...]
Received message 1
Received message 2
Received message 3
Received message 4
Received message 5
Received message 6
Received message 7
Received message 8
Received message 9
Received message 10
Result: OK
[...]
```

To see the client code, look in the [client directory](#) of this project.



## CHAPTER 8. PATIENT PORTAL

A simple database-backed web application that runs in the public cloud but keeps its data in a private database

This example is part of a [suite of examples](#) showing the different ways you can use Skupper to connect services across cloud providers, data centers, and edge sites.

### Overview

This example is a simple database-backed web application that shows how you can use Skupper to access a database at a remote site without exposing it to the public internet.

It contains three services:

- A PostgreSQL database running on a bare-metal or virtual machine in a private data center.
- A payment-processing service running on Kubernetes in a private data center.
- A web frontend service running on Kubernetes in the public cloud. It uses the PostgreSQL database and the payment-processing service.

The example uses two Kubernetes namespaces, **private** and **public**, to represent the Kubernetes cluster in the private data center and the cluster in the public cloud. It uses Podman to run the database.

### Prerequisites

- The **kubect**l command-line tool, version 1.15 or later ([installation guide](#))
- Access to at least one Kubernetes cluster, from [any provider you choose](#)

### Procedure

- [Install the Skupper command-line tool](#)
- [Set up your Kubernetes namespaces](#)
- [Set up your Podman network](#)
- [Deploy the application](#)
- [Create your sites](#)
- [Link your sites](#)
- [Expose application services](#)
- [Access the frontend](#)

1. Install the Skupper command-line tool

This example uses the Skupper command-line tool to deploy Skupper. You need to install the **skupper** command only once for each development environment.

See the [Installation](#) for details about installing the CLI. For configured systems, use the following command:

```
sudo dnf install skupper-cli
```

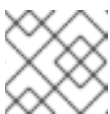
## 2. Set up your Kubernetes namespaces

Skupper is designed for use with multiple Kubernetes namespaces, usually on different clusters. The **skupper** and **kubectl** commands use your [kubeconfig](#) and current context to select the namespace where they operate.

Your kubeconfig is stored in a file in your home directory. The **skupper** and **kubectl** commands use the **KUBECONFIG** environment variable to locate it.

A single kubeconfig supports only one active context per user. Since you will be using multiple contexts at once in this exercise, you need to create distinct kubeconfigs.

For each namespace, open a new terminal window. In each terminal, set the **KUBECONFIG** environment variable to a different path and log in to your cluster. Then create the namespace you wish to use and set the namespace on your current context.



### NOTE

The login procedure varies by provider. See the documentation for yours:

- [Amazon Elastic Kubernetes Service \(EKS\)](#)
- [Azure Kubernetes Service \(AKS\)](#)
- [Google Kubernetes Engine \(GKE\)](#)
- [IBM Kubernetes Service](#)
- [OpenShift](#)

#### Public:

```
export KUBECONFIG=~/.kube/config-public
# Enter your provider-specific login command
kubectl create namespace public
kubectl config set-context --current --namespace public
```

#### Private:

```
export KUBECONFIG=~/.kube/config-private
# Enter your provider-specific login command
kubectl create namespace private
kubectl config set-context --current --namespace private
```

## 3. Set up your Podman network

Open a new terminal window and set the **SKUPPERPLATFORM** environment variable to **podman**. This sets the Skupper platform to Podman for this terminal session.

Use **podman network create** to create the Podman network that Skupper will use.

Use **systemctl** to enable the Podman API service.

#### Podman:

```
export SKUPPERPLATFORM=podman
podman network create skupper
systemctl --user enable --now podman.socket
```

If the **systemctl** command doesn't work, you can try the **podman system service** command instead:

```
podman system service --time=0 unix://$XDG_RUNTIME_DIR/podman/podman.sock &
```

#### 4. Deploy the application

Use **kubectl apply** to deploy the frontend and payment processor on Kubernetes. Use **podman run** to start the database on your local machine.



#### NOTE

It is important to name your running container using **--name** to avoid a collision with the container that Skupper creates for accessing the service.



#### NOTE

You must use **--network skupper** with the **podman run** command.

#### Public:

```
kubectl apply -f frontend/kubernetes.yaml
```

#### Private:

```
kubectl apply -f payment-processor/kubernetes.yaml
```

#### Podman:

```
podman run --name database-target --network skupper --detach --rm -p 5432:5432
quay.io/skupper/patient-portal-database
```

#### 5. Create your sites

##### Public:

```
skupper init
```

##### Private:

```
skupper init --ingress none
```

##### Podman:

```
skupper init --ingress none
```

#### 6. Link your sites

Creating a link requires use of two **skupper** commands in conjunction, **skupper token create** and **skupper link create**.

The **skupper token create** command generates a secret token that signifies permission to create a link. The token also carries the link details. Then, in a remote site, The **skupper link create** command uses the token to create a link to the site that generated it.



#### NOTE

The link token is truly a `_secret`. Anyone who has the token can link to your site. Make sure that only those you trust have access to it.

First, use **skupper token create** in site Public to generate the token. Then, use **skupper link create** in site Private to link the sites.

#### Public:

```
skupper token create --uses 2 ~/secret.token
```

#### Private:

```
skupper link create ~/secret.token
```

#### Podman:

```
skupper link create ~/secret.token
```

If your terminal sessions are on different machines, you may need to use **scp** or a similar tool to transfer the token securely. By default, tokens expire after a single use or 15 minutes after creation.

### 7. Expose application services

In Private, use **skupper expose** to expose the payment processor service.

In Podman, use **skupper service create** and **skupper service bind** to expose the database on the Skupper network.

Then, in Public, use **skupper service create** to make it available.



#### NOTE

Podman sites do not automatically replicate services to remote sites. You need to use **skupper service create** on each site where you wish to make a service available.

#### Private:

```
skupper expose deployment/payment-processor --port 8080
```

#### Podman:

```
skupper service create database 5432
skupper service bind database host database-target --target-port 5432
```

#### Public:

■

skupper service create database 5432

## 8. Access the frontend

In order to use and test the application, we need external access to the frontend.

Use **kubectl expose** with **--type LoadBalancer** to open network access to the frontend service.

Once the frontend is exposed, use **kubectl get service/frontend** to look up the external IP of the frontend service. If the external IP is **<pending>**, try again after a moment.

Once you have the external IP, use **curl** or a similar tool to request the **/api/health** endpoint at that address.



### NOTE

The **<external-ip>** field in the following commands is a placeholder. The actual value is an IP address.

### Public:

```
kubectl expose deployment/frontend --port 8080 --type LoadBalancer
kubectl get service/frontend
curl http://<external-ip>:8080/api/health
```

Sample output:

```
$ kubectl expose deployment/frontend --port 8080 --type LoadBalancer
service/frontend exposed

$ kubectl get service/frontend
NAME      TYPE          CLUSTER-IP   EXTERNAL-IP   PORT(S)          AGE
frontend  LoadBalancer 10.103.232.28 <external-ip> 8080:30407/TCP 15s

$ curl http://<external-ip>:8080/api/health
OK
```

If everything is in order, you can now access the web interface by navigating to <http://<external-ip>:8080/> in your browser.

## CHAPTER 9. TRADE ZOO

A simple trading application that runs in the public cloud but keeps its data in a private Kafka cluster

This example is part of a [suite of examples](#) showing the different ways you can use Skupper to connect services across cloud providers, data centers, and edge sites.

### Overview

This example is a simple Kafka application that shows how you can use Skupper to access a Kafka cluster at a remote site without exposing it to the public internet.

It contains four services:

- A Kafka cluster running in a private data center. The cluster has two topics, "orders" and "updates".
- An order processor running in the public cloud. It consumes from "orders", matching buy and sell offers to make trades. It publishes new and updated orders and trades to "updates".
- A market data service running in the public cloud. It looks at the completed trades and computes the latest and average prices, which it then publishes to "updates".
- A web frontend service running in the public cloud. It submits buy and sell orders to "orders" and consumes from "updates" in order to show what's happening.

To set up the Kafka cluster, this example uses the Kubernetes operator from the [Strimzi](#) project. The other services are small Python programs.

The example uses two Kubernetes namespaces, "private" and "public", to represent the private data center and public cloud.

### Prerequisites

- The **kubectl** command-line tool, version 1.15 or later ([installation guide](#))
- Access to at least one Kubernetes cluster, from [any provider you choose](#)

### Procedure

- [Install the Skupper command-line tool](#)
- [Set up your namespaces](#)
- [Deploy the Kafka cluster](#)
- [Deploy the application services](#)
- [Create your sites](#)
- [Link your sites](#)
- [Expose the Kafka cluster](#)
- [Access the frontend](#)

1. Install the Skupper command-line tool

This example uses the Skupper command-line tool to deploy Skupper. You need to install the **skupper** command only once for each development environment.

See the [Installation](#) for details about installing the CLI. For configured systems, use the following command:

```
sudo dnf install skupper-cli
```

## 2. Set up your namespaces

Skupper is designed for use with multiple Kubernetes namespaces, usually on different clusters. The **skupper** and **kubectl** commands use your [kubeconfig](#) and current context to select the namespace where they operate.

Your kubeconfig is stored in a file in your home directory. The **skupper** and **kubectl** commands use the **KUBECONFIG** environment variable to locate it.

A single kubeconfig supports only one active context per user. Since you will be using multiple contexts at once in this exercise, you need to create distinct kubeconfigs.

For each namespace, open a new terminal window. In each terminal, set the **KUBECONFIG** environment variable to a different path and log in to your cluster. Then create the namespace you wish to use and set the namespace on your current context.



### NOTE

The login procedure varies by provider. See the documentation for yours:

- [Amazon Elastic Kubernetes Service \(EKS\)](#)
- [Azure Kubernetes Service \(AKS\)](#)
- [Google Kubernetes Engine \(GKE\)](#)
- [IBM Kubernetes Service](#)
- [OpenShift](#)

#### Public:

```
export KUBECONFIG=~/.kube/config-public
# Enter your provider-specific login command
kubectl create namespace public
kubectl config set-context --current --namespace public
```

#### Private:

```
export KUBECONFIG=~/.kube/config-private
# Enter your provider-specific login command
kubectl create namespace private
kubectl config set-context --current --namespace private
```

## 3. Deploy the Kafka cluster

In Private, use the **kubectl create** and **kubectl apply** commands with the listed YAML files to install the operator and deploy the cluster and topic.

**Private:**

```
kubectl create -f kafka-cluster/strimzi.yaml
kubectl apply -f kafka-cluster/cluster1.yaml
kubectl wait --for condition=ready --timeout 900s kafka/cluster1
```

## NOTE:

By default, the Kafka bootstrap server returns broker addresses that include the Kubernetes namespace in their domain name. When, as in this example, the Kafka client is running in a namespace with a different name from that of the Kafka cluster, this prevents the client from resolving the Kafka brokers.

To make the Kafka brokers reachable, set the **advertisedHost** property of each broker to a domain name that the Kafka client can resolve at the remote site. In this example, this is achieved with the following listener configuration:

```
spec:
  kafka:
    listeners:
      - name: plain
        port: 9092
        type: internal
        tls: false
        configuration:
          brokers:
            - broker: 0
              advertisedHost: cluster1-kafka-0.cluster1-kafka-brokers
```

See [Advertised addresses for brokers](#) for more information.

## 4. Deploy the application services

In Public, use the **kubectl apply** command with the listed YAML files to install the application services.

**Public:**

```
kubectl apply -f order-processor/kubernetes.yaml
kubectl apply -f market-data/kubernetes.yaml
kubectl apply -f frontend/kubernetes.yaml
```

## 5. Create your sites

A Skupper `_site` is a location where components of your application are running. Sites are linked together to form a network for your application. In Kubernetes, a site is associated with a namespace.

For each namespace, use **skupper init** to create a site. This deploys the Skupper router and controller. Then use **skupper status** to see the outcome.

**Public:**

```
skupper init
skupper status
```

Sample output:



```
$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace 'public'. Use 'skupper status' to get more
information.

$ skupper status
Skupper is enabled for namespace "public". It is not connected to any other sites. It has
no exposed services.
```

**Private:**

```
skupper init
skupper status
```

Sample output:

```
$ skupper init
Waiting for LoadBalancer IP or hostname...
Waiting for status...
Skupper is now installed in namespace 'private'. Use 'skupper status' to get more
information.

$ skupper status
Skupper is enabled for namespace "private". It is not connected to any other sites. It has
no exposed services.
```

As you move through the steps below, you can use **skupper status** at any time to check your progress.

## 6. Link your sites

A Skupper `_link` is a channel for communication between two sites. Links serve as a transport for application connections and requests.

Creating a link requires use of two **skupper** commands in conjunction, **skupper token create** and **skupper link create**.

The **skupper token create** command generates a secret token that signifies permission to create a link. The token also carries the link details. Then, in a remote site, The **skupper link create** command uses the token to create a link to the site that generated it.

**NOTE**

The link token is truly a `_secret`. Anyone who has the token can link to your site. Make sure that only those you trust have access to it.

First, use **skupper token create** in site Public to generate the token. Then, use **skupper link create** in site Private to link the sites.

**Public:**

```
skupper token create ~/secret.token
```

Sample output:

```
$ skupper token create ~/secret.token
Token written to ~/secret.token
```

**Private:**

```
skupper link create ~/secret.token
```

Sample output:

```
$ skupper link create ~/secret.token
Site configured to link to https://10.105.193.154:8081/ed9c37f6-d78a-11ec-a8c7-
04421a4c5042 (name=link1)
Check the status of the link using 'skupper link status'.
```

If your terminal sessions are on different machines, you may need to use **scp** or a similar tool to transfer the token securely. By default, tokens expire after a single use or 15 minutes after creation.

## 7. Expose the Kafka cluster

In Private, use **skupper expose** with the **--headless** option to expose the Kafka cluster as a headless service on the Skupper network.

Then, in Public, use **kubectl get service** to check that the **cluster1-kafka-brokers** service appears after a moment.

**Private:**

```
skupper expose statefulset/cluster1-kafka --headless --port 9092
```

**Public:**

```
kubectl get service/cluster1-kafka-brokers
```

## 8. Access the frontend

In order to use and test the application, we need external access to the frontend.

Use **kubectl expose** with **--type LoadBalancer** to open network access to the frontend service.

Once the frontend is exposed, use **kubectl get service/frontend** to look up the external IP of the frontend service. If the external IP is **<pending>**, try again after a moment.

Once you have the external IP, use **curl** or a similar tool to request the **/api/health** endpoint at that address.

**NOTE**

The **<external-ip>** field in the following commands is a placeholder. The actual value is an IP address.

**Public:**

```
kubectl expose deployment/frontend --port 8080 --type LoadBalancer
kubectl get service/frontend
curl http://<external-ip>:8080/api/health
```

Sample output:

```
$ kubectl expose deployment/frontend --port 8080 --type LoadBalancer
service/frontend exposed

$ kubectl get service/frontend
NAME      TYPE          CLUSTER-IP   EXTERNAL-IP   PORT(S)          AGE
frontend  LoadBalancer 10.103.232.28 <external-ip> 8080:30407/TCP 15s

$ curl http://<external-ip>:8080/api/health
OK
```

If everything is in order, you can now access the web interface by navigating to <http://<external-ip>:8080/> in your browser.