Red Hat

OpenShift Container Platform 4.9

Building applications

Creating and managing applications on OpenShift Container Platform

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Legal Notice

Abstract

This document provides instructions for the various ways to create and manage instances of user-provisioned applications running on OpenShift Container Platform. This includes working with projects and provisioning applications using the Open Service Broker API.

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CHAPTER 1. PROJECTS

1.1. WORKING WITH PROJECTS

A *project* allows a community of users to organize and manage their content in isolation from other communities.

NOTE

Projects starting with **openshift-** and **kube-** are default projects. These projects host cluster components that run as pods and other infrastructure components. As such, OpenShift Container Platform does not allow you to create projects starting with **openshift-** or **kube-** using the **oc new-project** command. Cluster administrators can create these projects using the **oc adm new-project** command.

NOTE

You cannot assign an SCC to pods created in one of the default namespaces: **default**, **kube-system**, **kube-public**, **openshift-node**, **openshift-infra**, and **openshift**. You cannot use these namespaces for running pods or services.

1.1.1. Creating a project using the web console

If allowed by your cluster administrator, you can create a new project.

NOTE

Projects starting with **openshift-** and **kube-** are considered critical by OpenShift Container Platform. As such, OpenShift Container Platform does not allow you to create Projects starting with **openshift-** using the web console.

NOTE

You cannot assign an SCC to pods created in one of the default namespaces: **default**, **kube-system**, **kube-public**, **openshift-node**, **openshift-infra**, and **openshift**. You cannot use these namespaces for running pods or services.

Procedure

1. Navigate to **Home** → **Projects**.
2. Click **Create Project**.
3. Enter your project details.
4. Click **Create**.

1.1.2. Creating a project using the Developer perspective in the web console

You can use the **Developer** perspective in the OpenShift Container Platform web console to create a project in your cluster.

NOTE

Projects starting with **openshift-** and **kube-** are considered critical by OpenShift Container Platform. As such, OpenShift Container Platform does not allow you to create projects starting with **openshift-** or **kube-** using the **Developer** perspective. Cluster administrators can create these projects using the **oc adm new-project** command.

NOTE

You cannot assign an SCC to pods created in one of the default namespaces: **default**, **kube-system**, **kube-public**, **openshift-node**, **openshift-infra**, and **openshift**. You cannot use these namespaces for running pods or services.

Prerequisites

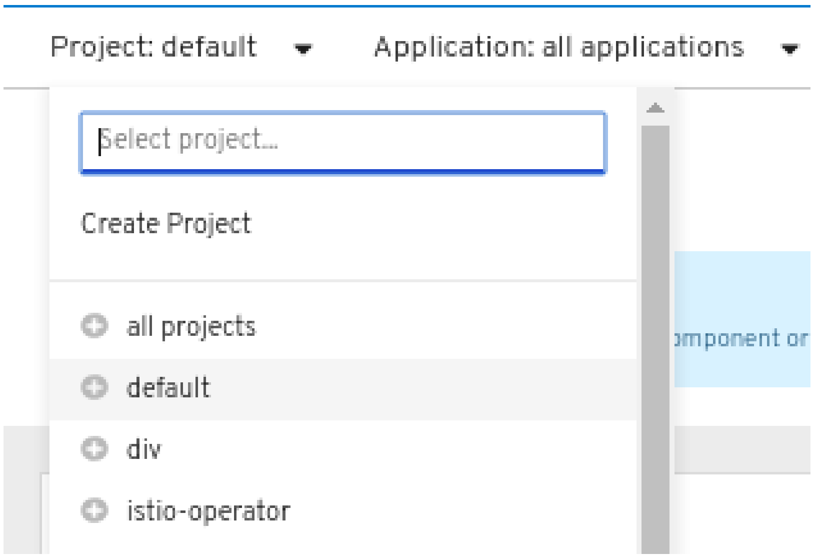
- Ensure that you have the appropriate roles and permissions to create projects, applications, and other workloads in OpenShift Container Platform.

Procedure

You can create a project using the **Developer** perspective, as follows:

1. Click the **Project** drop-down menu to see a list of all available projects. Select **Create Project**.

   Figure 1.1. Create project

2. In the **Create Project** dialog box, enter a unique name, such as **myproject**, in the **Name** field.

3. Optional: Add the **Display Name** and **Description** details for the project.

4. Click **Create**.

5. Use the left navigation panel to navigate to the **Project** view and see the dashboard for your project.

6. Optional:

   - Use the **Project** drop-down menu at the top of the screen and select **all projects** to list all of the projects in your cluster.
   - Use the **Details** tab to see the project details.

- If you have adequate permissions for a project, you can use the **Project Access** tab to provide or revoke *administrator*, *edit*, and *view* privileges for the project.

1.1.3. Creating a project using the CLI

If allowed by your cluster administrator, you can create a new project.

NOTE

Projects starting with **openshift-** and **kube-** are considered critical by OpenShift Container Platform. As such, OpenShift Container Platform does not allow you to create Projects starting with **openshift-** or **kube-** using the **oc new-project** command. Cluster administrators can create these Projects using the **oc adm new-project** command.

NOTE

You cannot assign an SCC to pods created in one of the default namespaces: **default**, **kube-system**, **kube-public**, **openshift-node**, **openshift-infra**, and **openshift**. You cannot use these namespaces for running pods or services.

Procedure

- Run:

```
$ oc new-project <project_name> \
    --description="<description>" --display-name="<display_name>"
```

For example:

```
$ oc new-project hello-openshift \
    --description="This is an example project" \
    --display-name="Hello OpenShift"
```

NOTE

The number of projects you are allowed to create might be limited by the system administrator. After your limit is reached, you might have to delete an existing project in order to create a new one.

1.1.4. Viewing a project using the web console

Procedure

1. Navigate to **Home** → **Projects**.
2. Select a project to view.
   On this page, click **Workloads** to see workloads in the project.

1.1.5. Viewing a project using the CLI

When viewing projects, you are restricted to seeing only the projects you have access to view based on the authorization policy.

Procedure

1. To view a list of projects, run:

```
$ oc get projects
```

2. You can change from the current project to a different project for CLI operations. The specified project is then used in all subsequent operations that manipulate project-scoped content:

```
$ oc project <project_name>
```

1.1.6. Providing access permissions to your project using the Developer perspective

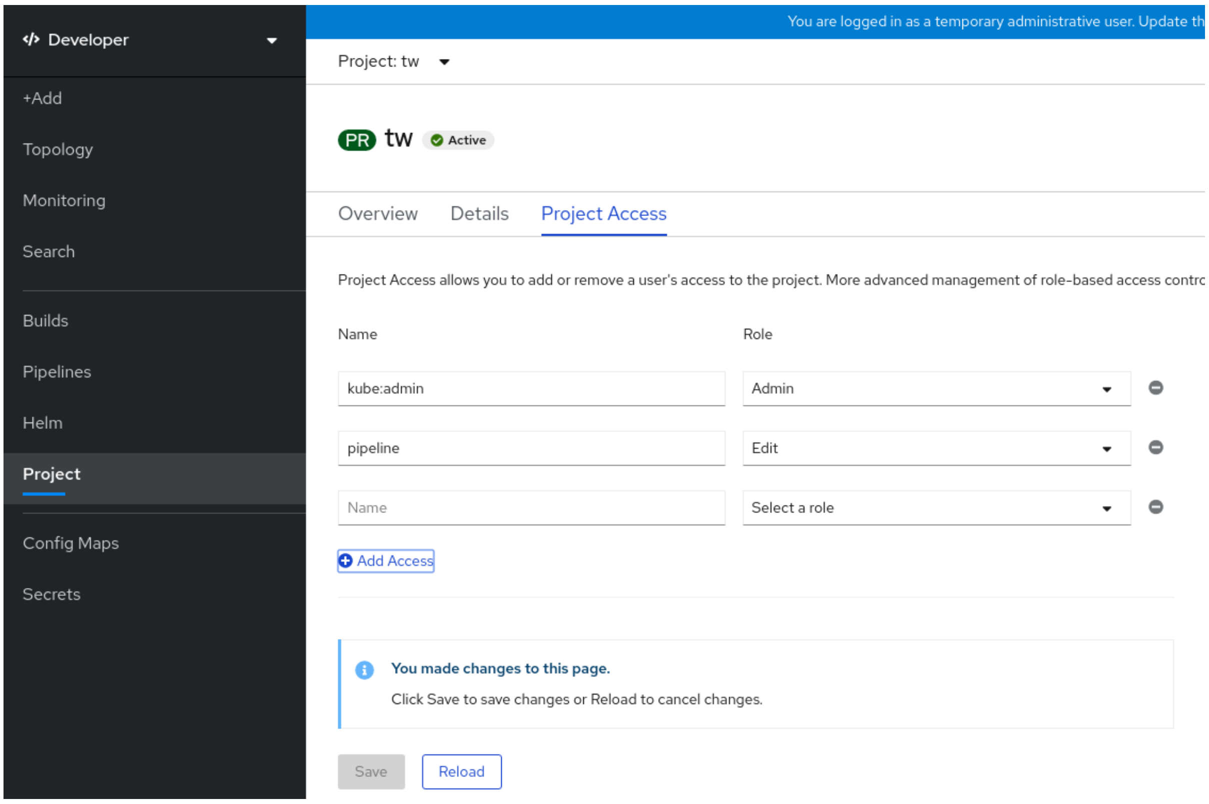
You can use the **Project** view in the **Developer** perspective to grant or revoke access permissions to your project.

Procedure

To add users to your project and provide **Admin**, **Edit**, or **View** access to them:

1. In the **Developer** perspective, navigate to the **Project** view.
2. In the **Project** page, select the **Project Access** tab.
3. Click **Add Access** to add a new row of permissions to the default ones.

Figure 1.2. Project permissions



You are logged in as a temporary administrative user. Update th

Project Access allows you to add or remove a user's access to the project. More advanced management of role-based access contro

Name	Role
kube:admin	Admin
pipeline	Edit
Name	Select a role

You made changes to this page.
Click Save to save changes or Reload to cancel changes.

4. Enter the user name, click the **Select a role** drop-down list, and select an appropriate role.
5. Click **Save** to add the new permissions.

You can also use:

- The **Select a role** drop-down list, to modify the access permissions of an existing user.
- The **Remove Access** icon, to completely remove the access permissions of an existing user to the project.

NOTE

Advanced role-based access control is managed in the **Roles** and **Roles Binding** views in the **Administrator** perspective.

1.1.7. Adding to a project

Procedure

1. Select **Developer** from the context selector at the top of the web console navigation menu.
2. Click **+Add**
3. At the top of the page, select the name of the project that you want to add to.
4. Click a method for adding to your project, and then follow the workflow.

NOTE

You can also add components to the topology using quick search.

1.1.8. Checking project status using the web console

Procedure

1. Navigate to **Home** → **Projects**.
2. Select a project to see its status.

1.1.9. Checking project status using the CLI

Procedure

1. Run:

```
$ oc status
```

This command provides a high-level overview of the current project, with its components and their relationships.

1.1.10. Deleting a project using the web console

You can delete a project by using the OpenShift Container Platform web console.

NOTE

If you do not have permissions to delete the project, the **Delete Project** option is not available.

Procedure

1. Navigate to **Home** → **Projects**.
2. Locate the project that you want to delete from the list of projects.
3. On the far right side of the project listing, select **Delete Project** from the Options menu ⋮.
4. When the **Delete Project** pane opens, enter the name of the project that you want to delete in the field.
5. Click **Delete**.

1.1.11. Deleting a project using the CLI

When you delete a project, the server updates the project status to **Terminating** from **Active**. Then, the server clears all content from a project that is in the **Terminating** state before finally removing the project. While a project is in **Terminating** status, you cannot add new content to the project. Projects can be deleted from the CLI or the web console.

Procedure

1. Run:

```
$ oc delete project <project_name>
```

1.2. CREATING A PROJECT AS ANOTHER USER

Impersonation allows you to create a project as a different user.

1.2.1. API impersonation

You can configure a request to the OpenShift Container Platform API to act as though it originated from another user. For more information, see User impersonation in the Kubernetes documentation.

1.2.2. Impersonating a user when you create a project

You can impersonate a different user when you create a project request. Because **system:authenticated:oauth** is the only bootstrap group that can create project requests, you must impersonate that group.

Procedure

- To create a project request on behalf of a different user:

```
$ oc new-project <project> --as=<user> \
    --as-group=system:authenticated --as-group=system:authenticated:oauth
```

1.3. CONFIGURING PROJECT CREATION

In OpenShift Container Platform, *projects* are used to group and isolate related objects. When a request is made to create a new project using the web console or **oc new-project** command, an endpoint in OpenShift Container Platform is used to provision the project according to a template, which can be customized.

As a cluster administrator, you can allow and configure how developers and service accounts can create, or *self-provision*, their own projects.

1.3.1. About project creation

The OpenShift Container Platform API server automatically provisions new projects based on the project template that is identified by the **projectRequestTemplate** parameter in the cluster's project configuration resource. If the parameter is not defined, the API server creates a default template that creates a project with the requested name, and assigns the requesting user to the **admin** role for that project.

When a project request is submitted, the API substitutes the following parameters into the template:

Table 1.1. Default project template parameters

Parameter	Description
PROJECT_NAME	The name of the project. Required.
PROJECT_DISPLAYNAME	The display name of the project. May be empty.
PROJECT_DESCRIPTION	The description of the project. May be empty.
PROJECT_ADMIN_USER	The user name of the administrating user.
PROJECT_REQUESTING_USER	The user name of the requesting user.

Access to the API is granted to developers with the **self-provisioner** role and the **self-provisioners** cluster role binding. This role is available to all authenticated developers by default.

1.3.2. Modifying the template for new projects

As a cluster administrator, you can modify the default project template so that new projects are created using your custom requirements.

To create your own custom project template:

Procedure

1. Log in as a user with **cluster-admin** privileges.

2. Generate the default project template:

```
$ oc adm create-bootstrap-project-template -o yaml > template.yaml
```

3. Use a text editor to modify the generated **template.yaml** file by adding objects or modifying existing objects.

4. The project template must be created in the **openshift-config** namespace. Load your modified template:

```
$ oc create -f template.yaml -n openshift-config
```

5. Edit the project configuration resource using the web console or CLI.

   - Using the web console:

     i. Navigate to the **Administration → Cluster Settings** page.

     ii. Click **Configuration** to view all configuration resources.

     iii. Find the entry for **Project** and click **Edit YAML**.

   - Using the CLI:

     i. Edit the **project.config.openshift.io/cluster** resource:

     ```
     $ oc edit project.config.openshift.io/cluster
     ```

6. Update the **spec** section to include the **projectRequestTemplate** and **name** parameters, and set the name of your uploaded project template. The default name is **project-request**.

   Project configuration resource with custom project template

   ```
   apiVersion: config.openshift.io/v1
   kind: Project
   metadata:
     ...
   spec:
     projectRequestTemplate:
       name: <template_name>
   ```

7. After you save your changes, create a new project to verify that your changes were successfully applied.

1.3.3. Disabling project self-provisioning

You can prevent an authenticated user group from self-provisioning new projects.

Procedure

1. Log in as a user with **cluster-admin** privileges.

2. View the **self-provisioners** cluster role binding usage by running the following command:

   ```
   $ oc describe clusterrolebinding.rbac self-provisioners
   ```

   Example output

```
Name:  self-provisioners
Labels:  <none>
Annotations: rbac.authorization.kubernetes.io/autoupdate=true
Role:
  Kind: ClusterRole
  Name: self-provisioner
Subjects:
  Kind Name    Namespace
  ---- ----    ---------
  Group system:authenticated:oauth
```

Review the subjects in the **self-provisioners** section.

3. Remove the **self-provisioner** cluster role from the group **system:authenticated:oauth**.

   - If the **self-provisioners** cluster role binding binds only the **self-provisioner** role to the **system:authenticated:oauth** group, run the following command:

     ```
     $ oc patch clusterrolebinding.rbac self-provisioners -p '{"subjects": null}'
     ```

   - If the **self-provisioners** cluster role binding binds the **self-provisioner** role to more users, groups, or service accounts than the **system:authenticated:oauth** group, run the following command:

     ```
     $ oc adm policy \
         remove-cluster-role-from-group self-provisioner \
         system:authenticated:oauth
     ```

4. Edit the **self-provisioners** cluster role binding to prevent automatic updates to the role. Automatic updates reset the cluster roles to the default state.

   - To update the role binding using the CLI:

     i. Run the following command:

     ```
     $ oc edit clusterrolebinding.rbac self-provisioners
     ```

     ii. In the displayed role binding, set the **rbac.authorization.kubernetes.io/autoupdate** parameter value to **false**, as shown in the following example:

     ```
     apiVersion: authorization.openshift.io/v1
     kind: ClusterRoleBinding
     metadata:
       annotations:
         rbac.authorization.kubernetes.io/autoupdate: "false"
       ...
     ```

   - To update the role binding by using a single command:

     ```
     $ oc patch clusterrolebinding.rbac self-provisioners -p '{ "metadata": { "annotations": {
     "rbac.authorization.kubernetes.io/autoupdate": "false" } } }'
     ```

5. Log in as an authenticated user and verify that it can no longer self-provision a project:

```
$ oc new-project test
```

Example output

```
Error from server (Forbidden): You may not request a new project via this API.
```

Consider customizing this project request message to provide more helpful instructions specific to your organization.

1.3.4. Customizing the project request message

When a developer or a service account that is unable to self-provision projects makes a project creation request using the web console or CLI, the following error message is returned by default:

```
You may not request a new project via this API.
```

Cluster administrators can customize this message. Consider updating it to provide further instructions on how to request a new project specific to your organization. For example:

- To request a project, contact your system administrator at **projectname@example.com**.
- To request a new project, fill out the project request form located at **https://internal.example.com/openshift-project-request**.

To customize the project request message:

Procedure

1. Edit the project configuration resource using the web console or CLI.
    - Using the web console:
        i. Navigate to the **Administration** → **Cluster Settings** page.
        ii. Click **Configuration** to view all configuration resources.
        iii. Find the entry for **Project** and click **Edit YAML**.
    - Using the CLI:
        i. Log in as a user with **cluster-admin** privileges.
        ii. Edit the **project.config.openshift.io/cluster** resource:

        ```
        $ oc edit project.config.openshift.io/cluster
        ```

2. Update the **spec** section to include the **projectRequestMessage** parameter and set the value to your custom message:

    Project configuration resource with custom project request message

    ```
    apiVersion: config.openshift.io/v1
    kind: Project
    metadata:
    ```

```
  ...
spec:
  projectRequestMessage: <message_string>
```

For example:

```
apiVersion: config.openshift.io/v1
kind: Project
metadata:
  ...
spec:
  projectRequestMessage: To request a project, contact your system administrator at
projectname@example.com.
```

3. After you save your changes, attempt to create a new project as a developer or service account that is unable to self-provision projects to verify that your changes were successfully applied.

CHAPTER 2. CREATING APPLICATIONS

2.1. CREATING APPLICATIONS USING THE DEVELOPER PERSPECTIVE

The **Developer** perspective in the web console provides you the following options from the **+Add** view to create applications and associated services and deploy them on OpenShift Container Platform:

- **Getting started resources**: Use these resources to help you get started with Developer Console. You can choose to hide the header using the **Options** menu ⋮.
  - **Creating applications using samples**: Use existing code samples to get started with creating applications on the OpenShift Container Platform.
  - **Build with guided documentation**: Follow the guided documentation to build applications and familiarize yourself with key concepts and terminologies.
  - **Explore new developer features**: Explore the new features and resources within the **Developer** perspective.
- **Developer catalog**: Explore the Developer Catalog to select the required applications, services, or source to image builders, and then add it to your project.
  - **All Services**: Browse the catalog to discover services across OpenShift Container Platform.
  - **Database**: Select the required database service and add it to your application.
  - **Operator Backed**: Select and deploy the required Operator-managed service.
  - **Helm chart**: Select the required Helm chart to simplify deployment of applications and services.
  - **Event Source**: Select an event source to register interest in a class of events from a particular system.

  NOTE

  The Managed services option is also available if the RHOAS Operator is installed.

- **Git repository**: Import an existing codebase, Devfile, or Dockerfile from your Git repository using the **From Git**, **From Devfile**, or **From Dockerfile** options respectively, to build and deploy an application on OpenShift Container Platform.
- **Container images**: Use existing images from an image stream or registry to deploy it on to the OpenShift Container Platform.
- **Pipelines**: Use Tekton pipeline to create CI/CD pipelines for your software delivery process on the OpenShift Container Platform.
- **Serverless**: Explore the **Serverless** options to create, build, and deploy stateless and serverless applications on the OpenShift Container Platform.
  - **Channel**: Create a Knative channel to create an event forwarding and persistence layer with in-memory and reliable implementations.

- **Samples**: Explore the available sample applications to create, build, and deploy an application quickly.
- **From Local Machine**: Explore the **From Local Machine** tile to import or upload files on your local machine for building and deploying applications easily.
  - **Import YAML**: Upload a YAML file to create and define resources for building and deploying applications.
  - **Upload JAR file**: Upload a JAR file to build and deploy Java applications.

Note that certain options, such as **Pipelines**, **Event Source**, and **Import Virtual Machines**, are displayed only when the OpenShift Pipelines Operator, OpenShift Serverless Operator, and OpenShift Virtualization Operator are installed, respectively.

2.1.1. Prerequisites

To create applications using the **Developer** perspective ensure that:

- You have logged in to the web console .
- You are in the **Developer** perspective.
- You have created a project or have access to a project with the appropriate roles and permissions to create applications and other workloads in OpenShift Container Platform.

To create serverless applications, in addition to the preceding prerequisites, ensure that:

- You have installed the OpenShift Serverless Operator.
- You have created a **KnativeServing** resource in the **knative-serving** namespace.

2.1.2. Creating Sample applications

You can use the basic sample applications in the **+Add** flow of the **Developer** perspective to create, build, and deploy applications quickly.

The following procedure explains the **Samples** option in the **Developer** perspective to create a sample application.

Procedure

1. In the **+Add** view, click on the **Samples** tile to see the **Samples** page.
2. On the **Samples** page, select one of the available sample applications to see the **Create Sample Application** form.
3. In the **Create Sample Application Form**
   - In the **Name** field, the deployment name is displayed by default. You can modify this name as required.
   - In the **Builder Image Version**, a builder image is selected by default. You can modify this image version by using the **Builder Image Version** drop-down list.
   - A sample Git repository URL is added by default.

4. Click **Create** to create the sample application. The build status of the sample application is displayed on the **Topology** view. After the sample application is created, you can see the deployment added to the application.

2.1.3. Importing a codebase from Git to create an application

You can use the **Developer** perspective to create, build, and deploy an application on OpenShift Container Platform using an existing codebase in GitHub.

The following procedure walks you through the **From Git** option in the **Developer** perspective to create an application.

Procedure

1. In the **+Add** view, click **From Git** in the **Git Repository** tile to see the **Import from git** form.
2. In the **Git** section, enter the Git repository URL for the codebase you want to use to create an application. For example, enter the URL of this sample Node.js application **https://github.com/sclorg/nodejs-ex**. The URL is then validated.
3. Optional: You can click **Show Advanced Git Options** to add details such as:
    - **Git Reference** to point to code in a specific branch, tag, or commit to be used to build the application.
    - **Context Dir** to specify the subdirectory for the application source code you want to use to build the application.
    - **Source Secret** to create a **Secret Name** with credentials for pulling your source code from a private repository.
4. Optional: You can import a devfile, a Dockerfile, or a builder image through your Git repository to further customize your deployment.
    - If your Git repository contains a devfile, a Dockerfile, or a builder image, it is automatically detected and populated on the respective path fields. If a devfile, a Dockerfile, and a builder image are detected in the same repository, the devfile is selected by default.
    - To edit the file import type and select a different strategy, click **Edit import strategy** option.
    - If multiple devfiles, Dockerfiles, or builder images are detected, to import a specific devfile, Dockerfile, or a builder image, specify the respective paths relative to the context directory.
5. After the Git URL is validated, the recommended builder image is selected and marked with a star. If the builder image is not auto-detected, select a builder image. For the **https://github.com/sclorg/nodejs-ex** Git URL, by default the Node.js builder image is selected.
    a. Optional: Use the **Builder Image Version** drop-down to specify a version.
    b. Optional: Use the **Edit import strategy** to select a different strategy.
6. In the **General** section:
    a. In the **Application** field, enter a unique name for the application grouping, for example, **myapp**. Ensure that the application name is unique in a namespace.

b. The **Name** field to identify the resources created for this application is automatically populated based on the Git repository URL if there are no existing applications. If there are existing applications, you can choose to deploy the component within an existing application, create a new application, or keep the component unassigned.

NOTE

The resource name must be unique in a namespace. Modify the resource name if you get an error.

7. In the **Resources** section, select:

- **Deployment**, to create an application in plain Kubernetes style.
- **Deployment Config**, to create an OpenShift Container Platform style application.
- **Serverless Deployment**, to create a Knative service.

NOTE

The **Serverless Deployment** option is displayed in the **Import from git** form only if the OpenShift Serverless Operator is installed in your cluster. For further details, refer to the OpenShift Serverless documentation.

8. In the **Pipelines** section, select **Add Pipeline**, and then click **Show Pipeline Visualization** to see the pipeline for the application.

9. In the **Advanced Options** section, the **Create a route to the application** is selected by default so that you can access your application using a publicly available URL. You can clear the check box if you do not want to expose your application on a public route.

10. Optional: You can use the following advanced options to further customize your application:

Routing

Click the **Routing** link to:

- Customize the hostname for the route.
- Specify the path the router watches.
- Select the target port for the traffic from the drop-down list.
- Secure your route by selecting the **Secure Route** check box. Select the required TLS termination type and set a policy for insecure traffic from the respective drop-down lists.
  For serverless applications, the Knative service manages all the routing options above. However, you can customize the target port for traffic, if required. If the target port is not specified, the default port of **8080** is used.

Domain mapping

If you are creating a **Serverless Deployment**, you can add a custom domain mapping to the Knative service during creation.

- In the **Advanced options** section, click **Show advanced Routing options**.

  - If the domain mapping CR that you want to map to the service already exists, you can select it from the **Domain mapping** drop-down menu.
  - If you want to create a new domain mapping CR, type the domain name into the box, and select the **Create** option. For example, if you type in **example.com**, the **Create** option is **Create "example.com"**.

Health Checks

Click the **Health Checks** link to add Readiness, Liveness, and Startup probes to your application. All the probes have prepopulated default data; you can add the probes with the default data or customize it as required.
To customize the health probes:

- Click **Add Readiness Probe**, if required, modify the parameters to check if the container is ready to handle requests, and select the check mark to add the probe.
- Click **Add Liveness Probe**, if required, modify the parameters to check if a container is still running, and select the check mark to add the probe.
- Click **Add Startup Probe**, if required, modify the parameters to check if the application within the container has started, and select the check mark to add the probe.
  For each of the probes, you can specify the request type - **HTTP GET**, **Container Command**, or **TCP Socket**, from the drop-down list. The form changes as per the selected request type. You can then modify the default values for the other parameters, such as the success and failure thresholds for the probe, number of seconds before performing the first probe after the container starts, frequency of the probe, and the timeout value.

Build Configuration and Deployment

Click the **Build Configuration** and **Deployment** links to see the respective configuration options. Some options are selected by default; you can customize them further by adding the necessary triggers and environment variables.
For serverless applications, the **Deployment** option is not displayed as the Knative configuration resource maintains the desired state for your deployment instead of a **DeploymentConfig** resource.

Scaling

Click the **Scaling** link to define the number of pods or instances of the application you want to deploy initially.
For serverless applications, you can:

- Set the upper and lower limit for the number of pods that can be set by the autoscaler. If the lower limit is not specified, it defaults to zero.
- Define the soft limit for the required number of concurrent requests per instance of the application at a given time. It is the recommended configuration for autoscaling. If not specified, it takes the value specified in the cluster configuration.
- Define the hard limit for the number of concurrent requests allowed per instance of the application at a given time. This is configured in the revision template. If not specified, it defaults to the value specified in the cluster configuration.

Resource Limit

[illegible]

Click the **Resource Limit** link to set the amount of **CPU** and **Memory** resources a container is guaranteed or allowed to use when running.

Labels

Click the **Labels** link to add custom labels to your application.

11. Click **Create** to create the application and see its build status in the **Topology** view.

2.1.4. Upload JAR files for easy deployment of Java applications

You can use the JAR files in the **Topology** view of the **Developer** perspective to deploy your Java applications. You can upload a JAR file using the following options:

- Navigate to the **+Add** view of the **Developer** perspective, and click **Upload JAR file** in the **From Local Machine** tile. Browse and select your JAR file, or drag and drop a JAR file to deploy your application.
- Navigate to the **Topology** view and use the **Upload JAR file** option, or drag and drop a JAR file to deploy your application.
- Use the in-context menu in the **Topology** view, and then use the **Upload JAR file** option to upload your JAR file to deploy your application.

Use the following instructions to upload a JAR file in the **Topology** view to deploy a Java application:

Procedure

1. In the **Topology** view, right-click anywhere in the **Topology** view to see the **Add to Project** menu.
2. Hover over the **Add to Project** menu to see the menu options, and then select the **Upload JAR file** option to see the **Upload JAR file** form . Alternatively, you can drag and drop the JAR file in the **Topology** view.
3. In the **JAR file** field, browse for the required JAR file on your local machine and upload it. Alternatively, you can drag and drop the JAR file on the field. A toast alert is displayed at the top right if an incompatible file type is dragged and dropped on the **Topology** view. A field error is displayed if an incompatible file type is dropped on the field in the upload form.
4. You can further specify optional Java commands to customize your deployed application. The Runtime Icon and Builder Image is selected by default. If a Builder Image is not auto-detected, select a Builder Image. If required, you can change the version using the **Builder Image Version** drop-down list.
5. In the optional **Application Name** field, enter a unique name for your application for the resource labelling.
6. In the **Name** field, enter a unique component name to name the associated resources.
7. In the **Resources** field, choose the resource type for your application.
8. In the **Advanced options**, click on **Create a Route to the Application**to configure a public URL for your deployed application.
9. Click **Create** to deploy the application. The user sees a toast notification notifying that the JAR file is being uploaded and takes a while. The toast notification also includes a link to view the build logs.

NOTE

If the user attempts to close the browser tab while the build is running, a web alert would be displayed asking the user if they actually want to leave the page.

After the JAR file is uploaded and the application is deployed, you can see the deployment in the **Topology** view.

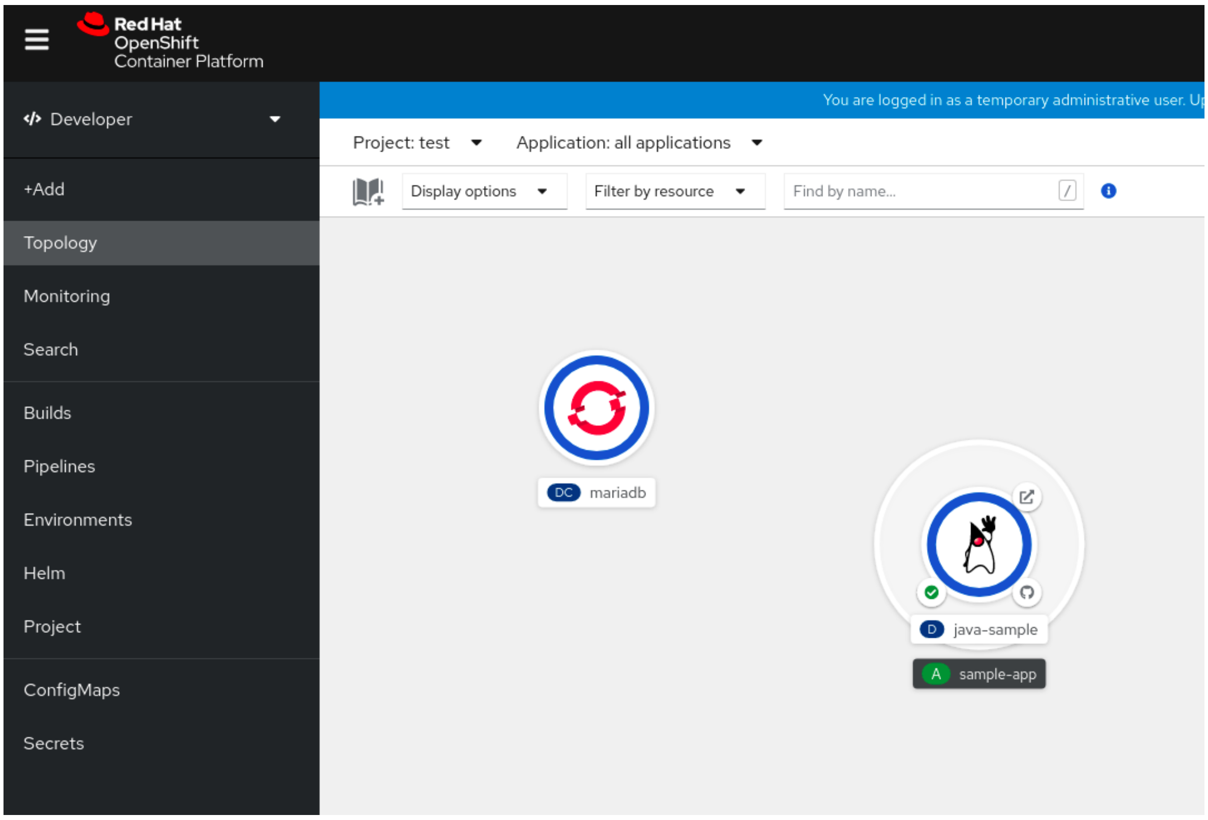
2.1.5. Using the Developer Catalog to add services or components to your application

You use the Developer Catalog to deploy applications and services based on Operator backed services such as Databases, Builder Images, and Helm Charts. The Developer Catalog contains a collection of application components, services, event sources, or source-to-image builders that you can add to your project. Cluster administrators can customize the content made available in the catalog.

Procedure

1. In the **Developer** perspective, navigate to the **+Add** view and from the **Developer Catalog** tile, click **All Services** to view all the available services in the **Developer Catalog**.
2. Under **All Services**, select the kind of service or the component you need to add to your project. For this example, select **Databases** to list all the database services and then click **MariaDB** to see the details for the service.
3. Click **Instantiate Template** to see an automatically populated template with details for the **MariaDB** service, and then click **Create** to create and view the MariaDB service in the **Topology** view.

Figure 2.1. MariaDB in Topology



2.2. CREATING APPLICATIONS FROM INSTALLED OPERATORS

Operators are a method of packaging, deploying, and managing a Kubernetes application. You can create applications on OpenShift Container Platform using Operators that have been installed by a cluster administrator.

This guide walks developers through an example of creating applications from an installed Operator using the OpenShift Container Platform web console.

Additional resources

- See the Operators guide for more on how Operators work and how the Operator Lifecycle Manager is integrated in OpenShift Container Platform.

2.2.1. Creating an etcd cluster using an Operator

This procedure walks through creating a new etcd cluster using the etcd Operator, managed by Operator Lifecycle Manager (OLM).

Prerequisites

- Access to an OpenShift Container Platform 4.9 cluster.
- The etcd Operator already installed cluster-wide by an administrator.

Procedure

1. Create a new project in the OpenShift Container Platform web console for this procedure. This example uses a project called **my-etcd**.
2. Navigate to the **Operators → Installed Operators** page. The Operators that have been installed to the cluster by the cluster administrator and are available for use are shown here as a list of cluster service versions (CSVs). CSVs are used to launch and manage the software provided by the Operator.

   TIP

   You can get this list from the CLI using:

   ```
   $ oc get csv
   ```

3. On the **Installed Operators** page, click the etcd Operator to view more details and available actions.
   As shown under **Provided APIs**, this Operator makes available three new resource types, including one for an **etcd Cluster** (the **EtcdCluster** resource). These objects work similar to the built-in native Kubernetes ones, such as **Deployment** or **ReplicaSet**, but contain logic specific to managing etcd.
4. Create a new etcd cluster:
   a. In the **etcd Cluster** API box, click **Create instance**.
   b. The next screen allows you to make any modifications to the minimal starting template of an **EtcdCluster** object, such as the size of the cluster. For now, click **Create** to finalize. This

triggers the Operator to start up the pods, services, and other components of the new etcd cluster.

5. Click on the **example** etcd cluster, then click the **Resources** tab to see that your project now contains a number of resources created and configured automatically by the Operator.
   Verify that a Kubernetes service has been created that allows you to access the database from other pods in your project.

6. All users with the **edit** role in a given project can create, manage, and delete application instances (an etcd cluster, in this example) managed by Operators that have already been created in the project, in a self-service manner, just like a cloud service. If you want to enable additional users with this ability, project administrators can add the role using the following command:

   ```
   $ oc policy add-role-to-user edit <user> -n <target_project>
   ```

You now have an etcd cluster that will react to failures and rebalance data as pods become unhealthy or are migrated between nodes in the cluster. Most importantly, cluster administrators or developers with proper access can now easily use the database with their applications.

2.3. CREATING APPLICATIONS USING THE CLI

You can create an OpenShift Container Platform application from components that include source or binary code, images, and templates by using the OpenShift Container Platform CLI.

The set of objects created by **new-app** depends on the artifacts passed as input: source repositories, images, or templates.

2.3.1. Creating an application from source code

With the **new-app** command you can create applications from source code in a local or remote Git repository.

The **new-app** command creates a build configuration, which itself creates a new application image from your source code. The **new-app** command typically also creates a **Deployment** object to deploy the new image, and a service to provide load-balanced access to the deployment running your image.

OpenShift Container Platform automatically detects whether the pipeline or source build strategy should be used, and in the case of source builds, detects an appropriate language builder image.

2.3.1.1. Local

To create an application from a Git repository in a local directory:

```
$ oc new-app /<path to source code>
```

NOTE

If you use a local Git repository, the repository must have a remote named **origin** that points to a URL that is accessible by the OpenShift Container Platform cluster. If there is no recognized remote, running the **new-app** command will create a binary build.

2.3.1.2. Remote

To create an application from a remote Git repository:

```
$ oc new-app https://github.com/sclorg/cakephp-ex
```

To create an application from a private remote Git repository:

```
$ oc new-app https://github.com/youruser/yourprivaterepo --source-secret=yoursecret
```

NOTE

If you use a private remote Git repository, you can use the **--source-secret** flag to specify an existing source clone secret that will get injected into your build config to access the repository.

You can use a subdirectory of your source code repository by specifying a **--context-dir** flag. To create an application from a remote Git repository and a context subdirectory:

```
$ oc new-app https://github.com/sclorg/s2i-ruby-container.git \
    --context-dir=2.0/test/puma-test-app
```

Also, when specifying a remote URL, you can specify a Git branch to use by appending **#<branch_name>** to the end of the URL:

```
$ oc new-app https://github.com/openshift/ruby-hello-world.git#beta4
```

2.3.1.3. Build strategy detection

If a Jenkins file exists in the root or specified context directory of the source repository when creating a new application, OpenShift Container Platform generates a pipeline build strategy. Otherwise, it generates a source build strategy.

Override the build strategy by setting the **--strategy** flag to either **pipeline** or **source**.

```
$ oc new-app /home/user/code/myapp --strategy=docker
```

NOTE

The **oc** command requires that files containing build sources are available in a remote Git repository. For all source builds, you must use **git remote -v**.

2.3.1.4. Language detection

If you use the source build strategy, **new-app** attempts to determine the language builder to use by the presence of certain files in the root or specified context directory of the repository:

Table 2.1. Languages detected by new-app

Language	Files
dotnet	**project.json**, ***.csproj**

Language	Files
jee	**pom.xml**
nodejs	**app.json**, **package.json**
perl	**cpanfile**, **index.pl**
php	**composer.json**, **index.php**
python	**requirements.txt**, **setup.py**
ruby	**Gemfile**, **Rakefile**, **config.ru**
scala	**build.sbt**
golang	**Godeps**, **main.go**

After a language is detected, **new-app** searches the OpenShift Container Platform server for image stream tags that have a **supports** annotation matching the detected language, or an image stream that matches the name of the detected language. If a match is not found, **new-app** searches the Docker Hub registry for an image that matches the detected language based on name.

You can override the image the builder uses for a particular source repository by specifying the image, either an image stream or container specification, and the repository with a ~ as a separator. Note that if this is done, build strategy detection and language detection are not carried out.

For example, to use the **myproject/my-ruby** imagestream with the source in a remote repository:

```
$ oc new-app myproject/my-ruby~https://github.com/openshift/ruby-hello-world.git
```

To use the **openshift/ruby-20-centos7:latest** container image stream with the source in a local repository:

```
$ oc new-app openshift/ruby-20-centos7:latest~/home/user/code/my-ruby-app
```

NOTE

Language detection requires the Git client to be locally installed so that your repository can be cloned and inspected. If Git is not available, you can avoid the language detection step by specifying the builder image to use with your repository with the **<image>~<repository>** syntax.

The **-i <image> <repository>** invocation requires that **new-app** attempt to clone **repository** to determine what type of artifact it is, so this will fail if Git is not available.

The **-i <image> --code <repository>** invocation requires **new-app** clone **repository** to determine whether **image** should be used as a builder for the source code, or deployed separately, as in the case of a database image.

2.3.2. Creating an application from an image

You can deploy an application from an existing image. Images can come from image streams in the OpenShift Container Platform server, images in a specific registry, or images in the local Docker server.

The **new-app** command attempts to determine the type of image specified in the arguments passed to it. However, you can explicitly tell **new-app** whether the image is a container image using the **--docker-image** argument or an image stream using the **-i|--image-stream** argument.

NOTE

If you specify an image from your local Docker repository, you must ensure that the same image is available to the OpenShift Container Platform cluster nodes.

2.3.2.1. Docker Hub MySQL image

Create an application from the Docker Hub MySQL image, for example:

```
$ oc new-app mysql
```

2.3.2.2. Image in a private registry

Create an application using an image in a private registry, specify the full container image specification:

```
$ oc new-app myregistry:5000/example/myimage
```

2.3.2.3. Existing image stream and optional image stream tag

Create an application from an existing image stream and optional image stream tag:

```
$ oc new-app my-stream:v1
```

2.3.3. Creating an application from a template

You can create an application from a previously stored template or from a template file, by specifying the name of the template as an argument. For example, you can store a sample application template and use it to create an application.

Upload an application template to your current project's template library. The following example uploads an application template from a file called **examples/sample-app/application-template-stibuild.json**:

```
$ oc create -f examples/sample-app/application-template-stibuild.json
```

Then create a new application by referencing the application template. In this example, the template name is **ruby-helloworld-sample**:

```
$ oc new-app ruby-helloworld-sample
```

To create a new application by referencing a template file in your local file system, without first storing it in OpenShift Container Platform, use the **-f|--file** argument. For example:

```
$ oc new-app -f examples/sample-app/application-template-stibuild.json
```

2.3.3.1. Template parameters

When creating an application based on a template, use the **-p|--param** argument to set parameter values that are defined by the template:

```
$ oc new-app ruby-helloworld-sample \
    -p ADMIN_USERNAME=admin -p ADMIN_PASSWORD=mypassword
```

You can store your parameters in a file, then use that file with **--param-file** when instantiating a template. If you want to read the parameters from standard input, use **--param-file=-**. The following is an example file called **helloworld.params**:

```
ADMIN_USERNAME=admin
ADMIN_PASSWORD=mypassword
```

Reference the parameters in the file when instantiating a template:

```
$ oc new-app ruby-helloworld-sample --param-file=helloworld.params
```

2.3.4. Modifying application creation

The **new-app** command generates OpenShift Container Platform objects that build, deploy, and run the application that is created. Normally, these objects are created in the current project and assigned names that are derived from the input source repositories or the input images. However, with **new-app** you can modify this behavior.

Table 2.2. **new-app** output objects

Object	Description
BuildConfig	A **BuildConfig** object is created for each source repository that is specified in the command line. The **BuildConfig** object specifies the strategy to use, the source location, and the build output location.
ImageStreams	For the **BuildConfig** object, two image streams are usually created. One represents the input image. With source builds, this is the builder image. With **Docker** builds, this is the **FROM** image. The second one represents the output image. If a container image was specified as input to **new-app**, then an image stream is created for that image as well.
DeploymentConfig	A **DeploymentConfig** object is created either to deploy the output of a build, or a specified image. The **new-app** command creates**emptyDir** volumes for all Docker volumes that are specified in containers included in the resulting **DeploymentConfig** object .
Service	The **new-app** command attempts to detect exposed ports in input images. It uses the lowest numeric exposed port to generate a service that exposes that port. To expose a different port, after **new-app** has completed, simply use the**oc expose** command to generate additional services.

Object	Description
Other	Other objects can be generated when instantiating templates, according to the template.

2.3.4.1. Specifying environment variables

When generating applications from a template, source, or an image, you can use the **-e|--env** argument to pass environment variables to the application container at run time:

```
$ oc new-app openshift/postgresql-92-centos7 \
    -e POSTGRESQL_USER=user \
    -e POSTGRESQL_DATABASE=db \
    -e POSTGRESQL_PASSWORD=password
```

The variables can also be read from file using the **--env-file** argument. The following is an example file called **postgresql.env**:

```
POSTGRESQL_USER=user
POSTGRESQL_DATABASE=db
POSTGRESQL_PASSWORD=password
```

Read the variables from the file:

```
$ oc new-app openshift/postgresql-92-centos7 --env-file=postgresql.env
```

Additionally, environment variables can be given on standard input by using **--env-file=-**:

```
$ cat postgresql.env | oc new-app openshift/postgresql-92-centos7 --env-file=-
```

NOTE

Any **BuildConfig** objects created as part of **new-app** processing are not updated with environment variables passed with the **-e|--env** or **--env-file** argument.

2.3.4.2. Specifying build environment variables

When generating applications from a template, source, or an image, you can use the **--build-env** argument to pass environment variables to the build container at run time:

```
$ oc new-app openshift/ruby-23-centos7 \
    --build-env HTTP_PROXY=http://myproxy.net:1337/ \
    --build-env GEM_HOME=~/.gem
```

The variables can also be read from a file using the **--build-env-file** argument. The following is an example file called **ruby.env**:

```
HTTP_PROXY=http://myproxy.net:1337/
GEM_HOME=~/.gem
```

Read the variables from the file:

```
$ oc new-app openshift/ruby-23-centos7 --build-env-file=ruby.env
```

Additionally, environment variables can be given on standard input by using **--build-env-file=-**:

```
$ cat ruby.env | oc new-app openshift/ruby-23-centos7 --build-env-file=-
```

2.3.4.3. Specifying labels

When generating applications from source, images, or templates, you can use the **-l|--label** argument to add labels to the created objects. Labels make it easy to collectively select, configure, and delete objects associated with the application.

```
$ oc new-app https://github.com/openshift/ruby-hello-world -l name=hello-world
```

2.3.4.4. Viewing the output without creation

To see a dry-run of running the **new-app** command, you can use the **-o|--output** argument with a **yaml** or **json** value. You can then use the output to preview the objects that are created or redirect it to a file that you can edit. After you are satisfied, you can use **oc create** to create the OpenShift Container Platform objects.

To output **new-app** artifacts to a file, run the following:

```
$ oc new-app https://github.com/openshift/ruby-hello-world \
    -o yaml > myapp.yaml
```

Edit the file:

```
$ vi myapp.yaml
```

Create a new application by referencing the file:

```
$ oc create -f myapp.yaml
```

2.3.4.5. Creating objects with different names

Objects created by **new-app** are normally named after the source repository, or the image used to generate them. You can set the name of the objects produced by adding a **--name** flag to the command:

```
$ oc new-app https://github.com/openshift/ruby-hello-world --name=myapp
```

2.3.4.6. Creating objects in a different project

Normally, **new-app** creates objects in the current project. However, you can create objects in a different project by using the **-n|--namespace** argument:

```
$ oc new-app https://github.com/openshift/ruby-hello-world -n myproject
```

2.3.4.7. Creating multiple objects

The **new-app** command allows creating multiple applications specifying multiple parameters to **new-app**. Labels specified in the command line apply to all objects created by the single command. Environment variables apply to all components created from source or images.

To create an application from a source repository and a Docker Hub image:

```
$ oc new-app https://github.com/openshift/ruby-hello-world mysql
```

NOTE

If a source code repository and a builder image are specified as separate arguments, **new-app** uses the builder image as the builder for the source code repository. If this is not the intent, specify the required builder image for the source using the **~** separator.

2.3.4.8. Grouping images and source in a single pod

The **new-app** command allows deploying multiple images together in a single pod. To specify which images to group together, use the **+** separator. The **--group** command line argument can also be used to specify the images that should be grouped together. To group the image built from a source repository with other images, specify its builder image in the group:

```
$ oc new-app ruby+mysql
```

To deploy an image built from source and an external image together:

```
$ oc new-app \
    ruby~https://github.com/openshift/ruby-hello-world \
    mysql \
    --group=ruby+mysql
```

2.3.4.9. Searching for images, templates, and other inputs

To search for images, templates, and other inputs for the **oc new-app** command, add the **--search** and **--list** flags. For example, to find all of the images or templates that include PHP:

```
$ oc new-app --search php
```

CHAPTER 3. VIEWING APPLICATION COMPOSITION USING THE TOPOLOGY VIEW

The **Topology** view in the **Developer** perspective of the web console provides a visual representation of all the applications within a project, their build status, and the components and services associated with them.

3.1. PREREQUISITES

To view your applications in the **Topology** view and interact with them, ensure that:

- You have logged in to the web console .
- You are in the **Developer** perspective.
- You have the appropriate roles and permissions in a project to create applications and other workloads in OpenShift Container Platform.
- You have created and deployed an application on OpenShift Container Platform using the **Developer** perspective.

3.2. VIEWING THE TOPOLOGY OF YOUR APPLICATION

You can navigate to the **Topology** view using the left navigation panel in the **Developer** perspective. After you deploy an application, you are directed automatically to the **Graph view** where you can see the status of the application pods, quickly access the application on a public URL, access the source code to modify it, and see the status of your last build. You can zoom in and out to see more details for a particular application.

The **Topology** view also provides you the option to monitor your applications using the **List** view. Use the **List view** icon ( ) to see a list of all your applications and use the **Graph view** icon ( ) to switch back to the graph view.

You can customize the views as required using the following:

- Use the **Find by name** field to find the required components. Search results may appear outside of the visible area; click **Fit to Screen** from the lower-left toolbar to resize the **Topology** view to show all components.
- Use the **Display Options** drop-down list to configure the **Topology** view of the various application groupings. The options are available depending on the types of components deployed in the project:
  - **Mode** (**Connectivity** or **Consumption**)
    - Connectivity: Select to show all the connections between the different nodes in the topology.
    - Consumption: Select to show the resource consumption for all nodes in the topology.
  - **Expand** group
    - Virtual Machines: Toggle to show or hide the virtual machines.

  - Application Groupings: Clear to condense the application groups into cards with an overview of an application group and alerts associated with it.
  - Helm Releases: Clear to condense the components deployed as Helm Release into cards with an overview of a given release.
  - Knative Services: Clear to condense the Knative Service components into cards with an overview of a given component.
  - Operator Groupings: Clear to condense the components deployed with an Operator into cards with an overview of the given group.
- **Show** elements based on **Pod Count** or **Labels**
  - Pod Count: Select to show the number of pods of a component in the component icon.
  - Labels: Toggle to show or hide the component labels.

3.3. INTERACTING WITH APPLICATIONS AND COMPONENTS

The **Topology** view in the **Developer** perspective of the web console provides the following options to interact with applications and components:

- Click **Open URL** (↗) to see your application exposed by the route on a public URL.
- Click **Edit Source code** to access your source code and modify it.

NOTE

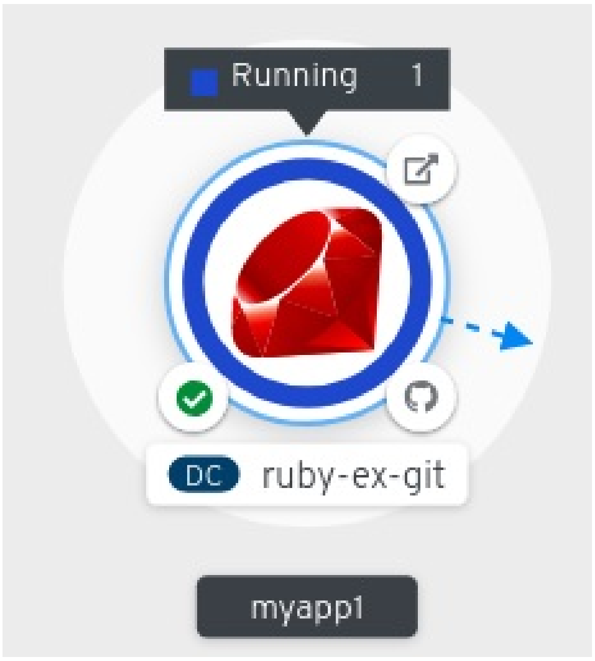
This feature is available only when you create applications using the **From Git**, **From Catalog**, and the **From Dockerfile** options.

- Hover your cursor over the lower left icon on the Pod to see the name of the latest build and its status. The status of the application build is indicated as **New** (⧗), **Pending** (⧗), **Running** (⟳), **Completed** (✓), **Failed** (✖), and **Canceled** (⊘).
- The status or phase of the pod is indicated by different colors and tooltips as:
  - **Running** (🟦): The pod is bound to a node and all of the containers are created. At least one container is still running or is in the process of starting or restarting.
  - **Not Ready** (🟦): The pods which are running multiple containers, not all containers are ready.
  - **Warning**(🟨): Containers in pods are being terminated, however termination did not succeed. Some containers may be other states.
  - **Failed**(🟥): All containers in the pod terminated but least one container has terminated in failure. That is, the container either exited with non-zero status or was terminated by the system.
  - **Pending**(🟦): The pod is accepted by the Kubernetes cluster, but one or more of the containers has not been set up and made ready to run. This includes time a pod spends waiting to be scheduled as well as the time spent downloading container images over the network.

  - **Succeeded**(🟩): All containers in the pod terminated successfully and will not be restarted.
  - **Terminating**(■): When a pod is being deleted, it is shown as **Terminating** by some kubectl commands. **Terminating** status is not one of the pod phases. A pod is granted a graceful termination period, which defaults to 30 seconds.
  - **Unknown**(🟪): The state of the pod could not be obtained. This phase typically occurs due to an error in communicating with the node where the pod should be running.

- After you create an application and an image is deployed, the status is shown as **Pending**. After the application is built, it is displayed as **Running**.

Figure 3.1. Application topology



The application resource name is appended with indicators for the different types of resource objects as follows:

  - CJ: **CronJob**
  - D: **Deployment**
  - DC: **DeploymentConfig**
  - DS: **DaemonSet**
  - J: **Job**
  - P: **Pod**
  - SS: **StatefulSet**
  - (Knative): A serverless application

NOTE

Serverless applications take some time to load and display on the **Graph view**. When you deploy a serverless application, it first creates a service resource and then a revision. After that, it is deployed and displayed on the **Graph view**. If it is the only workload, you might be redirected to the **Add** page. After the revision is deployed, the serverless application is displayed on the **Graph view**.

3.4. SCALING APPLICATION PODS AND CHECKING BUILDS AND ROUTES

The **Topology** view provides the details of the deployed components in the **Overview** panel. You can use the **Overview** and **Resources** tabs to scale the application pods, check build status, services, and routes as follows:

- Click on the component node to see the **Overview** panel to the right. Use the **Overview** tab to:
    - Scale your pods using the up and down arrows to increase or decrease the number of instances of the application manually. For serverless applications, the pods are automatically scaled down to zero when idle and scaled up depending on the channel traffic.
    - Check the **Labels**, **Annotations**, and **Status** of the application.
- Click the **Resources** tab to:
    - See the list of all the pods, view their status, access logs, and click on the pod to see the pod details.
    - See the builds, their status, access logs, and start a new build if needed.
    - See the services and routes used by the component.

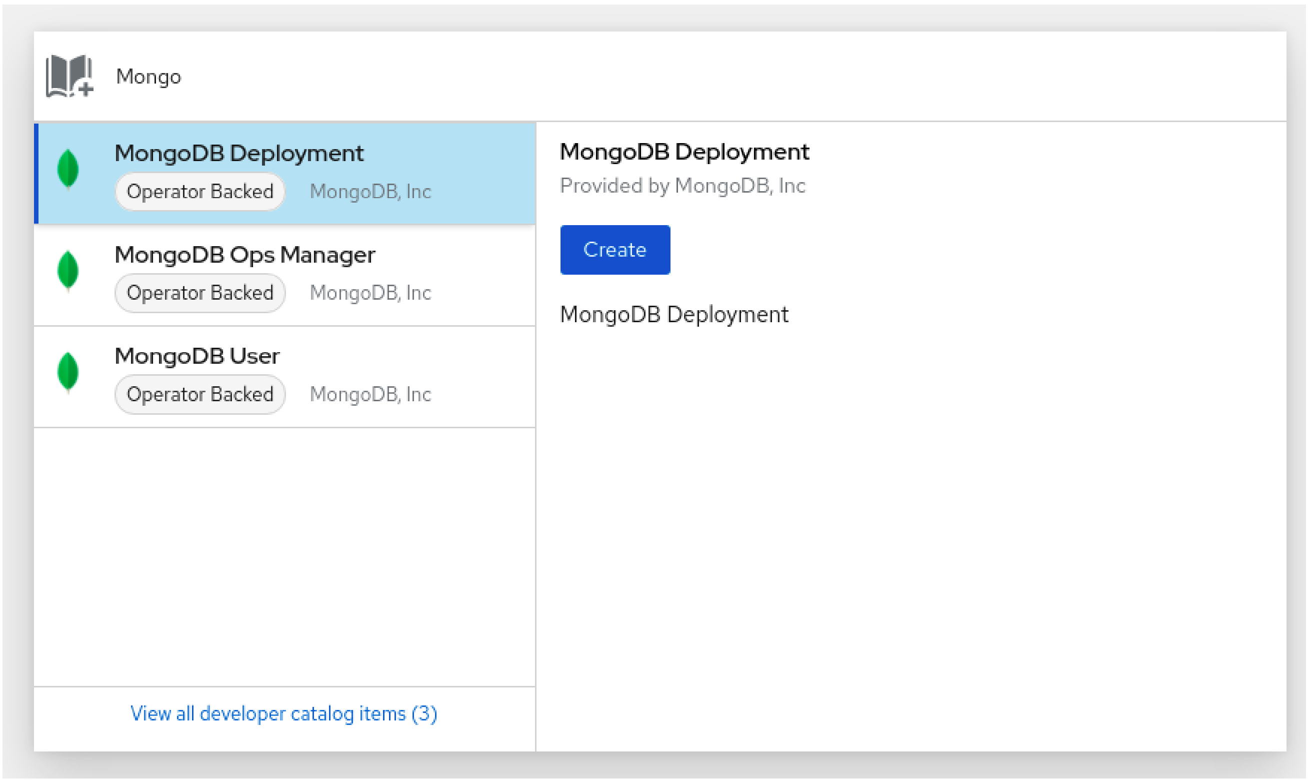
  For serverless applications, the **Resources** tab provides information on the revision, routes, and the configurations used for that component.

3.5. ADDING COMPONENTS TO AN EXISTING PROJECT

Procedure

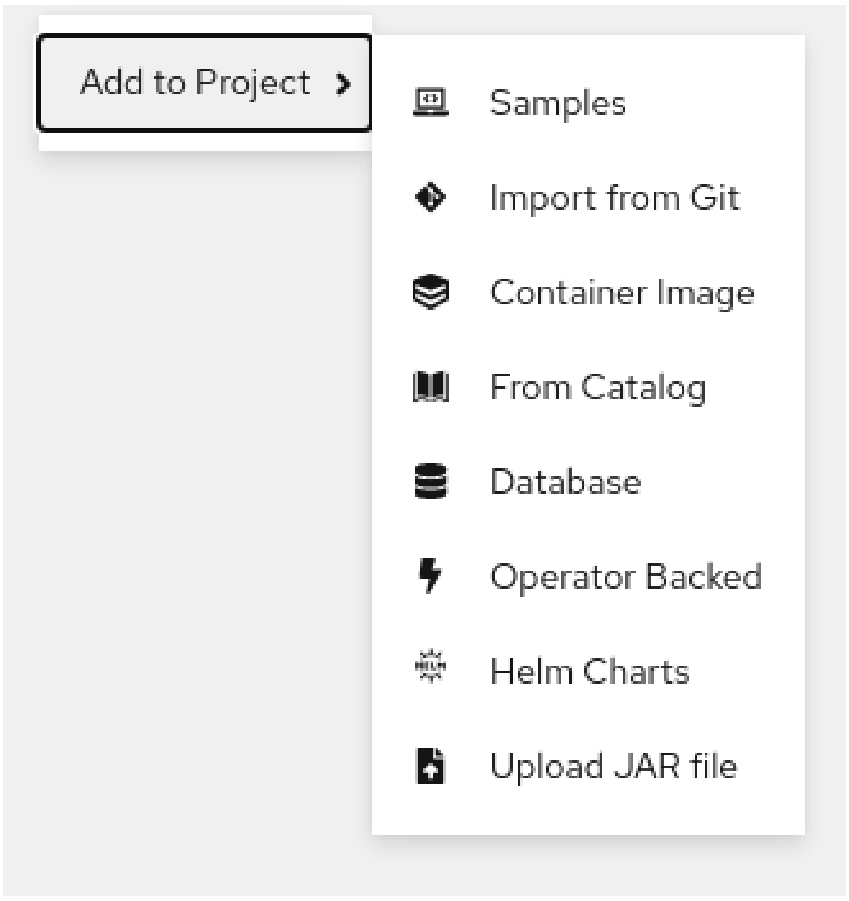
1. Click **Add to Project** ( ) next to left navigation pane or press **Ctrl**+**Space**
2. Search for the component and select **Create** or press **Enter** to add the component to the project and see it in the topology **Graph view**.

Figure 3.2. Adding component via quick search



Alternatively, you can also use the **Import from Git**, **Container Image**, **Database**, **From Catalog**, **Operator Backed**, **Helm Charts**, **Samples**, or **Upload JAR file** options in the context menu by right-clicking in the topology **Graph view** to add a component to your project.

Figure 3.3. Context menu to add services



3.6. GROUPING MULTIPLE COMPONENTS WITHIN AN APPLICATION

You can use the **+Add** view to add multiple components or services to your project and use the topology **Graph view** to group applications and resources within an application group.

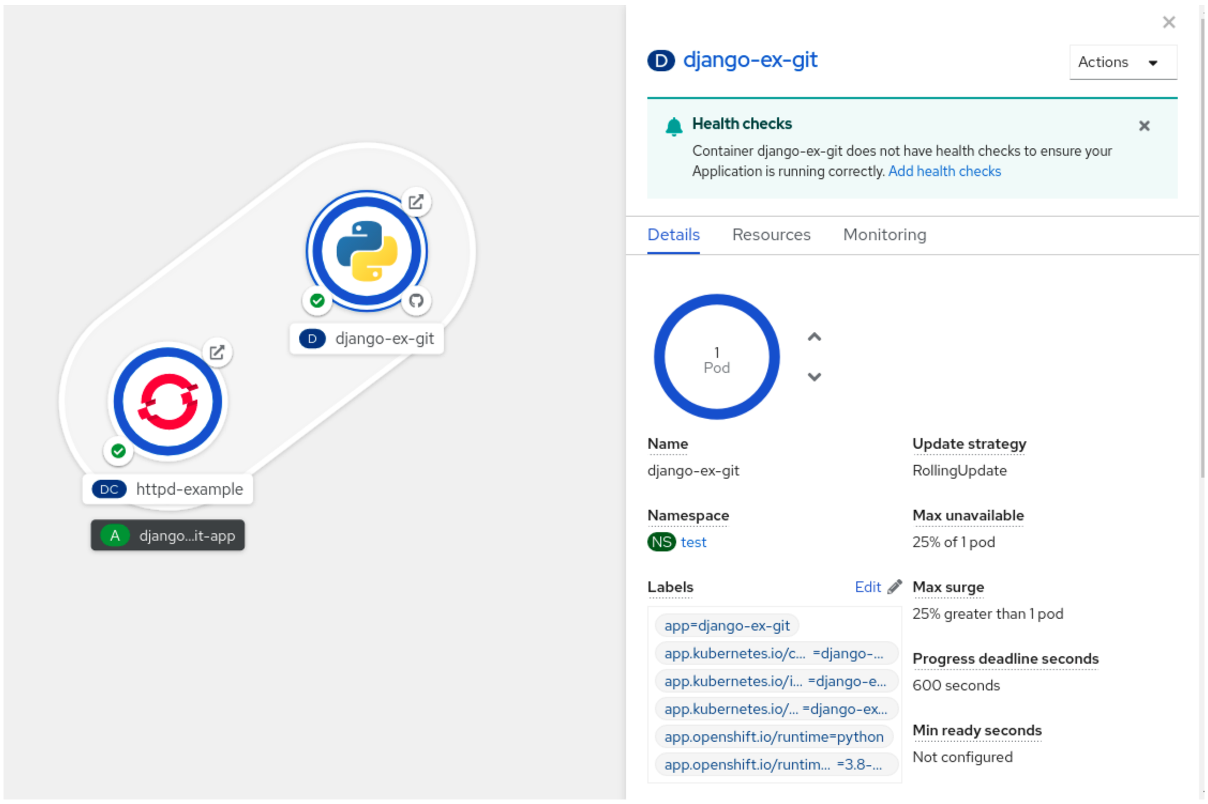
Prerequisites

- You have created and deployed minimum two or more components on OpenShift Container Platform using the **Developer** perspective.

Procedure

- To add a service to the existing application group, press **Shift**+ drag it to the existing application group. Dragging a component and adding it to an application group adds the required labels to the component.

Figure 3.4. Application grouping



django-ex-git

Health checks

Container django-ex-git does not have health checks to ensure your Application is running correctly. Add health checks

Name
django-ex-git

Namespace
NS test

Labels
app=django-ex-git
app.kubernetes.io/c... =django-...
app.kubernetes.io/i... =django-e...
app.kubernetes.io/... =django-ex...
app.openshift.io/runtime=python
app.openshift.io/runtim... =3.8-...

Update strategy
RollingUpdate

Max unavailable
25% of 1 pod

Max surge
25% greater than 1 pod

Progress deadline seconds
600 seconds

Min ready seconds
Not configured

Alternatively, you can also add the component to an application as follows:

1. Click the service pod to see the **Overview** panel to the right.
2. Click the **Actions** drop-down menu and select **Edit Application Grouping**.
3. In the **Edit Application Grouping** dialog box, click the **Application** drop-down list, and select an appropriate application group.
4. Click **Save** to add the service to the application group.

You can remove a component from an application group by selecting the component and using **Shift**+ drag to drag it out of the application group.

3.7. ADDING SERVICES TO YOUR APPLICATION

To add a service to your application use the **+Add** actions using the context menu in the topology **Graph view**.

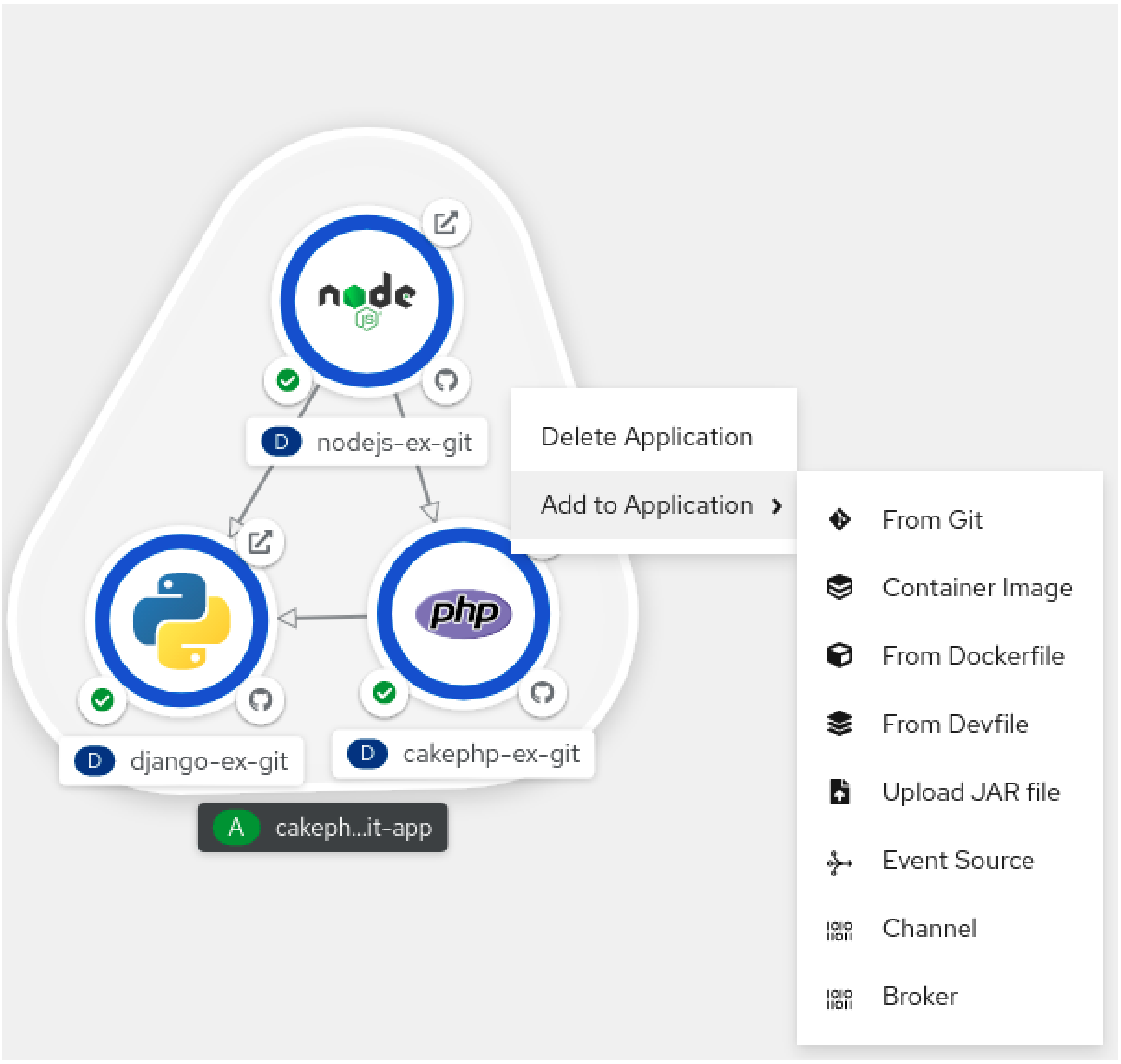
NOTE

In addition to the context menu, you can add services by using the sidebar or hovering and dragging the dangling arrow from the application group.

Procedure

1. Right-click an application group in the topology **Graph view** to display the context menu.

   Figure 3.5. Add resource context menu



2. Use **Add to Application** to select a method for adding a service to the application group, such as **From Git**, **Container Image**, **From Dockerfile**, **From Devfile**, **Upload JAR file**, **Event Source**, **Channel**, or **Broker**.

3. Complete the form for the method you choose and click **Create**. For example, to add a service based on the source code in your Git repository, choose the **From Git** method, fill in the **Import from Git** form, and click **Create**.

3.8. REMOVING SERVICES FROM YOUR APPLICATION

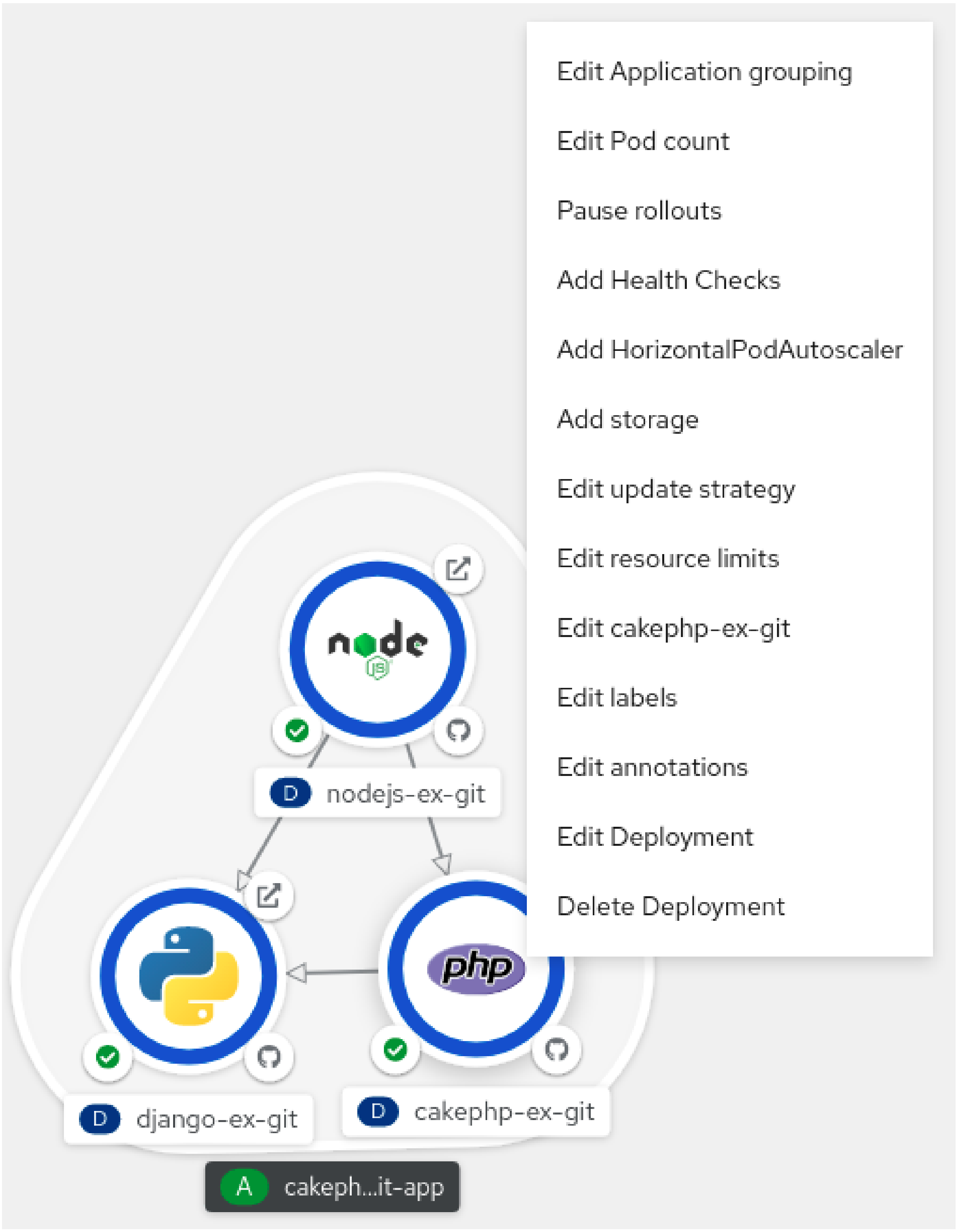
In the topology **Graph view** remove a service from your application using the context menu.

Procedure

1. Right-click on a service in an application group in the topology **Graph view** to display the context menu.

2. Select **Delete Deployment** to delete the service.

Figure 3.6. Deleting deployment option



3.9. LABELS AND ANNOTATIONS USED FOR THE TOPOLOGY VIEW

The **Topology** view uses the following labels and annotations:

Icon displayed in the node

Icons in the node are defined by looking for matching icons using the **app.openshift.io/runtime** label, followed by the **app.kubernetes.io/name** label. This matching is done using a predefined set of icons.

Link to the source code editor or the source

The **app.openshift.io/vcs-uri** annotation is used to create links to the source code editor.

Node Connector

The **app.openshift.io/connects-to** annotation is used to connect the nodes.

App grouping

The **app.kubernetes.io/part-of=<appname>** label is used to group the applications, services, and components.

For detailed information on the labels and annotations OpenShift Container Platform applications must use, see Guidelines for labels and annotations for OpenShift applications .

3.10. ADDITIONAL RESOURCES

- See Importing a codebase from Git to create an application for more information on creating an application from Git.
- See Connecting an application to a service using the Developer perspective .

CHAPTER 4. CONNECTING APPLICATIONS TO SERVICES

4.1. {SERVICEBINDING-TITLE} RELEASE NOTES

The Service Binding Operator consists of a controller and an accompanying custom resource definition (CRD) for service binding. It manages the data plane for workloads and backing services. The Service Binding Controller reads the data made available by the control plane of backing services. Then, it projects this data to workloads according to the rules specified through the **ServiceBinding** resource.

With Service Binding Operator, you can:

- Bind your workloads together with Operator-managed backing services.
- Automate configuration of binding data.
- Provide service operators a low-touch administrative experience to provision and manage access to services.
- Enrich development lifecycle with a consistent and declarative service binding method that eliminates discrepancies in cluster environments.

4.1.1. Making open source more inclusive

Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see Red Hat CTO Chris Wright's message .

4.1.2. Release notes for Service Binding Operator 1.0

Service Binding Operator is now available on OpenShift Container Platform 4.7, 4.8 and 4.9.

The custom resource definition (CRD) of the Service Binding Operator 1.0 supports the following APIs:

- **Service Binding** with the **binding.operators.coreos.com** API group.
- **Service Binding (Spec API Tech Preview)**with the **servicebinding.io** API group.

IMPORTANT

Service Binding (Spec API Tech Preview)with the **servicebinding.io** API group is a Technology Preview feature only. Technology Preview features are not supported with Red Hat production service level agreements (SLAs) and might not be functionally complete. Red Hat does not recommend using them in production. These features provide early access to upcoming product features, enabling customers to test functionality and provide feedback during the development process.

For more information about the support scope of Red Hat Technology Preview features, see https://access.redhat.com/support/offerings/techpreview/.

4.1.2.1. Support matrix

Some features in this release are currently in Technology Preview. These experimental features are not intended for production use.

Technology Preview Features Support Scope

In the table below, features are marked with the following statuses:

- **TP**: *Technology Preview*
- **GA**: *General Availability*

Note the following scope of support on the Red Hat Customer Portal for these features:

Table 4.1. Support matrix

Feature	Service Binding Operator 1.0
binding.operators.coreos.com API group	GA
servicebinding.io API group	TP

4.1.2.2. New features

Service Binding Operator 1.0 supports OpenShift Container Platform 4.9 and later running on:

- IBM Power Systems
- IBM Z and LinuxONE

This section highlights what is new in Service Binding Operator 1.0:

- Exposal of binding data from services
    - Based on annotations present in CRD, custom resources (CRs), or resources.
    - Based on descriptors present in Operator Lifecycle Manager (OLM) descriptors.
    - Support for provisioned services
- Workload projection
    - Projection of binding data as files, with volume mounts.
    - Projection of binding data as environment variables.
- Service Binding Options
    - Bind backing services in a namespace that is different from the workload namespace.
    - Project binding data into the specific container workloads.
    - Auto-detection of the binding data from resources owned by the backing service CR.
    - Compose custom binding data from the exposed binding data.
    - Support for non-**PodSpec** compliant workload resources.

- Security
  - Support for role-based access control (RBAC).

4.1.3. Additional resources

- Understanding Service Binding Operator.

4.2. UNDERSTANDING SERVICE BINDING OPERATOR

Application developers need access to backing services to build and connect workloads. Connecting workloads to backing services is always a challenge because each service provider suggests a different way to access their secrets and consume them in a workload. In addition, manual configuration and maintenance of this binding together of workloads and backing services make the process tedious, inefficient, and error-prone.

The Service Binding Operator enables application developers to easily bind workloads together with Operator-managed backing services, without any manual procedures to configure the binding connection.

4.2.1. Service Binding terminology

This section summarizes the basic terms used in Service Binding.

Service binding	The representation of the action of providing information about a service to a workload. Examples include establishing the exchange of credentials between a Java application and a database that it requires.
Backing service	Any service or software that the application consumes over the network as part of its normal operation. Examples include a database, a message broker, an application with REST endpoints, an event stream, an Application Performance Monitor (APM), or a Hardware Security Module (HSM).
Workload (application)	Any process, running within a container. Examples include a Spring Boot application, a NodeJS Express application, or a Ruby on Rails application.
Binding data	Information about a service that you use to configure the behavior of other resources within the cluster. Examples include credentials, connection details, volume mounts, or secrets.
Binding connection	Any connection that establishes an interaction between the connected components such as a bindable backing service and an application requiring that backing service.

4.2.2. About Service Binding Operator

The Service Binding Operator consists of a controller and an accompanying custom resource definition (CRD) for service binding. It manages the data plane for workloads and backing services. The Service Binding Controller reads the data made available by the control plane of backing services. Then, it projects this data to workloads according to the rules specified through the **ServiceBinding** resource.

As a result, the Service Binding Operator enables workloads to use backing services or external services by automatically collecting and sharing binding data with the workloads. The process involves making the backing service bindable and binding the workload and the service together.

4.2.2.1. Making an Operator-managed backing service bindable

To make a service bindable, as an Operator provider you need to expose the binding data required by workloads to bind with the services provided by the Operator. You can provide the binding data either as annotations or as descriptors in the CRD of the Operator that manages the backing service.

4.2.2.2. Binding a workload together with a backing service

By using the Service Binding Operator, as an application developer, you need to declare the intent of establishing a binding connection. You must create a **Service Binding** CR that references the backing service. This action triggers the Service Binding Operator to project the exposed binding data into the workload. The Service Binding Operator receives the declared intent and binds the workload together with the backing service.

The CRD of the Service Binding Operator supports the following APIs:

- **Service Binding** with the **binding.operators.coreos.com** API group.
- **Service Binding (Spec API Tech Preview)** with the **servicebinding.io** API group.

> **IMPORTANT**
>
> **Service Binding (Spec API Tech Preview)** with the **servicebinding.io** API group is a Technology Preview feature only. Technology Preview features are not supported with Red Hat production service level agreements (SLAs) and might not be functionally complete. Red Hat does not recommend using them in production. These features provide early access to upcoming product features, enabling customers to test functionality and provide feedback during the development process. For more information about the support scope of Red Hat Technology Preview features, see https://access.redhat.com/support/offerings/techpreview/.

With Service Binding Operator, you can:

- Bind your workloads to Operator-managed backing services.
- Automate configuration of binding data.
- Provide service operators a low-touch administrative experience to provision and manage access to services.
- Enrich development lifecycle with a consistent and declarative service binding method that eliminates discrepancies in cluster environments.

4.2.3. Key features

- Exposal of binding data from services
  - Based on annotations present in CRD, custom resources (CRs), or resources.
  - Based on descriptors present in Operator Lifecycle Manager (OLM) descriptors.
- Workload projection
  - Projection of binding data as files, with volume mounts.

- Projection of binding data as environment variables.
- Service Binding Options
  - Bind backing services in a namespace that is different from the workload namespace.
  - Project binding data into the specific container workloads.
  - Auto-detection of the binding data from resources owned by the backing service CR.
  - Compose custom binding data from the exposed binding data.
  - Support for non-**PodSpec** compliant workload resources.
- Security
  - Support for role-based access control (RBAC).

4.2.4. Additional resources

- Getting started with service binding.

4.3. INSTALLING SERVICE BINDING OPERATOR

This guide walks cluster administrators through the process of installing the Service Binding Operator to an OpenShift Container Platform cluster.

You can install Service Binding Operator on OpenShift Container Platform 4.7 and later.

4.3.1. Installing the Service Binding Operator using the web console

You can install Service Binding Operator using the OpenShift Container Platform OperatorHub. When you install the Service Binding Operator, the custom resources (CRs) required for the service binding configuration are automatically installed along with the Operator.

Prerequisites
You have access to an OpenShift Container Platform cluster using an account with **cluster-admin** permissions.

Procedure

1. In the **Administrator** perspective of the web console, navigate to **Operators** → **OperatorHub**.
2. Use the **Filter by keyword** box to search for **Service Binding Operator** in the catalog. Click the **Service Binding Operator** tile.
3. Read the brief description about the Operator on the **Service Binding Operator** page. Click **Install**.
4. On the **Install Operator** page:
   a. Select **All namespaces on the cluster (default)** for the **Installation Mode**. This mode installs the Operator in the default **openshift-operators** namespace, which enables the Operator to watch and be made available to all namespaces in the cluster.
   b. Select **Automatic** for the **Approval Strategy**. This ensures that the future upgrades to the

Operator are handled automatically by the Operator Lifecycle Manager (OLM). If you select the **Manual** approval strategy, OLM creates an update request. As a cluster administrator, you must then manually approve the OLM update request to update the Operator to the new version.

c. Select an **Update Channel**.

- By default, the **stable** channel enables installation of the latest stable and supported release of the Service Binding Operator.

5. Click **Install**.

NOTE

The Operator is installed automatically into the **openshift-operators** namespace.

6. On the **Installed Operator – ready for use** pane, click **View Operator**. You will see the Operator listed on the **Installed Operators** page.

7. Verify that the **Status** is set to **Succeeded** to confirm successful installation of Service Binding Operator.

4.3.2. Additional Resources

- Getting started with service binding.

4.4. GETTING STARTED WITH SERVICE BINDING

Service Binding Operator manages the data plane for workloads and backing services. This guide provides instructions with examples to help you create a database instance, deploy an application, and use Service Binding Operator to create a binding connection between the application and the database service.

Prerequisites

- You have access to an OpenShift Container Platform cluster using an account with **cluster-admin** permissions.
- You have installed the **oc** CLI.
- You have installed PostgreSQL **psql** CLI.
- You have installed Service Binding Operator from OperatorHub.
- You have installed the Crunchy Postgres for Kubernetes Operator from OperatorHub using the **v5** Update channel. The installed Operator is available in an appropriate namespace, such as the **my-postgresql** namespace.

4.4.1. Creating a PostgreSQL database instance

To create a PostgreSQL database instance, you must create a **PostgresCluster** custom resource (CR) and configure the database.

Procedure

1. Create the **PostgresCluster** CR and the **my-postgresql** namespace by running the following command in shell:

```
$ oc apply -f - << EOD
---
apiVersion: v1
kind: Namespace
metadata:
 name: my-postgresql
---
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    service.binding: 'path={.metadata.annotations.dbsecret},objectType=Secret'
    dbsecret: hippo-pguser-hippo
    proxy: hippo-pgbouncer
    type: postgresql
    service.binding/database: path={.metadata.name}
    service.binding/port: path={.spec.port}
    service.binding/username: path={.metadata.name}
    service.binding/host: path={.metadata.annotations.proxy}
    service.binding/type: path={.metadata.annotations.type}
spec:
  image: registry.developers.crunchydata.com/crunchydata/crunchy-postgres-ha:centos8-
13.4-0
  postgresVersion: 13
  instances:
    - name: instance1
      dataVolumeClaimSpec:
        accessModes:
        - "ReadWriteOnce"
        resources:
          requests:
            storage: 1Gi
  backups:
    pgbackrest:
      image: registry.developers.crunchydata.com/crunchydata/crunchy-pgbackrest:centos8-
2.33-2
      repos:
      - name: repo1
        volume:
          volumeClaimSpec:
            accessModes:
            - "ReadWriteOnce"
            resources:
              requests:
                storage: 1Gi
      - name: repo2
        volume:
          volumeClaimSpec:
            accessModes:
            - "ReadWriteOnce"
            resources:
```

```
            requests:
              storage: 1Gi
  proxy:
    pgBouncer:
        image: registry.developers.crunchydata.com/crunchydata/crunchy-pgbouncer:centos8-
1.15-2
EOD
```

The annotations added in this **PostgresCluster** CR help in enabling the service binding connection and trigger the Operator reconciliation.

The output verifies that the database instance is created:

Example output

```
namespace/my-postgresql configured
postgrescluster.postgres-operator.crunchydata.com/hippo created
```

2. After you have created the database instance, ensure that all the pods in **my-postgresql** namespace are running (it will take a few minutes):

```
$ oc get pods -n my-postgresql
```

The output verifies that the database is created:

Example output

```
NAME                              READY   STATUS      RESTARTS   AGE
hippo-backup-6th6--1-28849        0/1     Completed   0          1m
hippo-instance1-sl4r-0            2/2     Running     0          2m
hippo-pgbouncer-8454474bc7-lhcn9  2/2     Running     0          2m
```

The new database is empty at this stage. You can set its schema and project a sample data set to interact with the sample application.

3. Initialize the database with the schema and sample data. To do so, use the following custom shell script by copying the code into the shell and running it:

```
$ cat << EOD | bash
#!/bin/bash

export pgo_cluster_name=hippo
export cluster_namespace=my-postgresql
export pgo_cluster_username=hippo
export PGPASSWORD=\$(oc -n "\${cluster_namespace}" get secrets \
  "\${pgo_cluster_name}-pguser-\${pgo_cluster_username}" -o "jsonpath={.data['password']}"
| base64 -d)
nohup oc -n \${cluster_namespace} port-forward svc/hippo-pgbouncer 5432:5432 &
sleep 5
curl -LO https://raw.githubusercontent.com/spring-petclinic/spring-petclinic-
rest/master/src/main/resources/db/postgresql/initDB.sql
psql -h localhost -U "\${pgo_cluster_username}" "\${pgo_cluster_name}" -f initDB.sql
curl -LO https://raw.githubusercontent.com/spring-petclinic/spring-petclinic-
```

```
rest/master/src/main/resources/db/postgresql/populateDB.sql
psql -h localhost -U "\${pgo_cluster_username}" "\${pgo_cluster_name}" -f populateDB.sql
EOD
```

The output in the terminal shows you that the database is being configured for the application.

After the database is configured, you can deploy the sample application and connect it to the database service.

4.4.2. Deploying the Spring PetClinic sample application

To deploy the Spring PetClinic sample application on an OpenShift Container Platform cluster, you must use a deployment configuration and configure your local environment to be able to test the application.

Procedure

1. Deploy the **spring-petclinic-rest** application with the **PostgresCluster** custom resource (CR) by running the following command in shell:

```
$ oc apply -f - << EOD
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: spring-petclinic-rest
  namespace: my-postgresql
  labels:
    app: spring-petclinic-rest
spec:
  replicas: 1
  selector:
    matchLabels:
      app: spring-petclinic-rest
  template:
    metadata:
      labels:
        app: spring-petclinic-rest
    spec:
      containers:
        - name: application
          image: quay.io/baijum/spring-petclinic-rest:latest
          env:
          - name: SPRING_PROFILES_ACTIVE
            value: postgresql,spring-data-jpa
          ports:
          - name: http
            containerPort: 9966
---
apiVersion: v1
kind: Service
metadata:
  name: spring-petclinic-rest
  namespace: my-postgresql
spec:
  ports:
```

```
  - port: 80
    targetPort: 9966
  selector:
    app: spring-petclinic-rest
EOD
```

The output verifies that the Spring PetClinic sample application is created and deployed:

Example output

```
deployment.apps/spring-petclinic-rest created
service/spring-petclinic-rest created
```

2. Set up port forwarding from the application port to access the sample application from your local environment:

```
$ oc port-forward --address 0.0.0.0 svc/spring-petclinic-rest 9966:80 -n my-postgresql
```

3. Access http://localhost:9966/petclinic.
   You can now remotely access the Spring PetClinic sample application at localhost:9966.

NOTE

The application is not yet connected to the database service. If you try to interact with the application, it will return errors.

For example, if you try to access the list of all pets using **curl**, you can see an error message similar to the following sample message:

```
$ curl -X GET "http://localhost:9966/petclinic/api/pets" -H "accept: application/json"

{"className":"org.springframework.transaction.CannotCreateTransactionException","exMessa
ge":"Could
not open JPA EntityManager for transaction; nested exception is
org.hibernate.exception.JDBCConnectionException: Unable to acquire JDBC
Connection"}
```

You can now use the Service Binding Operator to connect the application to the database service.

4.4.3. Connecting the Spring PetClinic sample application to the PostgreSQL database service

To connect the sample application to the database service, you must create a **ServiceBinding** custom resource (CR) that triggers the Service Binding Operator to project the binding data into the application.

Procedure

1. Create a **ServiceBinding** CR to project the binding data:

```
$ oc apply -f - << EOD
---
apiVersion: binding.operators.coreos.com/v1alpha1
```

```
kind: ServiceBinding
metadata:
  name: spring-petclinic-rest
  namespace: my-postgresql
spec:
  services: (1)
  - group: postgres-operator.crunchydata.com
    version: v1beta1
    kind: PostgresCluster (2)
    name: hippo
  - group: ""
    version: v1
    kind: Secret
    name: hippo-pguser-hippo
  application: (3)
    name: spring-petclinic-rest
    group: apps
    version: v1
    resource: deployments
EOD
```

1. Specifies a list of service resources.
2. The CR of the database.
3. The sample application that points to a Deployment or any other similar resource with an embedded PodSpec.

The output verifies that the **ServiceBinding** CR is created to project the binding data into the sample application.

Example output

```
servicebinding.binding.operators.coreos.com/spring-petclinic-rest created
```

2. To verify that the binding is successful, check the status conditions of the binding resource:

```
$ oc get servicebindings spring-petclinic-rest -n my-postgresql -o jsonpath-as-
json='{.status.conditions}'
```

Example output

```
[
  [
    {
      "lastTransitionTime": "2021-09-06T13:42:28Z",
      "message": "",
      "reason": "DataCollected",
      "status": "True",
      "type": "CollectionReady",
    },
    {
      "lastTransitionTime": "2021-09-06T13:42:28Z",
      "message": "",
        "reason": "ApplicationUpdated",
        "status": "True",
        "type": "InjectionReady",
      },
      {
        "lastTransitionTime": "2021-09-06T13:42:28Z",
        "message": "",
        "reason": "ApplicationsBound",
        "status": "True",
        "type": "Ready",
      },
    ],
]
```

By default, the values from the binding data of the database service are projected as files into the workload container that runs the sample application.

3. To verify that the files in the application contain the projected binding data, use the following command in shell to print out the contents:

```
$ for i in username password host port type; do oc exec -it deploy/spring-petclinic-rest -n my-postgresql -- /bin/bash -c 'find /bindings/*/'$i' -exec echo -n {}:" " \; -exec cat {} \;'; echo; done
```

Example output: With all the values from the secret resource

```
/bindings/spring-petclinic-rest/username: hippo
/bindings/spring-petclinic-rest/password: w0ZB<0j1W|K;+4*TlK7-w^z/
/bindings/spring-petclinic-rest/host: hippo-pgbouncer
/bindings/spring-petclinic-rest/port: 5432
/bindings/spring-petclinic-rest/type: postgresql
```

4. Set up the port forwarding from the application port to access the sample application from your local environment:

```
$ oc port-forward --address 0.0.0.0 svc/spring-petclinic-rest 9966:80 -n my-postgresql
```

5. Access http://localhost:9966/petclinic.
You can now remotely access the Spring PetClinic sample application at localhost:9966.

6. To verify that the application is now connected to the database service, access the list of all pets:

```
$ curl -X GET "http://localhost:9966/petclinic/api/pets" -H "accept: application/json"
```

Example output

```
[{"id":1,"name":"Leo","birthDate":"2000/09/07","type":{"id":1,"name":"cat"},
"owner":{"id":1,"firstName":"George","lastName":"Franklin","address":"110...
```

The previous output shows the initially configured sample data and verifies that the application is now connected to the database service.

4.4.4. Additional Resources

- Installing Service Binding Operator.
- Creating applications using the Developer perspective .
- Managing resources from custom resource definitions .
- Known bindable Operators.

4.5. GETTING STARTED WITH SERVICE BINDING ON IBM POWER SYSTEMS, IBM Z, AND LINUXONE

The Service Binding Operator manages the data plane for workloads and backing services. This guide provides instructions with examples to help you create a database instance, deploy an application, and use the Service Binding Operator to create a binding connection between the application and the database service.

Prerequisites

- You have access to an OpenShift Container Platform cluster using an account with **cluster-admin** permissions.
- You have installed the **oc** CLI.
- You have installed PostgreSQL **psql** CLI.
- You have installed the Service Binding Operator from OperatorHub.

4.5.1. Deploying a PostgreSQL Operator

- To deploy the Dev4Devs PostgreSQL Operator in the **my-postgresql** namespace run the following command in shell:

```
$ oc apply -f - << EOD
---
apiVersion: v1
kind: Namespace
metadata:
  name: my-postgresql
---
apiVersion: operators.coreos.com/v1
kind: OperatorGroup
metadata:
  name: postgres-operator-group
  namespace: my-postgresql
---
apiVersion: operators.coreos.com/v1alpha1
kind: CatalogSource
metadata:
  name: ibm-multiarch-catalog
  namespace: openshift-marketplace
spec:
  sourceType: grpc
  image: quay.io/ibm/operator-registry-<architecture> 1
  imagePullPolicy: IfNotPresent
  displayName: ibm-multiarch-catalog
  updateStrategy:
    registryPoll:
      interval: 30m
---
apiVersion: operators.coreos.com/v1alpha1
kind: Subscription
metadata:
  name: postgresql-operator-dev4devs-com
  namespace: openshift-operators
spec:
  channel: alpha
  installPlanApproval: Automatic
  name: postgresql-operator-dev4devs-com
  source: ibm-multiarch-catalog
  sourceNamespace: openshift-marketplace
---
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: database-view
  labels:
    servicebinding.io/controller: "true"
rules:
  - apiGroups:
      - postgresql.dev4devs.com
    resources:
      - databases
    verbs:
      - get
      - list
EOD
```

1 The Operator image.

- For IBM Power Systems: **quay.io/ibm/operator-registry-ppc64le:release-4.9**
- For IBM Z and LinuxONE: **quay.io/ibm/operator-registry-s390x:release-4.8**

After the operator is installed, list the operator subscriptions in **openshift-operators** namespace:

```
$ oc get subs -n openshift-operators
```

Example output

```
NAME                             PACKAGE                          SOURCE              CHANNEL
postgresql-operator-dev4devs-com   postgresql-operator-dev4devs-com   ibm-multiarch-catalog
alpha
rh-service-binding-operator        rh-service-binding-operator        redhat-operators        stable
```

4.5.2. Creating a PostgreSQL database instance

To create a PostgreSQL database instance, you must create a **Database** custom resource (CR) and configure the database.

Procedure

1. Create the **Database** CR and the **my-postgresql** namespace by running the following command in shell:

   ```
   $ oc apply -f - << EOD
   apiVersion: postgresql.dev4devs.com/v1alpha1
   kind: Database
   metadata:
     name: sampledatabase
     namespace: my-postgresql
     annotations:
       host: sampledatabase
       type: postgresql
       port: "5432"
       service.binding/database: 'path={.spec.databaseName}'
       service.binding/port: 'path={.metadata.annotations.port}'
       service.binding/password: 'path={.spec.databasePassword}'
       service.binding/username: 'path={.spec.databaseUser}'
       service.binding/type: 'path={.metadata.annotations.type}'
       service.binding/host: 'path={.metadata.annotations.host}'
   spec:
     databaseCpu: 30m
     databaseCpuLimit: 60m
     databaseMemoryLimit: 512Mi
     databaseMemoryRequest: 128Mi
     databaseName: "sampledb"
     databaseNameKeyEnvVar: POSTGRESQL_DATABASE
     databasePassword: "samplepwd"
     databasePasswordKeyEnvVar: POSTGRESQL_PASSWORD
     databaseStorageRequest: 1Gi
     databaseUser: "sampleuser"
     databaseUserKeyEnvVar: POSTGRESQL_USER
     image: registry.redhat.io/rhel8/postgresql-96:latest
     databaseStorageClassName: nfs-storage-provisioner
     size: 1
   EOD
   ```

   The annotations added in this **Database** CR enable the service binding connection and trigger the Operator reconciliation.

   The output verifies that the database instance is created:

   Example output

   ```
   database.postgresql.dev4devs.com/sampledatabase created
   ```

2. After you have created the database instance, ensure that all the pods in the **my-postgresql** namespace are running (it will take a few minutes):

   ```
   $ oc get pods -n my-postgresql
   ```

   The output verifies that the database is created:

   Example output

```
NAME                                READY   STATUS     RESTARTS   AGE
sampledatabase-cbc655488-74kss          0/1     Running       0       32s
```

The new database is empty at this stage. You can set its schema and project a sample data set to interact with the sample application.

3. Initialize the database with the schema and sample data. To do so, use the following custom shell script by copying the code into the shell and running it:

```
$ cat << EOD | bash
#!/bin/bash

export pgo_cluster_name=sampledb
export cluster_namespace=my-postgresql
export pgo_cluster_username=sampleuser
nohup oc -n "\${cluster_namespace}" port-forward svc/sampledatabase 5432:5432 &
sleep 5
curl -LO https://raw.githubusercontent.com/spring-petclinic/spring-petclinic-
rest/master/src/main/resources/db/postgresql/initDB.sql
psql -h localhost -U "\${pgo_cluster_username}" "\${pgo_cluster_name}" -f initDB.sql
curl -LO https://raw.githubusercontent.com/spring-petclinic/spring-petclinic-
rest/master/src/main/resources/db/postgresql/populateDB.sql
psql -h localhost -U "\${pgo_cluster_username}" "\${pgo_cluster_name}" -f populateDB.sql
EOD
```

The output in the terminal shows you that the database is being configured for the application.

After the database is configured, you can deploy the sample application and connect it to the database service.

4.5.3. Deploying the Spring PetClinic sample application

To deploy the Spring PetClinic sample application on an OpenShift Container Platform cluster, you must use a deployment configuration and configure your local environment to be able to test the application.

Procedure

1. Deploy the **spring-petclinic-rest** application with the **PostgresCluster** custom resource (CR) by running the following command in shell:

```
$ oc apply -f - << EOD
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: spring-petclinic-rest
  namespace: my-postgresql
  labels:
    app: spring-petclinic-rest
spec:
  replicas: 1
  selector:
    matchLabels:
      app: spring-petclinic-rest
  template:
    metadata:
      labels:
        app: spring-petclinic-rest
    spec:
      containers:
        - name: application
          image: quay.io/service-binding/spring-petclinic-rest:latest
          env:
          - name: SPRING_PROFILES_ACTIVE
            value: postgresql,spring-data-jpa
          - name: org.springframework.cloud.bindings.boot.enable
            value: "true"
          ports:
          - name: http
            containerPort: 9966
---
apiVersion: v1
kind: Service
metadata:
  name: spring-petclinic-rest
  namespace: my-postgresql
spec:
  ports:
  - port: 80
    targetPort: 9966
  selector:
    app: spring-petclinic-rest
---
EOD
```

The output verifies that the Spring PetClinic sample application is created and deployed:

Example output

```
deployment.apps/spring-petclinic-rest created
service/spring-petclinic-rest created
```

```
$ oc get pods -n my-postgresql
```

The output verifies that the database is created:

Example output

```
NAME                                    READY   STATUS      RESTARTS   AGE
sampledatabase-cbc655488-6n25f          0/1     Running     0          1m
spring-petclinic-rest-7659d5b774-zkjpg  2/2     Running     0          2m
```

2. Set up port forwarding from the application port to access the sample application from your local environment:

```
$ oc port-forward --address 0.0.0.0 svc/spring-petclinic-rest 9966:80 -n my-postgresql
```

3. Access http://localhost:9966/petclinic.
You can now remotely access the Spring PetClinic sample application at localhost:9966.

NOTE

The application is not yet connected to the database service. If you try to interact with the application, it will return errors.

For example, if you try to access the list of all pets using **curl**, you can see an error message similar to the following sample message:

```
$ curl -X GET "http://localhost:9966/petclinic/api/pets" -H "accept: application/json"
```

Example output

```
{"className":"org.springframework.transaction.CannotCreateTransactionException","exMessa
ge":"Could
not open JPA EntityManager for transaction; nested exception is
org.hibernate.exception.JDBCConnectionException: Unable to acquire JDBC
Connection"}
```

You can now use the Service Binding Operator to connect the application to the database service.

4.5.4. Connecting the Spring PetClinic sample application to the PostgreSQL database service

To connect the sample application to the database service, you must create a **ServiceBinding** custom resource (CR) that triggers the Service Binding Operator to project the binding data into the application.

Procedure

1. Create a **ServiceBinding** CR to project the binding data:

```
$ oc apply -f - << EOD
---
apiVersion: binding.operators.coreos.com/v1alpha1
kind: ServiceBinding
metadata:
  name: spring-petclinic-rest
  namespace: my-postgresql
spec:
  services: (1)
  - group: postgresql.dev4devs.com
    version: v1beta1
    kind: Database (2)
    name: sampledatabase
    version: v1alpha1
  application: (3)
    name: spring-petclinic-rest
    group: apps
    version: v1
    resource: deployments
EOD
```

(1) Specifies a list of service resources.

2 The CR of the database.

3 The sample application that points to a Deployment or any other similar resource with an embedded PodSpec.

The output verifies that the **ServiceBinding** CR is created to project the binding data into the sample application.

Example output

```
servicebinding.binding.operators.coreos.com/spring-petclinic-rest created
```

2. To verify that the binding is successful, check the status conditions of the binding resource:

```
$ oc get servicebindings spring-petclinic-rest -n my-postgresql -o jsonpath-as-
json='{.status.conditions}'
```

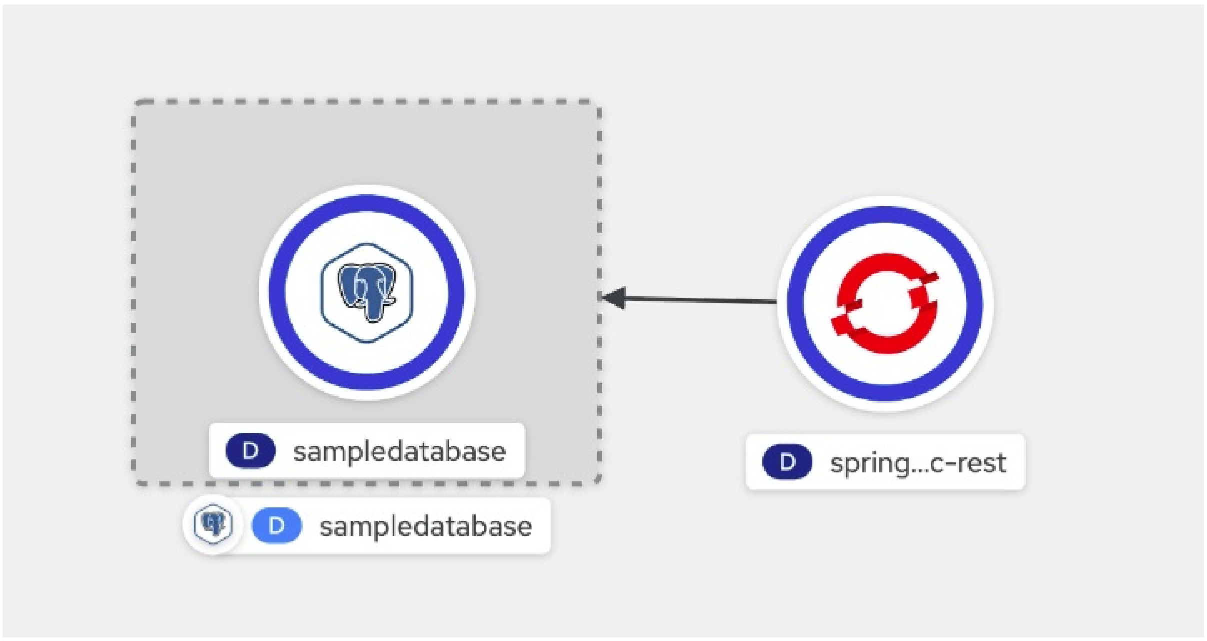
Example output

```
[
  [
    {
      "lastTransitionTime": "2021-09-06T13:42:28Z",
      "message": "",
      "reason": "DataCollected",
      "status": "True",
      "type": "CollectionReady",
    },
    {
      "lastTransitionTime": "2021-09-06T13:42:28Z",
      "message": "",
      "reason": "ApplicationUpdated",
      "status": "True",
      "type": "InjectionReady",
    },
    {
      "lastTransitionTime": "2021-09-06T13:42:28Z",
      "message": "",
      "reason": "ApplicationsBound",
      "status": "True",
      "type": "Ready",
    },
  ],
]
```

By default, the values from the binding data of the database service are projected as files into the workload container that runs the sample application.

3. Once this is created, you can go to the topology to see the visual connection.

Figure 4.1. Connecting spring-petclinic-rest to sampledatabase



4. Set up the port forwarding from the application port to access the sample application from your local environment:

```
$ oc port-forward --address 0.0.0.0 svc/spring-petclinic-rest 9966:80 -n my-postgresql
```

5. Access http://localhost:9966/petclinic.
   You can now remotely access the Spring PetClinic sample application at localhost:9966.

6. To verify that the application is now connected to the database service, access the list of all pets:

```
$ curl -X GET "http://localhost:9966/petclinic/api/pets" -H "accept: application/json"
```

Example output

```
[{"id":1,"name":"Leo","birthDate":"2000/09/07","type":{"id":1,"name":"cat"},
"owner":{"id":1,"firstName":"George","lastName":"Franklin","address":"110...
```

The previous output shows the initially configured sample data and verifies that the application is now connected to the database service.

4.5.5. Additional Resources

- Installing Service Binding Operator
- Creating applications using the Developer perspective
- Managing resources from custom resource definitions

4.6. EXPOSING BINDING DATA FROM A SERVICE

Application developers need access to backing services to build and connect workloads. Connecting workloads to backing services is always a challenge because each service provider requires a different way to access their secrets and consume them in a workload.

The Service Binding Operator enables application developers to easily bind workloads together with operator-managed backing services, without any manual procedures to configure the binding connection. For the Service Binding Operator to provide the binding data, as an Operator provider or user who creates backing services, you must expose the binding data to be automatically detected by the Service Binding Operator. Then, the Service Binding Operator automatically collects the binding data from the backing service and shares it with a workload to provide a consistent and predictable experience.

4.6.1. Methods of exposing binding data

This section describes the methods you can use to expose the binding data.

Ensure that you know and understand your workload requirements and environment, and how it works with the provided services.

Binding data is exposed under the following circumstances:

- Backing service is available as a provisioned service resource.
  The service you intend to connect to is compliant with the Service Binding specification. You must create a **Secret** resource with all the required binding data values and reference it in the backing service custom resource (CR). The detection of all the binding data values is automatic.

- Backing service is not available as a provisioned service resource.
  You must expose the binding data from the backing service. Depending on your workload requirements and environment, you can choose any of the following methods to expose the binding data:

  - Direct secret reference
  - Declaring binding data through custom resource definition (CRD) or CR annotations
  - Declaring binding data through Operator Lifecycle Manager (OLM) descriptors
  - Detection of binding data through owned resources

4.6.1.1. Provisioned service

Provisioned service represents a backing service CR with a reference to a **Secret** resource placed in the **.status.binding.name** field of the backing service CR.

As an Operator provider or the user who creates backing services, you can use this method to be compliant with the Service Binding specification, by creating a **Secret** resource and referencing it in the **.status.binding.name** section of the backing service CR. This **Secret** resource must provide all the binding data values required for a workload to connect to the backing service.

The following examples show an **AccountService** CR that represents a backing service and a **Secret** resource referenced from the CR.

Example: AccountService CR

```
apiVersion: example.com/v1alpha1
kind: AccountService
name: prod-account-service
spec:
  ...
```

```
status:
  binding:
    name: hippo-pguser-hippo
```

Example: Referenced Secret resource

```
apiVersion: v1
kind: Secret
metadata:
  name: hippo-pguser-hippo
data:
  password: "MTBz"
  user: "Z3Vlc3Q="
  ...
```

When creating a service binding resource, you can directly give the details of the **AccountService** resource in the **ServiceBinding** specification as follows:

Example: ServiceBinding resource

```
apiVersion: binding.operators.coreos.com/v1alpha1
kind: ServiceBinding
metadata:
  name: account-service
spec:
  ...
  services:
  - group: "example.com"
    version: v1alpha1
    kind: AccountService
    name: prod-account-service
  application:
    name: spring-petclinic-rest
    group: apps
    version: v1
    resource: deployments
```

IMPORTANT

Service Binding (Spec API Tech Preview)with the **servicebinding.io** API group is a Technology Preview feature only. Technology Preview features are not supported with Red Hat production service level agreements (SLAs) and might not be functionally complete. Red Hat does not recommend using them in production. These features provide early access to upcoming product features, enabling customers to test functionality and provide feedback during the development process. For more information about the support scope of Red Hat Technology Preview features, see https://access.redhat.com/support/offerings/techpreview/.

Example: ServiceBinding resource in Specification API

```
apiVersion: servicebinding.io/v1alpha3
kind: ServiceBinding
metadata:
  name: account-service
spec:
  ...
  service:
    apiVersion: example.com/v1alpha1
    kind: AccountService
    name: prod-account-service
  application:
    apiVersion: apps/v1
    kind: Deployment
    name: spring-petclinic-rest
```

This method exposes all the keys in the **hippo-pguser-hippo** referenced **Secret** resource as binding data that is to be projected into the workload.

4.6.1.2. Direct secret reference

You can use this method, if all the required binding data values are available in a **Secret** resource that you can reference in your Service Binding definition. In this method, a **ServiceBinding** resource directly references a **Secret** resource to connect to a service. All the keys in the **Secret** resource are exposed as binding data.

Example: Specification with the binding.operators.coreos.com API

```
apiVersion: binding.operators.coreos.com/v1alpha1
kind: ServiceBinding
metadata:
  name: account-service
spec:
  ...
  services:
  - group: ""
    version: v1
    kind: Secret
    name: hippo-pguser-hippo
```

Example: Specification that is compliant with the servicebinding.io API

```
apiVersion: servicebinding.io/v1alpha3
kind: ServiceBinding
metadata:
  name: account-service
spec:
  ...
  service:
    apiVersion: v1
    kind: Secret
    name: hippo-pguser-hippo
```

4.6.1.3. Declaring binding data through CRD or CR annotations

You can use this method to annotate the resources of the backing service to expose the binding data with specific annotations. Adding annotations under the **metadata** section alters the CRs and CRDs of the backing services. Service Binding Operator detects the annotations added to the CRs and CRDs and then creates a **Secret** resource with the values extracted based on the annotations.

The following examples show the annotations that are added under the **metadata** section and a referenced **ConfigMap** object from a resource:

Example: Exposing binding data from a Secret object defined in the CR annotations

```
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    service.binding: 'path={.metadata.name}-pguser-{.metadata.name},objectType=Secret'
    ...
```

The previous example places the name of the secret name in the **{.metadata.name}-pguser-{.metadata.name}** template that resolves to **hippo-pguser-hippo**. The template can contain multiple JSONPath expressions.

Example: Referenced Secret object from a resource

```
apiVersion: v1
kind: Secret
metadata:
  name: hippo-pguser-hippo
data:
  password: "MTBz"
  user: "Z3Vlc3Q="
```

Example: Exposing binding data from a ConfigMap object defined in the CR annotations

```
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    service.binding: 'path={.metadata.name}-config,objectType=ConfigMap'
    ...
```

The previous example places the name of the config map in the **{.metadata.name}-config** template that resolves to **hippo-config**. The template can contain multiple JSONPath expressions.

Example: Referenced ConfigMap object from a resource

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: hippo-config
data:
  db_timeout: "10s"
  user: "hippo"
```

4.6.1.4. Declaring binding data through OLM descriptors

You can use this method if your backing service is provided by an Operator. If your Operator is distributed as an OLM bundle, you can add OLM descriptors to describe the binding data that is to be exposed. The OLM descriptors are part of Cluster Service Version resources. The Service Binding Operator detects the OLM descriptors and then creates a **Secret** resource with the values extracted based on the detected OLM descriptors.

You can expose the binding data by using the **specDescriptors** array and **statusDescriptors** array. The **specDescriptors** array specifies a path under the **.spec** section of a CR. The **statusDescriptors** array specifies a path under the **.status** section of a CR.

Following are the only two fields that are used for binding the data:

- **Path**: A dot-delimited path of the field on the object as described by the descriptor.
- **X-Descriptors**: Defines the binding data.

The following examples show how to define an X-Descriptor depending on the resource to which you point the path:

Example: X-Descriptor definition for exposing a secret

```
- path: data.dbConfiguration
  x-descriptors:
  - urn:alm:descriptor:io.kubernetes:Secret
  - service.binding
```

Example: X-Descriptor definition for exposing a config map

```
- path: data.dbConfiguration
  x-descriptors:
  - urn:alm:descriptor:io.kubernetes:ConfigMap
  - service.binding
```

NOTE

- You must have a **service.binding** entry in the X-Descriptors to identify that it is a configuration for service binding.
- The absence of the **Secret** or **ConfigMap** specific X-Descriptors indicates that the descriptor is referencing the binding data value at the given path.

4.6.1.5. Detection of binding data through owned resources

You can use this method if your backing service owns one or more Kubernetes resources such as route, service, config map, or secret that you can use to detect the binding data. In this method, the Service Binding Operator detects the binding data from resources owned by the backing service CR.

The following examples show the **detectBindingResources** API option set to **true** in the **ServiceBinding** CR:

Example

```
apiVersion: binding.operators.coreos.com/v1alpha1
```

```
kind: ServiceBinding
metadata:
  name: spring-petclinic-rest-detect-all
  namespace: my-postgresql
spec:
  detectBindingResources: true
  services:
    - group: postgres-operator.crunchydata.com
      version: v1beta1
      kind: PostgresCluster
      name: hippo
  application:
    name: spring-petclinic-rest
    group: apps
    version: v1
    resource: deployments
```

In the previous example, **PostgresCluster** custom service resource owns one or more Kubernetes resources such as route, service, config map, or secret.

The Service Binding Operator automatically detects the binding data exposed on each of the owned resources.

4.6.2. Data model

Service binding annotations must use the following convention:

```
service.binding(/<NAME>)?:
    "<VALUE>|(path=<JSONPATH_TEMPLATE>(,objectType=<OBJECT_TYPE>)?(,elementType=
<ELEMENT_TYPE>)?(,sourceKey=<SOURCE_KEY>)?(,sourceValue=<SOURCE_VALUE>)?)"
```

where:

<NAME>	Specifies the name under which the binding value is to be exposed. You can exclude it only when the **objectType** parameter is set to **Secret** or **ConfigMap**.
<VALUE>	Specifies the constant value exposed when no **path** is set.

This section explains the data model used in the annotations and OLM descriptors. The data model is the same for custom resource definition (CRD) or custom resource (CR) annotations and Operator Lifecycle Manager (OLM) descriptors, but the syntax differs.

The data model provides the details on the allowed values and semantic for the **path**, **elementType**, **objectType**, **sourceKey**, and **sourceValue** parameters.

Table 4.2. Parameters and their descriptions

Parameter	Description	Default value
path	JSONPath template that consists JSONPath expressions enclosed by curly braces {}.	N/A

Parameter	Description	Default value
elementType	Specifies whether the value of the element referenced in the **path** parameter complies with any one of the following types: • **string** • **sliceOfStrings** • **sliceOfMaps**	**string**
objectType	Specifies whether the value of the element indicated in the **path** parameter refers to a **ConfigMap**, **Secret**, or plain string in the current namespace.	**Secret**, if **elementType** is non-string.
sourceKey	Specifies the key in the **ConfigMap** or **Secret** resource to be added to the binding secret when collecting the binding data. Note: • When used in conjunction with **elementType**=**sliceOfMaps**, the **sourceKey** parameter specifies the key in the slice of maps whose value is used as a key in the binding secret. • Use this optional parameter to expose a specific entry in the referenced **Secret** or **ConfigMap** resource as binding data. • When not specified, all keys and values from the **Secret** or **ConfigMap** resource are exposed and are added to the binding secret.	N/A
sourceValue	Specifies the key in the slice of maps. Note: • The value of this key is used as the base to generate the value of the entry for the key-value pair to be added to the binding secret. • In addition, the value of the **sourceKey** is used as the key of the entry for the key-value pair to be added to the binding secret. • It is mandatory only if **elementType**=**sliceOfMaps**.	N/A

NOTE

The **sourceKey** and **sourceValue** parameters are applicable only if the element indicated in the **path** parameter refers to a **ConfigMap** or **Secret** resource.

4.6.3. RBAC requirements

To expose the backing service binding data using the Service Binding Operator, you require certain Role-based access control (RBAC) permissions. Specify certain verbs under the **rules** field of the **ClusterRole** resource to grant the RBAC permissions for the backing service resources. When you define these **rules**, you allow the Service Binding Operator to read the binding data of the backing service resources throughout the cluster.

The Service Binding Operator performs requests against the Kubernetes API using a dedicated service account. By default, this account has permissions to bind services to workloads, both represented by the following standard Kubernetes or OpenShift objects:

- **Deployments**
- **DaemonSets**
- **ReplicaSets**
- **StatefulSets**
- **DeploymentConfigs**

The Operator service account is bound to an aggregated cluster role, allowing Operator providers or cluster administrators to enable binding custom service resources to workloads. To grant the required permissions within a **ClusterRole**, label it with the **servicebinding.io/controller** flag and set the flag value to **true**. The following example shows how to allow the Service Binding Operator to **get**, **watch**, and **list** the custom resources (CRs) of Crunchy PostgreSQL Operator:

Example: Enable binding to PostgreSQL database instances provisioned by Crunchy PostgreSQL Operator

```
apiVersion: rbac.authorization.k8s.io/v1
kind: ClusterRole
metadata:
  name: postgrescluster-reader
  labels:
     servicebinding.io/controller: "true"
rules:
- apiGroups:
    - postgres-operator.crunchydata.com
  resources:
    - postgresclusters
  verbs:
    - get
    - watch
    - list
  ...
```

This cluster role can be deployed during the installation of the backing service Operator.

4.6.4. Categories of exposable binding data

The Service Binding Operator enables you to expose the binding data values from the backing service resources and custom resource definitions (CRDs).

This section provides examples to show how you can use the various categories of exposable binding data. You must modify these examples to suit your work environment and requirements.

4.6.4.1. Exposing a string from a resource

The following example shows how to expose the string from the **metadata.name** field of the **PostgresCluster** custom resource (CR) as a username:

Example

```
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    service.binding/username: path={.metadata.name}
    ...
```

4.6.4.2. Exposing a constant value as the binding item

The following examples show how to expose a constant value from the **PostgresCluster** custom resource (CR):

Example: Exposing a constant value

```
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    "service.binding/type": "postgresql" (1)
```

(1) Binding **type** to be exposed with the **postgresql** value.

4.6.4.3. Exposing an entire config map or secret that is referenced from a resource

The following examples show how to expose an entire secret through annotations:

Example: Exposing an entire secret through annotations

```
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    service.binding: 'path={.metadata.name}-pguser-{.metadata.name},objectType=Secret'
```

Example: The referenced secret from the backing service resource

```
apiVersion: v1
kind: Secret
metadata:
  name: hippo-pguser-hippo
data:
  password: "MTBz"
  user: "Z3Vlc3Q="
```

The following example shows how to expose an entire config map through OLM descriptors:

Example: Exposing an entire config map through OLM descriptors

```
- path: data.dbConfiguration
  x-descriptors:
  - urn:alm:descriptor:io.kubernetes:ConfigMap
  - service.binding
```

This example uses the **path** attribute with a **urn:alm:descriptor:io.kubernetes:ConfigMap** entry to indicate that the path points to the **ConfigMap** service resource.

If you intend to project all the values from a **ConfigMap** service resource, you must specify it as an attribute in the backing service CR. For example, if the attribute is part of the **.spec** section, you can create and use a **specDescriptors** array. Or, if the attribute is part of the **.status** section, you can create and use a **statusDescriptors** array.

4.6.4.4. Exposing a specific entry from a config map or secret that is referenced from a resource

The following examples show how to expose a specific entry from a config map through annotations:

Example: Exposing an entry from a config map through annotations

```
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    service.binding: 'path={.metadata.name}-config,objectType=ConfigMap,sourceKey=user'
```

Example: The referenced config map from the backing service resource

The binding data should have a key with name as **db_timeout** and value as **10s**:

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: hippo-config
```

```
data:
  db_timeout: "10s"
  user: "hippo"
```

The following example shows how to expose a specific entry from a config map through OLM descriptors:

Example: Exposing an entry from a config map through OLM descriptors

```
- path: data.dbConfiguration
  x-descriptors:
  - urn:alm:descriptor:io.kubernetes:ConfigMap
  - service.binding:my_certificate:sourceKey=certificate
```

This example uses the **path** attribute with an **X-Descriptors** update for **service.binding** and **sourceKey** by providing the following information:

- Name of the binding key that is to be projected
- Name of the key in the Secret service resource

4.6.4.5. Exposing a resource definition value

The following example shows how to expose a resource definition value through annotations:

Example: Exposing a resource definition value through annotations

```
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    service.binding/username: path={.metadata.name}
    ...
```

The following example shows how to expose a resource definition value through OLM descriptors:

Example: Exposing a resource definition value through OLM descriptors

```
- path: data.connectionURL
  x-descriptors:
  - service.binding:uri
```

The previous example uses the **connectionURL** attribute that points to the required resource definition value that is to be projected as **uri**.

If required values are available as attributes of backing service resources, annotating these values using **X-Descriptors** identifies them as the binding data.

4.6.4.6. Exposing entries of a collection with the key and value from each entry

The following example shows how to expose the entries of a collection with the key and value from each entry through annotations:

Example: Exposing the entries of a collection through annotations

```
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    "service.binding/uri": "path=
{.status.connections},elementType=sliceOfMaps,sourceKey=type,sourceValue=url"
spec:
  ...
status:
  connections:
    - type: primary
      url: primary.example.com
    - type: secondary
      url: secondary.example.com
    - type: '404'
      url: black-hole.example.com
```

The following example shows how the previous entries of a collection in annotations are projected into the bound application.

Example: Binding data files

```
/bindings/<binding-name>/uri_primary => primary.example.com
/bindings/<binding-name>/uri_secondary => secondary.example.com
/bindings/<binding-name>/uri_404 => black-hole.example.com
```

The following example shows how to expose the entries of a collection with the key and value from each entry through OLM descriptors:

Example: Exposing the entries of a collection through OLM descriptors

```
- path: bootstrap
  x-descriptors:
  - service.binding:endpoints:elementType=sliceOfMaps:sourceKey=type:sourceValue=url
```

The previous example uses the **path** attribute with an **X-Descriptors** update for the required entries of a collection.

Example: Configuration from a backing service resource

```
status:
  connections:
    - type: primary
      url: primary.example.com
    - type: secondary
      url: secondary.example.com
    - type: '404'
      url: black-hole.example.com
```

The previous example helps you to project all those values with keys such as **primary**, **secondary**, and so on.

4.6.4.7. Exposing items of a collection with one key per item

The following example shows how to expose the items of a collection with one key per item through annotations:

Example: Exposing the items of a collection through annotations

```
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    "service.binding/tags": "path={.spec.tags},elementType=sliceOfStrings"
spec:
    tags:
      - knowledge
      - is
      - power
```

The following example shows how the previous items of a collection in annotations are projected into the bound application.

Example: Binding data files

```
/bindings/<binding-name>/tags_0 => knowledge
/bindings/<binding-name>/tags_1 => is
/bindings/<binding-name>/tags_2 => power
```

The following example shows how to expose the items of a collection with one key per item through OLM descriptors:

Example: Exposing the items of a collection through OLM descriptors

```
- path: spec.tags
  x-descriptors:
  - service.binding:tags:elementType=sliceOfStrings
```

The previous example uses the **path** attribute with an **X-Descriptors** update for the required items of a collection.

Example: Configuration from a backing service resource

```
spec:
  tags:
  - knowledge
  - is
  - power
```

4.6.4.8. Exposing values of collection entries with one key per entry value

The following example shows how to expose the values of collection entries with one key per entry value through annotations:

Example: Exposing the values of collection entries through annotations

```
apiVersion: postgres-operator.crunchydata.com/v1beta1
kind: PostgresCluster
metadata:
  name: hippo
  namespace: my-postgresql
  annotations:
    "service.binding/url": "path={.spec.connections},elementType=sliceOfStrings,sourceValue=url"
spec:
  connections:
    - type: primary
      url: primary.example.com
    - type: secondary
      url: secondary.example.com
    - type: '404'
      url: black-hole.example.com
```

The following example shows how the previous values of a collection in annotations are projected into the bound application.

Example: Binding data files

```
/bindings/<binding-name>/url_0 => primary.example.com
/bindings/<binding-name>/url_1 => secondary.example.com
/bindings/<binding-name>/url_2 => black-hole.example.com
```

The following example shows how to expose the values of collection entries with one key per entry value through OLM descriptors:

Example: Exposing the values of collection entries through OLM descriptors

```
- path: bootstrap
  x-descriptors:
  - service.binding:endpoints:elementType=sliceOfStrings:sourceValue=url
```

4.6.5. Additional resources

- OLM Descriptor Reference.
- Defining cluster service versions (CSVs) .
- Projecting binding data.

4.7. PROJECTING BINDING DATA

This section provides information on how you can consume the binding data.

4.7.1. Consumption of binding data

After the backing service exposes the binding data, for a workload to access and consume this data, you must project it into the workload from a backing service. Service Binding Operator automatically projects this set of data into the workload in the following methods:

1. By default, as files.
2. As environment variables, after you configure the **.spec.bindAsFiles** parameter from the **ServiceBinding** resource.

4.7.2. Configuration of the directory path to project the binding data inside workload container

By default, Service Binding Operator mounts the binding data as files at a specific directory in your workload resource. You can configure the directory path using the **SERVICE_BINDING_ROOT** environment variable setup in the container where your workload runs.

Example: Binding data mounted as files

```
$SERVICE_BINDING_ROOT (1)
├── account-database (2)
│   ├── type (3)
│   ├── provider (4)
│   ├── uri
│   ├── username
│   └── password
└── transaction-event-stream (5)
    ├── type
    ├── connection-count
    ├── uri
    ├── certificates
    └── private-key
```

1 Root directory.

2 5 Directory that stores the binding data.

3 Mandatory identifier that identifies the type of the binding data projected into the corresponding directory.

4 Optional: Identifier to identify the provider so that the application can identify the type of backing service it can connect to.

To consume the binding data as environment variables, use the built-in language feature of your programming language of choice that can read environment variables.

Example: Python client usage

```
import os
username = os.getenv("USERNAME")
password = os.getenv("PASSWORD")
```

4.7.2.1. Computation of the final path for projecting the binding data as files

The following table summarizes the configuration of how the final path for the binding data projection is computed when files are mounted at a specific directory:

Table 4.3. Summary of the final path computation

SERVICE_BINDING_ROOT	Final path
Not available	**/bindings/<ServiceBinding_ResourceName>**
dir/path/root	**dir/path/root/<ServiceBinding_ResourceName>**

In the previous table, the **<ServiceBinding_ResourceName>** entry specifies the name of the **ServiceBinding** resource that you configure in the **.metadata.name** section of the custom resource (CR).

To access and consume the binding data within the existing **SERVICE_BINDING_ROOT** environment variable, use the built-in language feature of your programming language of choice that can read environment variables.

Example: Python client usage

```
from pyservicebinding import binding
try:
    sb = binding.ServiceBinding()
except binding.ServiceBindingRootMissingError as msg:
    # log the error message and retry/exit
    print("SERVICE_BINDING_ROOT env var not set")
sb = binding.ServiceBinding()
bindings_list = sb.bindings("postgresql")
```

In the previous example, the **bindings_list** variable contains the binding data for the **postgresql** database service type.

4.7.3. Projecting the binding data

Depending on your workload requirements and environment, you can choose to project the binding data either as files or environment variables.

Prerequisites

- You understand the following concepts:
  - Environment and requirements of your workload, and how it works with the provided services.
  - Consumption of the binding data in your workload resource.
  - Configuration of how the final path for data projection is computed for the default method.
- The binding data is exposed from the backing service.

Procedure

1. To project the binding data as files, determine the destination folder by ensuring that the existing **SERVICE_BINDING_ROOT** environment variable is present in the container where your workload runs.

2. To project the binding data as environment variables, set the value for the **.spec.bindAsFiles** parameter to **false** from the **ServiceBinding** resource in the custom resource (CR).

4.7.4. Additional resources

- Exposing binding data from a service .
- Using the projected binding data in the source code of the application .

4.8. BINDING WORKLOADS USING SERVICE BINDING OPERATOR

Application developers must bind a workload to one or more backing services by using a binding secret. This secret is generated for the purpose of storing information to be consumed by the workload.

As an example, consider that the service you want to connect to is already exposing the binding data. In this case, you would also need a workload to be used along with the **ServiceBinding** custom resource (CR). By using this **ServiceBinding** CR, the workload sends a binding request with the details of the services to bind with.

Example of ServiceBinding CR

```
apiVersion: binding.operators.coreos.com/v1alpha1
kind: ServiceBinding
metadata:
  name: spring-petclinic-rest
  namespace: my-postgresql
spec:
  services: 1
  - group: postgres-operator.crunchydata.com
    version: v1beta1
    kind: PostgresCluster
    name: hippo
  - group: ""
    version: v1
    kind: Secret
    name: hippo-pguser-hippo
  application: 2
    name: spring-petclinic-rest
    group: apps
    version: v1
    resource: deployments
```

1 Specifies a list of service resources.

2 The sample application that points to a Deployment or any other similar resource with an embedded PodSpec.

As shown in the previous example, you can also directly use a **ConfigMap** or a **Secret** itself as a service resource to be used as a source of binding data.

4.8.1. Naming strategies

Naming strategies are available only for the **binding.operators.coreos.com** API group.

Naming strategies use Go templates to help you define custom binding names through the service binding request. Naming strategies apply for all attributes including the mappings in the **ServiceBinding** custom resource (CR).

A backing service projects the binding names as files or environment variables into the workload. If a workload expects the projected binding names in a particular format, but the binding names to be projected from the backing service are not available in that format, then you can change the binding names using naming strategies.

Predefined post-processing functions

While using naming strategies, depending on the expectations or requirements of your workload, you can use the following predefined post-processing functions in any combination to convert the character strings:

- **upper**: Converts the character strings into capital or uppercase letters.
- **lower**: Converts the character strings into lowercase letters.
- **title**: Converts the character strings where the first letter of each word is capitalized except for certain minor words.

Predefined naming strategies

Binding names declared through annotations or Operator Lifecycle Manager (OLM) descriptors are processed for their name change before their projection into the workload according to the following predefined naming strategies:

- **none**: When applied, there are no changes in the binding names.

  Example

  After the template compilation, the binding names take the **{{ .name }}** form.

  ```
  host: hippo-pgbouncer
  port: 5432
  ```

- **upper**: Applied when no **namingStrategy** is defined. When applied, converts all the character strings of the binding name key into capital or uppercase letters.

  Example

  After the template compilation, the binding names take the **{{ .service.kind | upper}}_{{ .name | upper }}** form.

  ```
  DATABASE_HOST: hippo-pgbouncer
  DATABASE_PORT: 5432
  ```

  If your workload requires a different format, you can define a custom naming strategy and change the binding name using a prefix and a separator, for example, **PORT_DATABASE**.

NOTE

- When the binding names are projected as files, by default the predefined **none** naming strategy is applied, and the binding names do not change.
- When the binding names are projected as environment variables and no **namingStrategy** is defined, by default the predefined **uppercase** naming strategy is applied.
- You can override the predefined naming strategies by defining custom naming strategies using different combinations of custom binding names and predefined post-processing functions.

4.8.2. Advanced binding options

Advanced binding options are available only for the **binding.operators.coreos.com** API group.

4.8.2.1. Changing the binding names before projecting them into the workload

You can specify the rules to change the binding names in the .spec.namingStrategy attribute of the **ServiceBinding** custom resource (CR). For example, consider a Spring PetClinic sample application that connects to the PostgreSQL database. In this case, the PostgreSQL database service exposes the host and port fields of the database to use for binding. The Spring PetClinic sample application can access this exposed binding data through the binding names.

Example: Spring PetClinic sample application in the ServiceBinding CR

```
...
    application:
      name: spring-petclinic-rest
      group: apps
      version: v1
      resource: deployments
...
```

Example: PostgreSQL database service in the ServiceBinding CR

```
...
    services:
    - group: postgres-operator.crunchydata.com
      version: v1beta1
      kind: PostgresCluster
      name: hippo
...
```

If **namingStrategy** is not defined and the binding names are projected as environment variables, then the **host: hippo-pgbouncer** value in the backing service and the projected environment variable would appear as shown in the following example:

Example

```
DATABASE_HOST: hippo-pgbouncer
```

where:

DATABASE	Specifies the **kind** backend service.
HOST	Specifies the binding name.

After applying the **POSTGRESQL_{{ .service.kind | upper }}_{{ .name | upper }}_ENV** naming strategy, the list of custom binding names prepared by the service binding request appears as shown in the following example:

Example

```
POSTGRESQL_DATABASE_HOST_ENV: hippo-pgbouncer
POSTGRESQL_DATABASE_PORT_ENV: 5432
```

The following items describe the expressions defined in the **POSTGRESQL_{{ .service.kind | upper }}_{{ .name | upper }}_ENV** naming strategy:

- **.name**: Refers to the binding name exposed by the backing service. In the previous example, the binding names are **HOST** and **PORT**.
- **.service.kind**: Refers to the kind of service resource whose binding names are changed with the naming strategy.
- **upper**: String function used to post-process the character string while compiling the Go template string.
- **POSTGRESQL**: Prefix of the custom binding name.
- **ENV**: Suffix of the custom binding name.

Similar to the previous example, you can define the string templates in **namingStrategy** to define how each key of the binding names should be prepared by the service binding request.

4.8.2.2. Composing custom binding data

As an application developer, you can compose custom binding data under the following circumstances:

- The backing service does not expose binding data.
- The values exposed are not available in the required format as expected by the workload.

For example, consider a case where the backing service CR exposes the host, port, and database user as binding data, but the workload requires that the binding data be consumed as a connection string. You can compose custom binding data using attributes in the Kubernetes resource representing the backing service.

Example

```
apiVersion: binding.operators.coreos.com/v1alpha1
kind: ServiceBinding
metadata:
  name: spring-petclinic-rest
  namespace: my-postgresql
spec:
    services:
    - group: postgres-operator.crunchydata.com
      version: v1beta1
      kind: PostgresCluster
      name: hippo (1)
      id: postgresDB (2)
    - group: ""
      version: v1
      kind: Secret
      name: hippo-pguser-hippo
      id: postgresSecret
    application:
      name: spring-petclinic-rest
      group: apps
      version: v1
      resource: deployments
    mappings:
      ## From the database service
      - name: JDBC_URL
        value: 'jdbc:postgresql://{{ .postgresDB.metadata.annotations.proxy }}:{{ .postgresDB.spec.port
}}/{{ .postgresDB.metadata.name }}'
      ## From both the services!
      - name: CREDENTIALS
        value: '{{ .postgresDB.metadata.name }}{{ translationService.postgresSecret.data.password }}'
      ## Generate JSON
      - name: DB_JSON (3)
        value: {{ json .postgresDB.status }} (4)
```

(1) Name of the backing service resource.

(2) Optional identifier.

(3) Generated JSON name that is to be projected as the file content or environment value. The JSON name contains the attributes of the backing service custom resource.

(4) Generated JSON value that is to be projected as the file content or environment value. The JSON value contains the attributes of the backing service custom resource.

4.8.3. Binding secondary workloads that are not compliant with PodSpec

A typical scenario in service binding involves configuring the backing service, the workload (Deployment), and Service Binding Operator. Consider a scenario that involves a secondary workload (which can also be an application Operator) that is not compliant with PodSpec and is between the primary workload (Deployment) and Service Binding Operator.

For such secondary workload resources, the location of the container path is arbitrary. For service binding, if the secondary workload in a CR is not compliant with the PodSpec, you must specify the location of the container path. Doing so projects the binding data into the container path specified in the secondary workload of the **ServiceBinding** CR, for example, when you do not want the binding data inside a pod.

Service Binding Operator provides an option to configure the value of where the container path or secret path is and bind these paths at a custom location. This option is available only for the **binding.operators.coreos.com** API group when the binding data is projected as environment variables.

4.8.3.1. Configuring the custom location of the container path

Consider a secondary workload CR, which is not compliant with the PodSpec and has containers located at the **spec.containers** path:

Example: Secondary workload CR

```
apiVersion: "operator.sbo.com/v1"
kind: SecondaryWorkload
metadata:
  name: secondary-workload
spec:
  containers:
  - name: hello-world
    image: quay.io/baijum/secondary-workload:latest
    ports:
    - containerPort: 9966
```

The following example shows how to configure the **spec.containers** path by specifying a value in the **ServiceBinding** CR and to bind this path to a **spec.application.bindingPath.containersPath** custom location:

Example: ServiceBinding CR with the spec.containers path in a custom location

```
apiVersion: binding.operators.coreos.com/v1alpha1
kind: ServiceBinding
metadata:
  name: spring-petclinic-rest
spec:
  services:
  - group: postgres-operator.crunchydata.com
    version: v1beta1
    kind: PostgresCluster
    name: hippo
    id: postgresDB
  - group: ""
    version: v1
    kind: Secret
    name: hippo-pguser-hippo
    id: postgresSecret
  application: (1)
    name: spring-petclinic-rest
    group: apps
    version: v1
    resource: deployments
  application: (2)
    name: secondary-workload
    group: operator.sbo.com
    version: v1
    resource: secondaryworkloads
    bindingPath:
      containersPath: spec.containers (3)
```

(1) The sample application that points to a Deployment or any other similar resource with an embedded PodSpec.

2 The secondary workload, which is not compliant with the PodSpec.

3 The custom location of the container path.

After you specify the location of the container path, Service Binding Operator generates the binding data, which becomes available in the container path specified in the secondary workload of the **ServiceBinding** CR.

The following example shows the **spec.containers** path with the **envFrom** and **secretRef** fields:

Example: Secondary workload CR with the envFrom and secretRef fields

```
apiVersion: "operator.sbo.com/v1"
kind: SecondaryWorkload
metadata:
  name: secondary-workload
spec:
  containers:
  - env: (1)
    - name: ServiceBindingOperatorChangeTriggerEnvVar
      value: "31793"
    envFrom:
    - secretRef:
        name: secret-resource-name (2)
    image: quay.io/baijum/secondary-workload:latest
    name: hello-world
    ports:
    - containerPort: 9966
    resources: {}
```

1 Unique array of containers with values generated by the Service Binding Operator. These values are based on the backing service CR.

2 Name of the **Secret** resource generated by the Service Binding Operator.

4.8.3.2. Configuring the custom location of the secret path

Consider a secondary workload CR, which is not compliant with the PodSpec, with only the secret at the **spec.secret** path:

Example: Secondary workload CR

```
apiVersion: "operator.sbo.com/v1"
kind: SecondaryWorkload
metadata:
  name: secondary-workload
spec:
  secret: ""
```

The following example shows how to configure the **spec.secret** path by specifying a value in the **ServiceBinding** CR and to bind this path at a **spec.application.bindingPath.secretPath** custom location:

Example: ServiceBinding CR with the spec.secret path in a custom location

```
apiVersion: binding.operators.coreos.com/v1alpha1
kind: ServiceBinding
metadata:
  name: spring-petclinic-rest
spec:
...
  application: 1
    name: secondary-workload
    group: operator.sbo.com
    version: v1
    resource: secondaryworkloads
    bindingPath:
      secretPath: spec.secret 2
...
```

1. The secondary workload, which is not compliant with the PodSpec.
2. The custom location of the secret path that contains the name of the **Secret** resource.

After you specify the location of the secret path, Service Binding Operator generates the binding data, which becomes available in the secret path specified in the secondary workload of the **ServiceBinding** CR.

The following example shows the **spec.secret** path with the **binding-request** value:

Example: Secondary workload CR with the binding-request value

```
...
apiVersion: "operator.sbo.com/v1"
kind: SecondaryWorkload
metadata:
  name: secondary-workload
spec:
  secret: binding-request-72ddc0c540ab3a290e138726940591debf14c581 1
...
```

1. Unique name of the **Secret** resource generated by the Service Binding Operator.

4.8.4. Unbinding workloads from a backing service

You can unbind a workload from a backing service by using the **oc** tool.

- To unbind a workload from a backing service, delete the **ServiceBinding** custom resource (CR) linked to it:

  ```
  $ oc delete ServiceBinding <.metadata.name>
  ```

  Example

  ```
  $ oc delete ServiceBinding spring-petclinic-rest
  ```

–

where:

spring-petclinic-rest	Specifies the name of the **ServiceBinding** CR.

4.8.5. Additional resources

- Binding a workload together with a backing service .
- Connecting the Spring PetClinic sample application to the PostgreSQL database service .

4.9. CONNECTING AN APPLICATION TO A SERVICE USING THE DEVELOPER PERSPECTIVE

In addition to grouping multiple components within an application, you can also use the **Topology** view to connect components with each other. You can either use a binding connector or a visual one to connect components.

A binding connection between the components can be established only if the target node is an Operator-backed service. This is indicated by the **Create a binding connector** tool-tip which appears when you drag an arrow to such a target node. When an application is connected to a service using a binding connector a **ServiceBinding** resource is created. Then, the Service Binding Operator controller projects the necessary binding data into the application deployment. After the request is successful, the application is redeployed establishing an interaction between the connected components.

A visual connector establishes only a visual connection between the components, depicting an intent to connect. No interaction between the components is established. If the target node is not an Operator-backed service the **Create a visual connector** tool-tip is displayed when you drag an arrow to a target node.

4.9.1. Creating a visual connection between components

You can depict an intent to connect application components using the visual connector.

This procedure walks you through an example of creating a visual connection between a PostgreSQL Database service and a Spring PetClinic sample application.

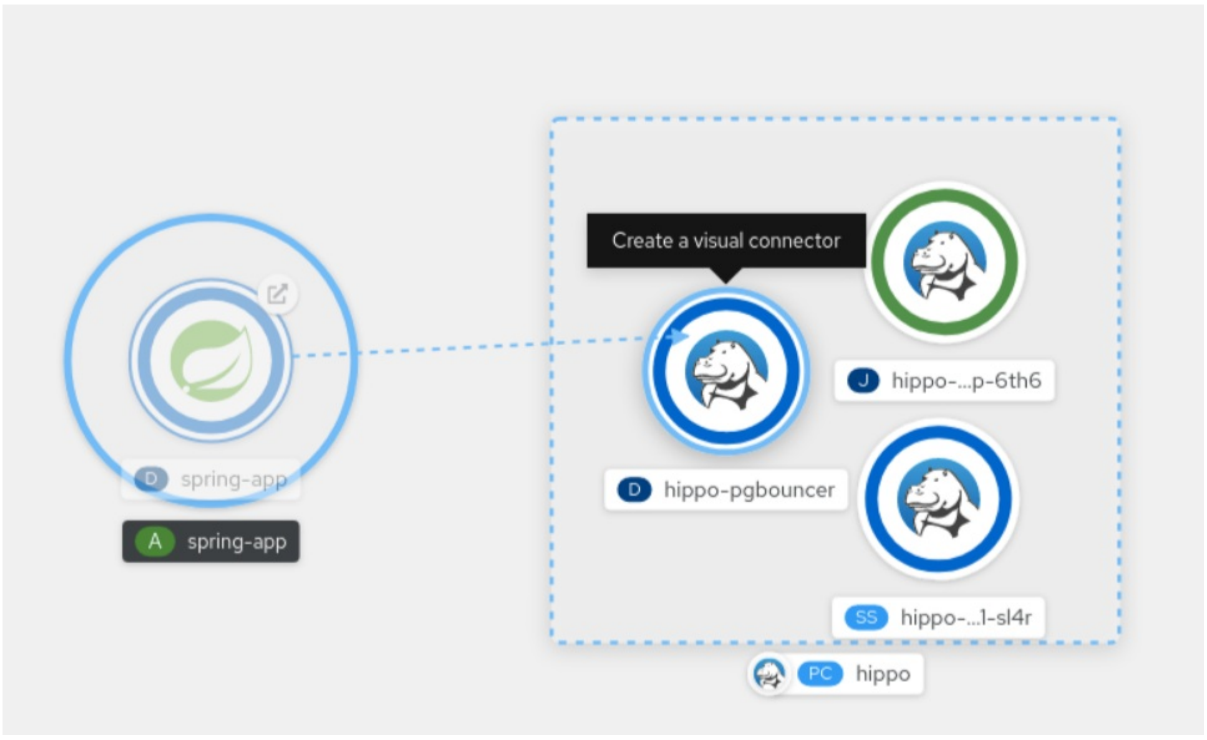
Prerequisites

- Ensure that you have created and deployed a Spring PetClinic sample application using the **Developer** perspective.
- Ensure that you have created and deployed a Crunchy PostgreSQL database instance using the **Developer** perspective. This instance has the following three components: **hippo-backup**, **hippo-instance**, and **hippo-pgbouncer**.

Procedure

1. Hover over the Spring PetClinic sample application to see a dangling arrow on the node.

Figure 4.2. Visual connector

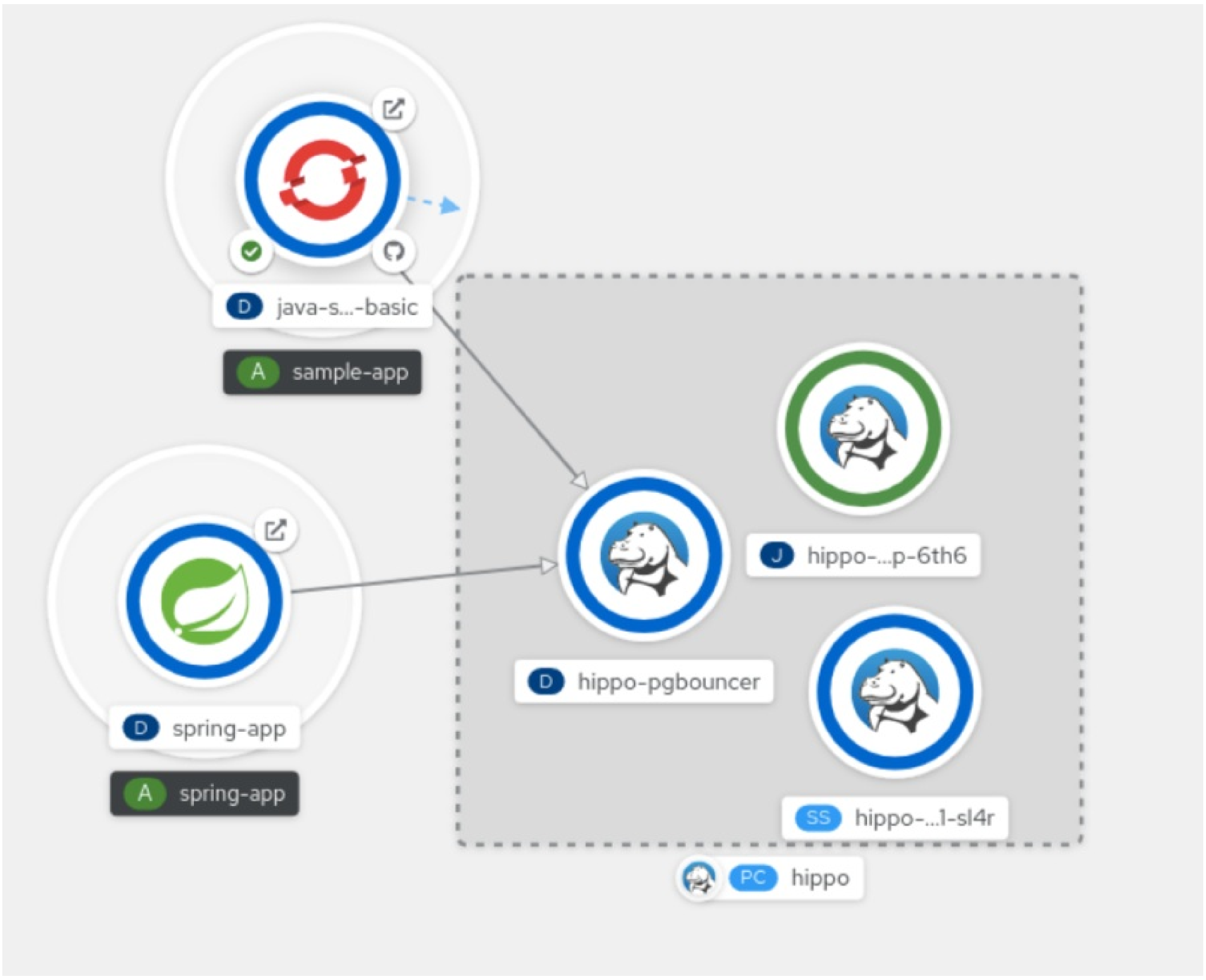


2. Click and drag the arrow towards the **hippo-pgbouncer** deployment to connect the Spring PetClinic sample application with it.

3. Click on the **spring-petclinic-rest** deployment to see the **Overview** panel. Under the **Details** tab, click the edit icon in the **Annotations** section to see the **Key = app.openshift.io/connects-to** and **Value = [{"apiVersion":"apps/v1","kind":"Deployment","name":"hippo-pgbouncer"}]** annotation added to the deployment.

Similarly you can create other applications and components and establish visual connections between them.

Figure 4.3. Connecting multiple applications



4.9.2. Creating a binding connection between components

You can establish a binding connection with Operator-backed components.

This procedure walks through an example of creating a binding connection between a PostgreSQL Database service and a Spring PetClinic sample application. To create a binding connection with a service that is backed by the PostgreSQL Database Operator, you must first add the Red Hat-provided PostgreSQL Database Operator to the **OperatorHub**, and then install the Operator. The PostreSQL Database Operator then creates and manages the **Database** resource, which exposes the binding information in secrets, config maps, status, and spec attributes.

Prerequisites

- Ensure that you have created and deployed a Spring PetClinic sample application using the **Developer** perspective.
- Ensure that you have installed the Service Binding Operator from the OperatorHub.
- Ensure that you have installed the **Crunchy Postgres for Kubernetes**Operator from the OperatorHub using **v5 Update** channel.
- Ensure that you have created and deployed a Crunchy PostgreSQL database instance using the **Developer** perspective. This instance has the following three components: **hippo-backup**, **hippo-instance**, and **hippo-pgbouncer**.

Procedure

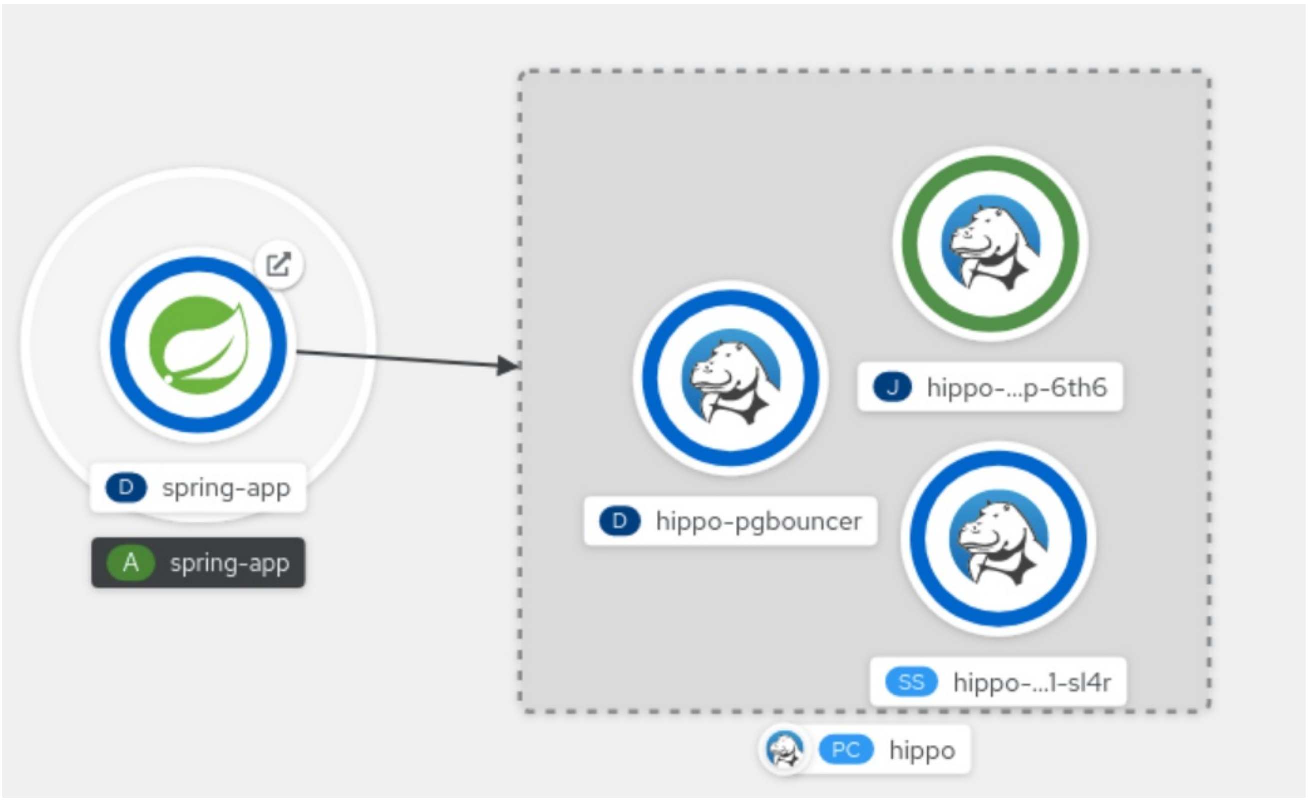
1. Switch to the **Developer** perspective and ensure that you are in the appropriate project, for example, **my-postgresql**. In the **Topology** view, hover over the Spring PetClinic sample application to see a dangling arrow on the node.

2. Click and drag the arrow towards the **hippo** database Postgres Cluster to make a binding connection with the Spring PetClinic sample application.
   Alternatively, in the **+Add** view, click the **YAML** option to see the **Import YAML** screen. Use the YAML editor and add the **ServiceBinding** resource:

```
apiVersion: binding.operators.coreos.com/v1alpha1
kind: ServiceBinding
metadata:
  name: spring-petclinic-rest
  namespace: my-postgresql
spec:
  services:
  - group: postgres-operator.crunchydata.com
    version: v1beta1
    kind: PostgresCluster
    name: hippo
  application:
    name: spring-petclinic-rest
    group: apps
    version: v1
    resource: deployments
```

A service binding request is created and the Service Binding Operator controller projects the database service connection information into the application deployment as files using a volume mount. After the request is successful, the application is redeployed and the connection is established.

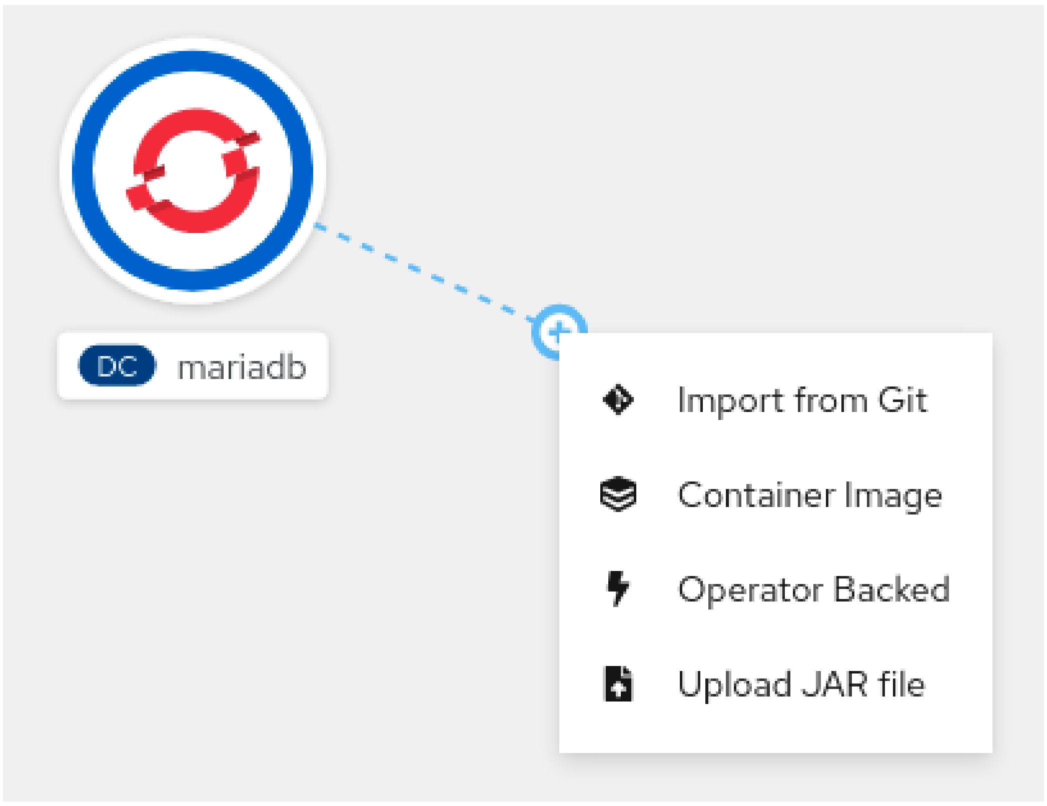
Figure 4.4. Binding connector



NOTE

You can also use the context menu by dragging the dangling arrow to add and create a binding connection to an operator-backed service.

Figure 4.5. Context menu to create binding connection



4.9.3. Additional resources

- Getting started with service binding.
- Known bindable Operators.

CHAPTER 5. WORKING WITH HELM CHARTS

5.1. UNDERSTANDING HELM

Helm is a software package manager that simplifies deployment of applications and services to OpenShift Container Platform clusters.

Helm uses a packaging format called *charts*. A Helm chart is a collection of files that describes the OpenShift Container Platform resources.

A running instance of the chart in a cluster is called a *release*. A new release is created every time a chart is installed on the cluster.

Each time a chart is installed, or a release is upgraded or rolled back, an incremental revision is created.

5.1.1. Key features

Helm provides the ability to:

- Search through a large collection of charts stored in the chart repository.
- Modify existing charts.
- Create your own charts with OpenShift Container Platform or Kubernetes resources.
- Package and share your applications as charts.

5.1.2. Red Hat Certification of Helm charts for OpenShift

You can choose to verify and certify your Helm charts by Red Hat for all the components you will be deploying on the Red Hat OpenShift Container Platform. Charts go through an automated Red Hat OpenShift certification workflow that guarantees security compliance as well as best integration and experience with the platform. Certification assures the integrity of the chart and ensures that the Helm chart works seamlessly on Red Hat OpenShift clusters.

5.1.3. Additional resources

- For more information on how to certify your Helm charts as a Red Hat partner, see Red Hat Certification of Helm charts for OpenShift.
- For more information on OpenShift and Container certification guides for Red Hat partners, see Partner Guide for OpenShift and Container Certification .
- For a list of the charts, see the Red Hat **Helm index** file.
- You can view the available charts at the Red Hat Marketplace. For more information, see Using the Red Hat Marketplace.

5.2. INSTALLING HELM

The following section describes how to install Helm on different platforms using the CLI.

You can also find the URL to the latest binaries from the OpenShift Container Platform web console by clicking the **?** icon in the upper-right corner and selecting **Command Line Tools**.

Prerequisites

- You have installed Go, version 1.13 or higher.

5.2.1. On Linux

1. Download the Helm binary and add it to your path:
    - Linux (x86_64, amd64)

      ```
      # curl -L https://mirror.openshift.com/pub/openshift-v4/clients/helm/latest/helm-linux-amd64 -o /usr/local/bin/helm
      ```

    - Linux on IBM Z and LinuxONE (s390x)

      ```
      # curl -L https://mirror.openshift.com/pub/openshift-v4/clients/helm/latest/helm-linux-s390x -o /usr/local/bin/helm
      ```

    - Linux on IBM Power Systems (ppc64le)

      ```
      # curl -L https://mirror.openshift.com/pub/openshift-v4/clients/helm/latest/helm-linux-ppc64le -o /usr/local/bin/helm
      ```

2. Make the binary file executable:

   ```
   # chmod +x /usr/local/bin/helm
   ```

3. Check the installed version:

   ```
   $ helm version
   ```

   Example output

   ```
   version.BuildInfo{Version:"v3.0",
   GitCommit:"b31719aab7963acf4887a1c1e6d5e53378e34d93", GitTreeState:"clean",
   GoVersion:"go1.13.4"}
   ```

5.2.2. On Windows 7/8

1. Download the latest **.exe** file and put in a directory of your preference.
2. Right click **Start** and click **Control Panel**.
3. Select **System and Security** and then click **System**.
4. From the menu on the left, select **Advanced systems settings** and click **Environment Variables** at the bottom.
5. Select **Path** from the **Variable** section and click **Edit**.
6. Click **New** and type the path to the folder with the **.exe** file into the field or click **Browse** and select the directory, and click **OK**.

5.2.3. On Windows 10

1. Download the latest **.exe** file and put in a directory of your preference.
2. Click **Search** and type **env** or **environment**.
3. Select **Edit environment variables for your account**
4. Select **Path** from the **Variable** section and click **Edit**.
5. Click **New** and type the path to the directory with the exe file into the field or click **Browse** and select the directory, and click **OK**.

5.2.4. On MacOS

1. Download the Helm binary and add it to your path:

   ```
   # curl -L https://mirror.openshift.com/pub/openshift-v4/clients/helm/latest/helm-darwin-amd64
   -o /usr/local/bin/helm
   ```

2. Make the binary file executable:

   ```
   # chmod +x /usr/local/bin/helm
   ```

3. Check the installed version:

   ```
   $ helm version
   ```

   Example output

   ```
   version.BuildInfo{Version:"v3.0",
   GitCommit:"b31719aab7963acf4887a1c1e6d5e53378e34d93", GitTreeState:"clean",
   GoVersion:"go1.13.4"}
   ```

5.3. CONFIGURING CUSTOM HELM CHART REPOSITORIES

You can install Helm charts on an OpenShift Container Platform cluster using the following methods:

- The CLI.
- The **Developer** perspective of the web console.

The **Developer Catalog**, in the **Developer** perspective of the web console, displays the Helm charts available in the cluster. By default, it lists the Helm charts from the Red Hat OpenShift Helm chart repository. For a list of the charts, see the Red Hat **Helm index** file.

As a cluster administrator, you can add multiple Helm chart repositories, apart from the default one, and display the Helm charts from these repositories in the **Developer Catalog**.

5.3.1. Installing a Helm chart on an OpenShift Container Platform cluster

Prerequisites

- You have a running OpenShift Container Platform cluster and you have logged into it.
- You have installed Helm.

Procedure

1. Create a new project:

```
$ oc new-project mysql
```

2. Add a repository of Helm charts to your local Helm client:

```
$ helm repo add stable https://kubernetes-charts.storage.googleapis.com/
```

Example output

```
"stable" has been added to your repositories
```

3. Update the repository:

```
$ helm repo update
```

4. Install an example MySQL chart:

```
$ helm install example-mysql stable/mysql
```

5. Verify that the chart has installed successfully:

```
$ helm list
```

Example output

```
NAME NAMESPACE REVISION UPDATED STATUS CHART APP VERSION
example-mysql mysql 1 2019-12-05 15:06:51.379134163 -0500 EST deployed mysql-1.5.0
5.7.27
```

5.3.2. Installing Helm charts using the Developer perspective

You can use either the **Developer** perspective in the web console or the CLI to select and install a chart from the Helm charts listed in the **Developer Catalog**. You can create Helm releases by installing Helm charts and see them in the **Developer** perspective of the web console.

Prerequisites

- You have logged in to the web console and have switched to the **Developer** perspective.

Procedure

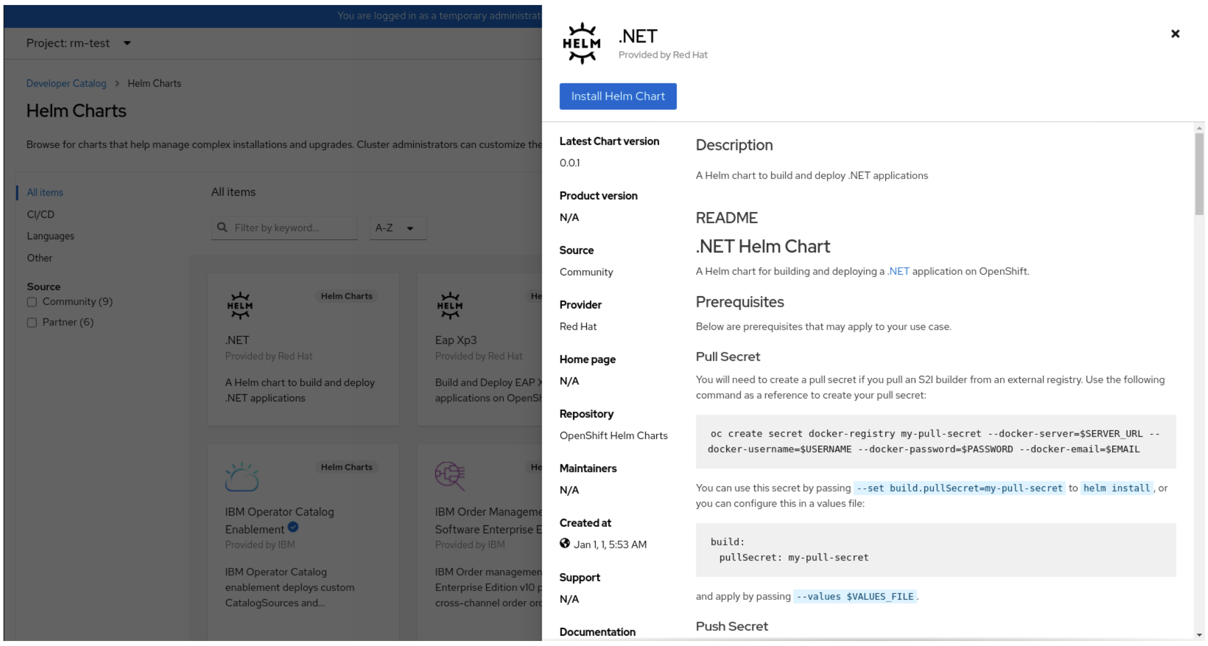
To create Helm releases from the Helm charts provided in the **Developer Catalog**:

1. In the **Developer** perspective, navigate to the **+Add** view and select a project. Then click **Helm Chart** option to see all the Helm Charts in the **Developer Catalog**.

2. Select a chart and read the description, README, and other details about the chart.

3. Click **Install Helm Chart**.

Figure 5.1. Helm charts in developer catalog



.NET
Provided by Red Hat

Install Helm Chart

Latest Chart version	0.0.1
Product version	N/A
Source	Community
Provider	Red Hat
Home page	N/A
Repository	OpenShift Helm Charts
Maintainers	N/A
Created at	Jan 1, 1, 5:53 AM
Support	N/A
Documentation	

Description

A Helm chart to build and deploy .NET applications

README

.NET Helm Chart

A Helm chart for building and deploying a .NET application on OpenShift.

Prerequisites

Below are prerequisites that may apply to your use case.

Pull Secret

You will need to create a pull secret if you pull an S2I builder from an external registry. Use the following command as a reference to create your pull secret:

```
oc create secret docker-registry my-pull-secret --docker-server=$SERVER_URL --
docker-username=$USERNAME --docker-password=$PASSWORD --docker-email=$EMAIL
```

You can use this secret by passing `--set build.pullSecret=my-pull-secret` to `helm install`, or you can configure this in a values file:

```
build:
  pullSecret: my-pull-secret
```

and apply by passing `--values $VALUES_FILE`.

Push Secret

4. In the **Install Helm Chart** page:

   a. Enter a unique name for the release in the **Release Name** field.

   b. Select the required chart version from the **Chart Version** drop-down list.

   c. Configure your Helm chart by using the **Form View** or the **YAML View**.

      NOTE

      Where available, you can switch between the **YAML View** and **Form View**. The data is persisted when switching between the views.

   d. Click **Install** to create a Helm release. You will be redirected to the **Topology** view where the release is displayed. If the Helm chart has release notes, the chart is pre-selected and the right panel displays the release notes for that release.

You can upgrade, rollback, or uninstall a Helm release by using the **Actions** button on the side panel or by right-clicking a Helm release.

5.3.3. Using Helm in the web terminal

You can use Helm by initializing the web terminal in the **Developer** perspective of the web console. For more information, see Using the web terminal.

5.3.4. Creating a custom Helm chart on OpenShift Container Platform

Procedure

1. Create a new project:

```
$ oc new-project nodejs-ex-k
```

2. Download an example Node.js chart that contains OpenShift Container Platform objects:

```
$ git clone https://github.com/redhat-developer/redhat-helm-charts
```

3. Go to the directory with the sample chart:

```
$ cd redhat-helm-charts/alpha/nodejs-ex-k/
```

4. Edit the **Chart.yaml** file and add a description of your chart:

```
apiVersion: v2 (1)
name: nodejs-ex-k (2)
description: A Helm chart for OpenShift (3)
icon: https://static.redhat.com/libs/redhat/brand-assets/latest/corp/logo.svg (4)
```

(1) The chart API version. It should be **v2** for Helm charts that require at least Helm 3.

(2) The name of your chart.

(3) The description of your chart.

(4) The URL to an image to be used as an icon.

5. Verify that the chart is formatted properly:

```
$ helm lint
```

Example output

```
[INFO] Chart.yaml: icon is recommended

1 chart(s) linted, 0 chart(s) failed
```

6. Navigate to the previous directory level:

```
$ cd ..
```

7. Install the chart:

```
$ helm install nodejs-chart nodejs-ex-k
```

8. Verify that the chart has installed successfully:

```
$ helm list
```

Example output

```
NAME NAMESPACE REVISION UPDATED STATUS CHART APP VERSION
nodejs-chart nodejs-ex-k 1 2019-12-05 15:06:51.379134163 -0500 EST deployed nodejs-
0.1.0  1.16.0
```

5.3.5. Adding custom Helm chart repositories

As a cluster administrator, you can add custom Helm chart repositories to your cluster and enable access to the Helm charts from these repositories in the **Developer Catalog**.

Procedure

1. To add a new Helm Chart Repository, you must add the Helm Chart Repository custom resource (CR) to your cluster.

   Sample Helm Chart Repository CR

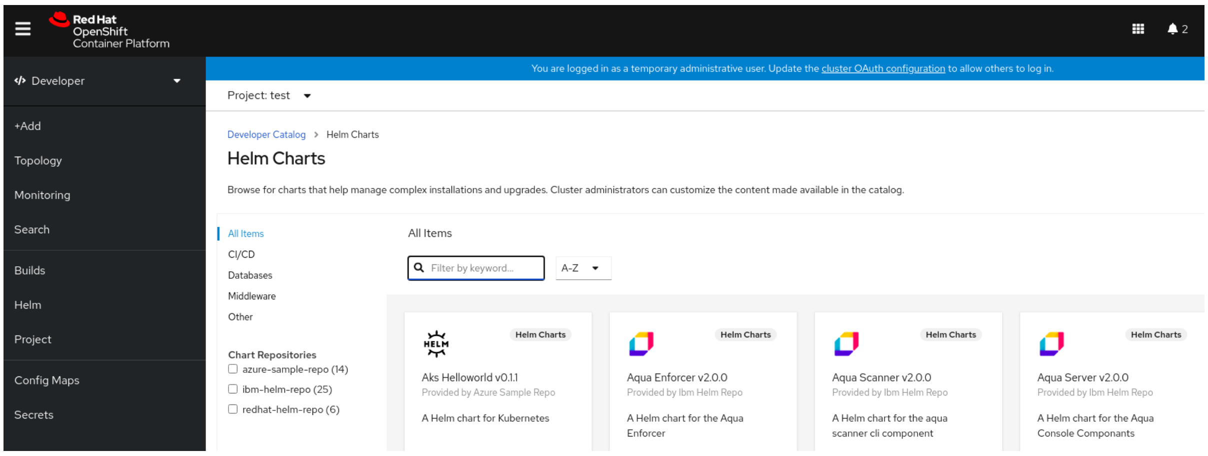
   ```
   apiVersion: helm.openshift.io/v1beta1
   kind: HelmChartRepository
   metadata:
     name: <name>
   spec:
    # optional name that might be used by console
    # name: <chart-display-name>
     connectionConfig:
       url: <helm-chart-repository-url>
   ```

   For example, to add an Azure sample chart repository, run:

   ```
   $ cat <<EOF | oc apply -f -
   apiVersion: helm.openshift.io/v1beta1
   kind: HelmChartRepository
   metadata:
     name: azure-sample-repo
   spec:
     name: azure-sample-repo
     connectionConfig:
       url: https://raw.githubusercontent.com/Azure-Samples/helm-charts/master/docs
   EOF
   ```

2. Navigate to the **Developer Catalog** in the web console to verify that the Helm charts from the chart repository are displayed.
   For example, use the **Chart repositories** filter to search for a Helm chart from the repository.

Figure 5.2. Chart repositories filter



You are logged in as a temporary administrative user. Update the cluster OAuth configuration to allow others to log in.

Helm Charts

Browse for charts that help manage complex installations and upgrades. Cluster administrators can customize the content made available in the catalog.

All Items

Aks Helloworld v0.1.1
Provided by Azure Sample Repo
A Helm chart for Kubernetes

Aqua Enforcer v2.0.0
Provided by Ibm Helm Repo
A Helm chart for the Aqua Enforcer

Aqua Scanner v2.0.0
Provided by Ibm Helm Repo
A Helm chart for the aqua scanner cli component

Aqua Server v2.0.0
Provided by Ibm Helm Repo
A Helm chart for the Aqua Console Componants

NOTE

If a cluster administrator removes all of the chart repositories, then you cannot view the Helm option in the **+Add** view, **Developer Catalog**, and left navigation panel.

5.3.6. Creating credentials and CA certificates to add Helm chart repositories

Some Helm chart repositories need credentials and custom certificate authority (CA) certificates to connect to it. You can use the web console as well as the CLI to add credentials and certificates.

Procedure

To configure the credentials and certificates, and then add a Helm chart repository using the CLI:

1. In the **openshift-config** namespace, create a **ConfigMap** object with a custom CA certificate in PEM encoded format, and store it under the **ca-bundle.crt** key within the config map:

```
$ oc create configmap helm-ca-cert \
--from-file=ca-bundle.crt=/path/to/certs/ca.crt \
-n openshift-config
```

2. In the **openshift-config** namespace, create a **Secret** object to add the client TLS configurations:

```
$ oc create secret tls helm-tls-configs \
--cert=/path/to/certs/client.crt \
--key=/path/to/certs/client.key \
-n openshift-config
```

Note that the client certificate and key must be in PEM encoded format and stored under the keys **tls.crt** and **tls.key**, respectively.

3. Add the Helm repository as follows:

```
$ cat <<EOF | oc apply -f -
apiVersion: helm.openshift.io/v1beta1
kind: HelmChartRepository
metadata:
  name: <helm-repository>
```

```
spec:
  name: <helm-repository>
  connectionConfig:
    url: <URL for the Helm repository>
    tlsConfig:
        name: helm-tls-configs
    ca:
 name: helm-ca-cert
EOF
```

The **ConfigMap** and **Secret** are consumed in the HelmChartRepository CR using the **tlsConfig** and **ca** fields. These certificates are used to connect to the Helm repository URL.

4. By default, all authenticated users have access to all configured charts. However, for chart repositories where certificates are needed, you must provide users with read access to the **helm-ca-cert** config map and **helm-tls-configs** secret in the **openshift-config** namespace, as follows:

```
$ cat <<EOF | kubectl apply -f -
apiVersion: rbac.authorization.k8s.io/v1
kind: Role
metadata:
  namespace: openshift-config
  name: helm-chartrepos-tls-conf-viewer
rules:
- apiGroups: [""]
  resources: ["configmaps"]
  resourceNames: ["helm-ca-cert"]
  verbs: ["get"]
- apiGroups: [""]
  resources: ["secrets"]
  resourceNames: ["helm-tls-configs"]
  verbs: ["get"]
---
kind: RoleBinding
apiVersion: rbac.authorization.k8s.io/v1
metadata:
  namespace: openshift-config
  name: helm-chartrepos-tls-conf-viewer
subjects:
  - kind: Group
    apiGroup: rbac.authorization.k8s.io
    name: 'system:authenticated'
roleRef:
  apiGroup: rbac.authorization.k8s.io
  kind: Role
  name: helm-chartrepos-tls-conf-viewer
EOF
```

5.3.7. Filtering Helm Charts by their certification level

You can filter Helm charts based on their certification level in the **Developer Catalog**.

Procedure

1. In the **Developer perspective**, navigate to the **+Add** view and select a project.

2. From the **Developer Catalog** tile, select the **Helm Chart** option to see all the Helm charts in the **Developer Catalog**.

3. Use the filters to the left of the list of Helm charts to filter the required charts:

   - Use the **Chart Repositories** filter to filter charts provided by **Red Hat Certification Charts** or **OpenShift Helm Charts**.

   - Use the **Source** filter to filter charts sourced from **Partners**, **Community**, or **Red Hat**. Certified charts are indicated with the (✓) icon.

NOTE

The **Source** filter will not be visible when there is only one provider type.

You can now select the required chart and install it.

5.3.8. Disabling Helm Chart repositories

You can disable Helm Charts from a particular Helm Chart Repository in the catalog by setting the **disabled** property in the **HelmChartRepository** custom resource to **true**.

Procedure

- To disable a Helm Chart repository by using CLI, add the **disabled: true** flag to the custom resource. For example, to remove an Azure sample chart repository, run:

```
$ cat <<EOF | oc apply -f -
apiVersion: helm.openshift.io/v1beta1
kind: HelmChartRepository
metadata:
  name: azure-sample-repo
spec:
  connectionConfig:
   url:https://raw.githubusercontent.com/Azure-Samples/helm-charts/master/docs
  disabled: true
EOF
```

- To disable a recently added Helm Chart repository by using Web Console:

  1. Go to **Custom Resource Definitions**and search for the **HelmChartRepository** custom resource.

  2. Go to **Instances**, find the repository you want to disable, and click its name.

  3. Go to the **YAML** tab, add the **disabled: true** flag in the **spec** section, and click **Save**.

     Example

```
spec:
  connectionConfig:
    url: <url-of-the-repositoru-to-be-disabled>
  disabled: true
```

▪

The repository is now disabled and will not appear in the catalog.

5.4. WORKING WITH HELM RELEASES

You can use the **Developer** perspective in the web console to upgrade, rollback, or uninstall a Helm release.

5.4.1. Prerequisites

- You have logged in to the web console and have switched to the **Developer** perspective.

5.4.2. Upgrading a Helm release

You can upgrade a Helm release to upgrade to a new chart version or update your release configuration.

Procedure

1. In the **Topology** view, select the Helm release to see the side panel.
2. Click **Actions** → **Upgrade Helm Release**.
3. In the **Upgrade Helm Release** page, select the **Chart Version** you want to upgrade to, and then click **Upgrade** to create another Helm release. The **Helm Releases** page displays the two revisions.

5.4.3. Rolling back a Helm release

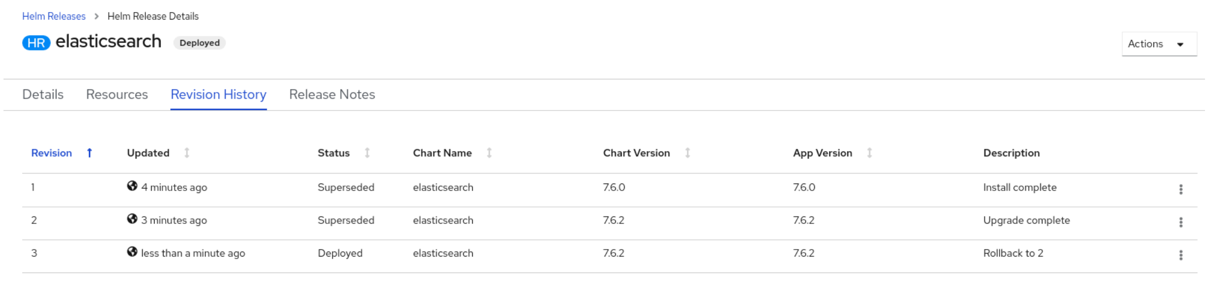
If a release fails, you can rollback the Helm release to a previous version.

Procedure

To rollback a release using the **Helm** view:

1. In the **Developer** perspective, navigate to the **Helm** view to see the **Helm Releases** in the namespace.
2. Click the **Options** menu ⋮ adjoining the listed release, and select **Rollback**.
3. In the **Rollback Helm Release** page, select the **Revision** you want to rollback to and click **Rollback**.
4. In the **Helm Releases** page, click on the chart to see the details and resources for that release.
5. Go to the **Revision History** tab to see all the revisions for the chart.

Figure 5.3. Helm revision history


Helm Releases > Helm Release Details
HR elasticsearch Deployed
Actions
Details
Resources
Revision History
Release Notes

Revision	Updated	Status	Chart Name	Chart Version	App Version	Description
1	4 minutes ago	Superseded	elasticsearch	7.6.0	7.6.0	Install complete
2	3 minutes ago	Superseded	elasticsearch	7.6.2	7.6.2	Upgrade complete
3	less than a minute ago	Deployed	elasticsearch	7.6.2	7.6.2	Rollback to 2

6. If required, you can further use the **Options** menu ⋮ adjoining a particular revision and select the revision to rollback to.

5.4.4. Uninstalling a Helm release

Procedure

1. In the **Topology** view, right-click the Helm release and select **Uninstall Helm Release**.
2. In the confirmation prompt, enter the name of the chart and click **Uninstall**.

CHAPTER 6. DEPLOYMENTS

6.1. UNDERSTANDING DEPLOYMENT AND DEPLOYMENTCONFIG OBJECTS

The **Deployment** and **DeploymentConfig** API objects in OpenShift Container Platform provide two similar but different methods for fine-grained management over common user applications. They are composed of the following separate API objects:

- A **DeploymentConfig** or **Deployment** object, either of which describes the desired state of a particular component of the application as a pod template.
- **DeploymentConfig** objects involve one or more *replication controllers*, which contain a point-in-time record of the state of a deployment as a pod template. Similarly, **Deployment** objects involve one or more *replica sets*, a successor of replication controllers.
- One or more pods, which represent an instance of a particular version of an application.

6.1.1. Building blocks of a deployment

Deployments and deployment configs are enabled by the use of native Kubernetes API objects **ReplicaSet** and **ReplicationController**, respectively, as their building blocks.

Users do not have to manipulate replication controllers, replica sets, or pods owned by **DeploymentConfig** objects or deployments. The deployment systems ensure changes are propagated appropriately.

TIP

If the existing deployment strategies are not suited for your use case and you must run manual steps during the lifecycle of your deployment, then you should consider creating a custom deployment strategy.

The following sections provide further details on these objects.

6.1.1.1. Replication controllers

A replication controller ensures that a specified number of replicas of a pod are running at all times. If pods exit or are deleted, the replication controller acts to instantiate more up to the defined number. Likewise, if there are more running than desired, it deletes as many as necessary to match the defined amount.

A replication controller configuration consists of:

- The number of replicas desired, which can be adjusted at run time.
- A **Pod** definition to use when creating a replicated pod.
- A selector for identifying managed pods.

A selector is a set of labels assigned to the pods that are managed by the replication controller. These labels are included in the **Pod** definition that the replication controller instantiates. The replication controller uses the selector to determine how many instances of the pod are already running in order to adjust as needed.

The replication controller does not perform auto-scaling based on load or traffic, as it does not track either. Rather, this requires its replica count to be adjusted by an external auto-scaler.

The following is an example definition of a replication controller:

```
apiVersion: v1
kind: ReplicationController
metadata:
  name: frontend-1
spec:
  replicas: 1  1
  selector:    2
    name: frontend
  template:    3
    metadata:
      labels:  4
        name: frontend 5
    spec:
      containers:
      - image: openshift/hello-openshift
        name: helloworld
        ports:
        - containerPort: 8080
          protocol: TCP
      restartPolicy: Always
```

1 The number of copies of the pod to run.

2 The label selector of the pod to run.

3 A template for the pod the controller creates.

4 Labels on the pod should include those from the label selector.

5 The maximum name length after expanding any parameters is 63 characters.

6.1.1.2. Replica sets

Similar to a replication controller, a **ReplicaSet** is a native Kubernetes API object that ensures a specified number of pod replicas are running at any given time. The difference between a replica set and a replication controller is that a replica set supports set-based selector requirements whereas a replication controller only supports equality-based selector requirements.

NOTE

Only use replica sets if you require custom update orchestration or do not require updates at all. Otherwise, use deployments. Replica sets can be used independently, but are used by deployments to orchestrate pod creation, deletion, and updates. Deployments manage their replica sets automatically, provide declarative updates to pods, and do not have to manually manage the replica sets that they create.

The following is an example **ReplicaSet** definition:

```
apiVersion: apps/v1
kind: ReplicaSet
metadata:
  name: frontend-1
  labels:
    tier: frontend
spec:
  replicas: 3
  selector: 1
    matchLabels: 2
      tier: frontend
    matchExpressions: 3
      - {key: tier, operator: In, values: [frontend]}
  template:
    metadata:
      labels:
        tier: frontend
    spec:
      containers:
      - image: openshift/hello-openshift
        name: helloworld
        ports:
        - containerPort: 8080
          protocol: TCP
      restartPolicy: Always
```

1 A label query over a set of resources. The result of **matchLabels** and **matchExpressions** are logically conjoined.

2 Equality-based selector to specify resources with labels that match the selector.

3 Set-based selector to filter keys. This selects all resources with key equal to **tier** and value equal to **frontend**.

6.1.2. DeploymentConfig objects

Building on replication controllers, OpenShift Container Platform adds expanded support for the software development and deployment lifecycle with the concept of **DeploymentConfig** objects. In the simplest case, a **DeploymentConfig** object creates a new replication controller and lets it start up pods.

However, OpenShift Container Platform deployments from **DeploymentConfig** objects also provide the ability to transition from an existing deployment of an image to a new one and also define hooks to be run before or after creating the replication controller.

The **DeploymentConfig** deployment system provides the following capabilities:

- A **DeploymentConfig** object, which is a template for running applications.
- Triggers that drive automated deployments in response to events.
- User-customizable deployment strategies to transition from the previous version to the new version. A strategy runs inside a pod commonly referred as the deployment process.
- A set of hooks (lifecycle hooks) for executing custom behavior in different points during the lifecycle of a deployment.

- Versioning of your application to support rollbacks either manually or automatically in case of deployment failure.

- Manual replication scaling and autoscaling.

When you create a **DeploymentConfig** object, a replication controller is created representing the **DeploymentConfig** object's pod template. If the deployment changes, a new replication controller is created with the latest pod template, and a deployment process runs to scale down the old replication controller and scale up the new one.

Instances of your application are automatically added and removed from both service load balancers and routers as they are created. As long as your application supports graceful shutdown when it receives the **TERM** signal, you can ensure that running user connections are given a chance to complete normally.

The OpenShift Container Platform **DeploymentConfig** object defines the following details:

1. The elements of a **ReplicationController** definition.

2. Triggers for creating a new deployment automatically.

3. The strategy for transitioning between deployments.

4. Lifecycle hooks.

Each time a deployment is triggered, whether manually or automatically, a deployer pod manages the deployment (including scaling down the old replication controller, scaling up the new one, and running hooks). The deployment pod remains for an indefinite amount of time after it completes the deployment to retain its logs of the deployment. When a deployment is superseded by another, the previous replication controller is retained to enable easy rollback if needed.

Example DeploymentConfig definition

```
apiVersion: v1
kind: DeploymentConfig
metadata:
  name: frontend
spec:
  replicas: 5
  selector:
    name: frontend
  template: { ... }
  triggers:
  - type: ConfigChange 1
  - imageChangeParams:
      automatic: true
      containerNames:
      - helloworld
      from:
        kind: ImageStreamTag
        name: hello-openshift:latest
    type: ImageChange  2
  strategy:
    type: Rolling      3
```

1 A config change trigger causes a new deployment to be created any time the replication controller template changes.

2 An image change trigger causes a new deployment to be created each time a new version of the backing image is available in the named image stream.

3 The default **Rolling** strategy makes a downtime-free transition between deployments.

6.1.3. Deployments

Kubernetes provides a first-class, native API object type in OpenShift Container Platform called **Deployment**. **Deployment** objects serve as a descendant of the OpenShift Container Platform-specific **DeploymentConfig** object.

Like **DeploymentConfig** objects, **Deployment** objects describe the desired state of a particular component of an application as a pod template. Deployments create replica sets, which orchestrate pod lifecycles.

For example, the following deployment definition creates a replica set to bring up one **hello-openshift** pod:

Deployment definition

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: hello-openshift
spec:
  replicas: 1
  selector:
    matchLabels:
      app: hello-openshift
  template:
    metadata:
      labels:
        app: hello-openshift
    spec:
      containers:
      - name: hello-openshift
        image: openshift/hello-openshift:latest
        ports:
        - containerPort: 80
```

6.1.4. Comparing Deployment and DeploymentConfig objects

Both Kubernetes **Deployment** objects and OpenShift Container Platform-provided **DeploymentConfig** objects are supported in OpenShift Container Platform; however, it is recommended to use **Deployment** objects unless you need a specific feature or behavior provided by **DeploymentConfig** objects.

The following sections go into more detail on the differences between the two object types to further help you decide which type to use.

6.1.4.1. Design

One important difference between **Deployment** and **DeploymentConfig** objects is the properties of the CAP theorem that each design has chosen for the rollout process. **DeploymentConfig** objects prefer consistency, whereas **Deployments** objects take availability over consistency.

For **DeploymentConfig** objects, if a node running a deployer pod goes down, it will not get replaced. The process waits until the node comes back online or is manually deleted. Manually deleting the node also deletes the corresponding pod. This means that you can not delete the pod to unstick the rollout, as the kubelet is responsible for deleting the associated pod.

However, deployment rollouts are driven from a controller manager. The controller manager runs in high availability mode on masters and uses leader election algorithms to value availability over consistency. During a failure it is possible for other masters to act on the same deployment at the same time, but this issue will be reconciled shortly after the failure occurs.

6.1.4.2. DeploymentConfig object-specific features

Automatic rollbacks
Currently, deployments do not support automatically rolling back to the last successfully deployed replica set in case of a failure.

Triggers
Deployments have an implicit config change trigger in that every change in the pod template of a deployment automatically triggers a new rollout. If you do not want new rollouts on pod template changes, pause the deployment:

```
$ oc rollout pause deployments/<name>
```

Lifecycle hooks
Deployments do not yet support any lifecycle hooks.

Custom strategies
Deployments do not support user-specified custom deployment strategies yet.

6.1.4.3. Deployment-specific features

Rollover
The deployment process for **Deployment** objects is driven by a controller loop, in contrast to **DeploymentConfig** objects which use deployer pods for every new rollout. This means that the **Deployment** object can have as many active replica sets as possible, and eventually the deployment controller will scale down all old replica sets and scale up the newest one.

DeploymentConfig objects can have at most one deployer pod running, otherwise multiple deployers end up conflicting while trying to scale up what they think should be the newest replication controller. Because of this, only two replication controllers can be active at any point in time. Ultimately, this translates to faster rapid rollouts for **Deployment** objects.

Proportional scaling
Because the deployment controller is the sole source of truth for the sizes of new and old replica sets owned by a deployment, it is able to scale ongoing rollouts. Additional replicas are distributed proportionally based on the size of each replica set.

Deployments cannot be scaled when a rollout is ongoing because the controller will end up having issues with the deployer process about the size of the new replication controller.

Pausing mid-rollout

Deployments can be paused at any point in time, meaning you can also pause ongoing rollouts. On the other hand, you cannot pause deployer pods currently, so if you try to pause a deployment in the middle of a rollout, the deployer process will not be affected and will continue until it finishes.

6.2. MANAGING DEPLOYMENT PROCESSES

6.2.1. Managing DeploymentConfig objects

DeploymentConfig objects can be managed from the OpenShift Container Platform web console's **Workloads** page or using the **oc** CLI. The following procedures show CLI usage unless otherwise stated.

6.2.1.1. Starting a deployment

You can start a rollout to begin the deployment process of your application.

Procedure

1. To start a new deployment process from an existing **DeploymentConfig** object, run the following command:

```
$ oc rollout latest dc/<name>
```

NOTE

If a deployment process is already in progress, the command displays a message and a new replication controller will not be deployed.

6.2.1.2. Viewing a deployment

You can view a deployment to get basic information about all the available revisions of your application.

Procedure

1. To show details about all recently created replication controllers for the provided **DeploymentConfig** object, including any currently running deployment process, run the following command:

```
$ oc rollout history dc/<name>
```

2. To view details specific to a revision, add the **--revision** flag:

```
$ oc rollout history dc/<name> --revision=1
```

3. For more detailed information about a **DeploymentConfig** object and its latest revision, use the **oc describe** command:

```
$ oc describe dc <name>
```

6.2.1.3. Retrying a deployment

If the current revision of your **DeploymentConfig** object failed to deploy, you can restart the deployment process.

Procedure

1. To restart a failed deployment process:

   ```
   $ oc rollout retry dc/<name>
   ```

   If the latest revision of it was deployed successfully, the command displays a message and the deployment process is not retried.

   > **NOTE**
   >
   > Retrying a deployment restarts the deployment process and does not create a new deployment revision. The restarted replication controller has the same configuration it had when it failed.

6.2.1.4. Rolling back a deployment

Rollbacks revert an application back to a previous revision and can be performed using the REST API, the CLI, or the web console.

Procedure

1. To rollback to the last successful deployed revision of your configuration:

   ```
   $ oc rollout undo dc/<name>
   ```

   The **DeploymentConfig** object's template is reverted to match the deployment revision specified in the undo command, and a new replication controller is started. If no revision is specified with **--to-revision**, then the last successfully deployed revision is used.

2. Image change triggers on the **DeploymentConfig** object are disabled as part of the rollback to prevent accidentally starting a new deployment process soon after the rollback is complete.
   To re-enable the image change triggers:

   ```
   $ oc set triggers dc/<name> --auto
   ```

> **NOTE**
>
> Deployment configs also support automatically rolling back to the last successful revision of the configuration in case the latest deployment process fails. In that case, the latest template that failed to deploy stays intact by the system and it is up to users to fix their configurations.

6.2.1.5. Executing commands inside a container

You can add a command to a container, which modifies the container's startup behavior by overruling the image's **ENTRYPOINT**. This is different from a lifecycle hook, which instead can be run once per deployment at a specified time.

Procedure

1. Add the **command** parameters to the **spec** field of the **DeploymentConfig** object. You can also add an **args** field, which modifies the **command** (or the **ENTRYPOINT** if **command** does not exist).

   ```
   spec:
     containers:
     - name: <container_name>
       image: 'image'
       command:
         - '<command>'
       args:
         - '<argument_1>'
         - '<argument_2>'
         - '<argument_3>'
   ```

   For example, to execute the **java** command with the **-jar** and **/opt/app-root/springboots2idemo.jar** arguments:

   ```
   spec:
     containers:
     - name: example-spring-boot
       image: 'image'
       command:
         - java
       args:
         - '-jar'
         - /opt/app-root/springboots2idemo.jar
   ```

6.2.1.6. Viewing deployment logs

Procedure

1. To stream the logs of the latest revision for a given **DeploymentConfig** object:

   ```
   $ oc logs -f dc/<name>
   ```

   If the latest revision is running or failed, the command returns the logs of the process that is responsible for deploying your pods. If it is successful, it returns the logs from a pod of your application.

2. You can also view logs from older failed deployment processes, if and only if these processes (old replication controllers and their deployer pods) exist and have not been pruned or deleted manually:

   ```
   $ oc logs --version=1 dc/<name>
   ```

6.2.1.7. Deployment triggers

A **DeploymentConfig** object can contain triggers, which drive the creation of new deployment processes in response to events inside the cluster.

WARNING

If no triggers are defined on a **DeploymentConfig** object, a config change trigger is added by default. If triggers are defined as an empty field, deployments must be started manually.

Config change deployment triggers
The config change trigger results in a new replication controller whenever configuration changes are detected in the pod template of the **DeploymentConfig** object.

NOTE

If a config change trigger is defined on a **DeploymentConfig** object, the first replication controller is automatically created soon after the **DeploymentConfig** object itself is created and it is not paused.

Config change deployment trigger

```
triggers:
  - type: "ConfigChange"
```

Image change deployment triggers
The image change trigger results in a new replication controller whenever the content of an image stream tag changes (when a new version of the image is pushed).

Image change deployment trigger

```
triggers:
  - type: "ImageChange"
    imageChangeParams:
      automatic: true (1)
      from:
        kind: "ImageStreamTag"
        name: "origin-ruby-sample:latest"
        namespace: "myproject"
      containerNames:
        - "helloworld"
```

(1) If the **imageChangeParams.automatic** field is set to **false**, the trigger is disabled.

With the above example, when the **latest** tag value of the **origin-ruby-sample** image stream changes and the new image value differs from the current image specified in the **DeploymentConfig** object's **helloworld** container, a new replication controller is created using the new image for the **helloworld** container.

NOTE

If an image change trigger is defined on a **DeploymentConfig** object (with a config change trigger and **automatic=false**, or with **automatic=true**) and the image stream tag pointed by the image change trigger does not exist yet, the initial deployment process will automatically start as soon as an image is imported or pushed by a build to the image stream tag.

6.2.1.7.1. Setting deployment triggers

Procedure

1. You can set deployment triggers for a **DeploymentConfig** object using the **oc set triggers** command. For example, to set a image change trigger, use the following command:

```
$ oc set triggers dc/<dc_name> \
    --from-image=<project>/<image>:<tag> -c <container_name>
```

6.2.1.8. Setting deployment resources

A deployment is completed by a pod that consumes resources (memory, CPU, and ephemeral storage) on a node. By default, pods consume unbounded node resources. However, if a project specifies default container limits, then pods consume resources up to those limits.

NOTE

The minimum memory limit for a deployment is 12 MB. If a container fails to start due to a **Cannot allocate memory** pod event, the memory limit is too low. Either increase or remove the memory limit. Removing the limit allows pods to consume unbounded node resources.

You can also limit resource use by specifying resource limits as part of the deployment strategy. Deployment resources can be used with the recreate, rolling, or custom deployment strategies.

Procedure

1. In the following example, each of **resources**, **cpu**, **memory**, and **ephemeral-storage** is optional:

```
type: "Recreate"
resources:
  limits:
    cpu: "100m" (1)
    memory: "256Mi" (2)
    ephemeral-storage: "1Gi" (3)
```

(1) **cpu** is in CPU units: **100m** represents 0.1 CPU units (100 * 1e-3).

(2) **memory** is in bytes: **256Mi** represents 268435456 bytes (256 * 2 ^ 20).

(3) **ephemeral-storage** is in bytes: **1Gi** represents 1073741824 bytes (2 ^ 30).

However, if a quota has been defined for your project, one of the following two items is required:

- A **resources** section set with an explicit **requests**:

  ```
  type: "Recreate"
  resources:
    requests: (1)
      cpu: "100m"
      memory: "256Mi"
      ephemeral-storage: "1Gi"
  ```

  (1) The **requests** object contains the list of resources that correspond to the list of resources in the quota.

- A limit range defined in your project, where the defaults from the **LimitRange** object apply to pods created during the deployment process.

To set deployment resources, choose one of the above options. Otherwise, deploy pod creation fails, citing a failure to satisfy quota.

Additional resources

- For more information about resource limits and requests, see Understanding managing application memory.

6.2.1.9. Scaling manually

In addition to rollbacks, you can exercise fine-grained control over the number of replicas by manually scaling them.

NOTE

Pods can also be auto-scaled using the **oc autoscale** command.

Procedure

1. To manually scale a **DeploymentConfig** object, use the **oc scale** command. For example, the following command sets the replicas in the **frontend DeploymentConfig** object to **3**.

   ```
   $ oc scale dc frontend --replicas=3
   ```

   The number of replicas eventually propagates to the desired and current state of the deployment configured by the **DeploymentConfig** object **frontend**.

6.2.1.10. Accessing private repositories from DeploymentConfig objects

You can add a secret to your **DeploymentConfig** object so that it can access images from a private repository. This procedure shows the OpenShift Container Platform web console method.

Procedure

1. Create a new project.

2. From the **Workloads** page, create a secret that contains credentials for accessing a private image repository.

3. Create a **DeploymentConfig** object.

4. On the **DeploymentConfig** object editor page, set the **Pull Secret** and save your changes.

6.2.1.11. Assigning pods to specific nodes

You can use node selectors in conjunction with labeled nodes to control pod placement.

Cluster administrators can set the default node selector for a project in order to restrict pod placement to specific nodes. As a developer, you can set a node selector on a **Pod** configuration to restrict nodes even further.

Procedure

1. To add a node selector when creating a pod, edit the **Pod** configuration, and add the **nodeSelector** value. This can be added to a single **Pod** configuration, or in a **Pod** template:

```
apiVersion: v1
kind: Pod
spec:
  nodeSelector:
    disktype: ssd
...
```

   Pods created when the node selector is in place are assigned to nodes with the specified labels. The labels specified here are used in conjunction with the labels added by a cluster administrator.

   For example, if a project has the **type=user-node** and **region=east** labels added to a project by the cluster administrator, and you add the above **disktype: ssd** label to a pod, the pod is only ever scheduled on nodes that have all three labels.

   NOTE

   Labels can only be set to one value, so setting a node selector of **region=west** in a **Pod** configuration that has **region=east** as the administrator-set default, results in a pod that will never be scheduled.

6.2.1.12. Running a pod with a different service account

You can run a pod with a service account other than the default.

Procedure

1. Edit the **DeploymentConfig** object:

```
$ oc edit dc/<deployment_config>
```

2. Add the **serviceAccount** and **serviceAccountName** parameters to the **spec** field, and specify the service account you want to use:

```
spec:
  securityContext: {}
  serviceAccount: <service_account>
```

```
serviceAccountName: <service_account>
```

6.3. USING DEPLOYMENT STRATEGIES

A *deployment strategy* is a way to change or upgrade an application. The aim is to make the change without downtime in a way that the user barely notices the improvements.

Because the end user usually accesses the application through a route handled by a router, the deployment strategy can focus on **DeploymentConfig** object features or routing features. Strategies that focus on the deployment impact all routes that use the application. Strategies that use router features target individual routes.

Many deployment strategies are supported through the **DeploymentConfig** object, and some additional strategies are supported through router features. Deployment strategies are discussed in this section.

Choosing a deployment strategy

Consider the following when choosing a deployment strategy:

- Long-running connections must be handled gracefully.
- Database conversions can be complex and must be done and rolled back along with the application.
- If the application is a hybrid of microservices and traditional components, downtime might be required to complete the transition.
- You must have the infrastructure to do this.
- If you have a non-isolated test environment, you can break both new and old versions.

A deployment strategy uses readiness checks to determine if a new pod is ready for use. If a readiness check fails, the **DeploymentConfig** object retries to run the pod until it times out. The default timeout is **10m**, a value set in **TimeoutSeconds** in **dc.spec.strategy.*params**.

6.3.1. Rolling strategy

A rolling deployment slowly replaces instances of the previous version of an application with instances of the new version of the application. The rolling strategy is the default deployment strategy used if no strategy is specified on a **DeploymentConfig** object.

A rolling deployment typically waits for new pods to become **ready** via a readiness check before scaling down the old components. If a significant issue occurs, the rolling deployment can be aborted.

When to use a rolling deployment:

- When you want to take no downtime during an application update.
- When your application supports having old code and new code running at the same time.

A rolling deployment means you to have both old and new versions of your code running at the same time. This typically requires that your application handle N-1 compatibility.

Example rolling strategy definition

```
strategy:
  type: Rolling
  rollingParams:
    updatePeriodSeconds: 1 1
    intervalSeconds: 1 2
    timeoutSeconds: 120 3
    maxSurge: "20%" 4
    maxUnavailable: "10%" 5
    pre: {} 6
    post: {}
```

1 The time to wait between individual pod updates. If unspecified, this value defaults to **1**.

2 The time to wait between polling the deployment status after update. If unspecified, this value defaults to **1**.

3 The time to wait for a scaling event before giving up. Optional; the default is **600**. Here, *giving up* means automatically rolling back to the previous complete deployment.

4 **maxSurge** is optional and defaults to **25%** if not specified. See the information below the following procedure.

5 **maxUnavailable** is optional and defaults to **25%** if not specified. See the information below the following procedure.

6 **pre** and **post** are both lifecycle hooks.

The rolling strategy:

1. Executes any **pre** lifecycle hook.
2. Scales up the new replication controller based on the surge count.
3. Scales down the old replication controller based on the max unavailable count.
4. Repeats this scaling until the new replication controller has reached the desired replica count and the old replication controller has been scaled to zero.
5. Executes any **post** lifecycle hook.

IMPORTANT

When scaling down, the rolling strategy waits for pods to become ready so it can decide whether further scaling would affect availability. If scaled up pods never become ready, the deployment process will eventually time out and result in a deployment failure.

The **maxUnavailable** parameter is the maximum number of pods that can be unavailable during the update. The **maxSurge** parameter is the maximum number of pods that can be scheduled above the original number of pods. Both parameters can be set to either a percentage (e.g., **10%**) or an absolute value (e.g., **2**). The default value for both is **25%**.

These parameters allow the deployment to be tuned for availability and speed. For example:

- **maxUnavailable*=0** and **maxSurge*=20%** ensures full capacity is maintained during the update and rapid scale up.
- **maxUnavailable*=10%** and **maxSurge*=0** performs an update using no extra capacity (an in-place update).
- **maxUnavailable*=10%** and **maxSurge*=10%** scales up and down quickly with some potential for capacity loss.

Generally, if you want fast rollouts, use **maxSurge**. If you have to take into account resource quota and can accept partial unavailability, use **maxUnavailable**.

6.3.1.1. Canary deployments

All rolling deployments in OpenShift Container Platform are *canary deployments*; a new version (the canary) is tested before all of the old instances are replaced. If the readiness check never succeeds, the canary instance is removed and the **DeploymentConfig** object will be automatically rolled back.

The readiness check is part of the application code and can be as sophisticated as necessary to ensure the new instance is ready to be used. If you must implement more complex checks of the application (such as sending real user workloads to the new instance), consider implementing a custom deployment or using a blue-green deployment strategy.

6.3.1.2. Creating a rolling deployment

Rolling deployments are the default type in OpenShift Container Platform. You can create a rolling deployment using the CLI.

Procedure

1. Create an application based on the example deployment images found in Quay.io:

```
$ oc new-app quay.io/openshifttest/deployment-example:latest
```

2. If you have the router installed, make the application available via a route or use the service IP directly.

```
$ oc expose svc/deployment-example
```

3. Browse to the application at **deployment-example.<project>.<router_domain>** to verify you see the **v1** image.
4. Scale the **DeploymentConfig** object up to three replicas:

```
$ oc scale dc/deployment-example --replicas=3
```

5. Trigger a new deployment automatically by tagging a new version of the example as the **latest** tag:

```
$ oc tag deployment-example:v2 deployment-example:latest
```

6. In your browser, refresh the page until you see the **v2** image.

7. When using the CLI, the following command shows how many pods are on version 1 and how many are on version 2. In the web console, the pods are progressively added to v2 and removed from v1:

   ```
   $ oc describe dc deployment-example
   ```

During the deployment process, the new replication controller is incrementally scaled up. After the new pods are marked as **ready** (by passing their readiness check), the deployment process continues.

If the pods do not become ready, the process aborts, and the deployment rolls back to its previous version.

6.3.1.3. Starting a rolling deployment using the Developer perspective

Prerequisites

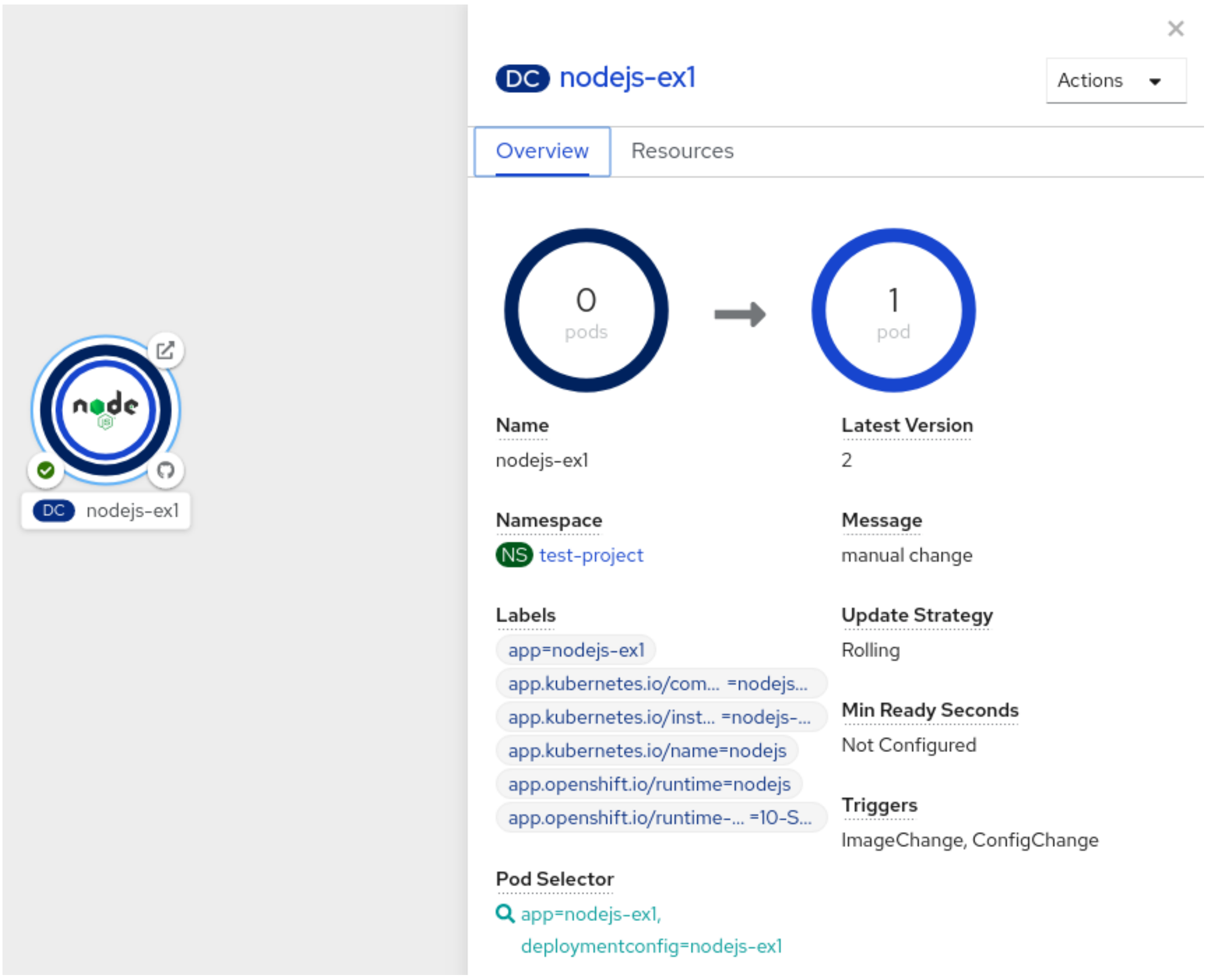
- Ensure that you are in the **Developer** perspective of the web console.
- Ensure that you have created an application using the **Add** view and see it deployed in the **Topology** view.

Procedure

To start a rolling deployment to upgrade an application:

1. In the **Topology** view of the **Developer** perspective, click on the application node to see the **Overview** tab in the side panel. Note that the **Update Strategy** is set to the default **Rolling** strategy.
2. In the **Actions** drop-down menu, select **Start Rollout** to start a rolling update. The rolling deployment spins up the new version of the application and then terminates the old one.

Figure 6.1. Rolling update



Name
nodejs-ex1

Latest Version
2

Namespace
NS test-project

Message
manual change

Labels
app=nodejs-ex1
app.kubernetes.io/com... =nodejs...
app.kubernetes.io/inst... =nodejs-...
app.kubernetes.io/name=nodejs
app.openshift.io/runtime=nodejs
app.openshift.io/runtime-... =10-S...

Update Strategy
Rolling

Min Ready Seconds
Not Configured

Triggers
ImageChange, ConfigChange

Pod Selector
app=nodejs-ex1, deploymentconfig=nodejs-ex1

Additional resources

- Creating and deploying applications on OpenShift Container Platform using the **Developer** perspective
- Viewing the applications in your project, verifying their deployment status, and interacting with them in the **Topology** view

6.3.2. Recreate strategy

The recreate strategy has basic rollout behavior and supports lifecycle hooks for injecting code into the deployment process.

Example recreate strategy definition

```
strategy:
  type: Recreate
  recreateParams: (1)
    pre: {} (2)
    mid: {}
    post: {}
```

(1) **recreateParams** are optional.

(2) **pre**, **mid**, and **post** are lifecycle hooks.

The recreate strategy:

1. Executes any **pre** lifecycle hook.
2. Scales down the previous deployment to zero.
3. Executes any **mid** lifecycle hook.
4. Scales up the new deployment.
5. Executes any **post** lifecycle hook.

IMPORTANT

During scale up, if the replica count of the deployment is greater than one, the first replica of the deployment will be validated for readiness before fully scaling up the deployment. If the validation of the first replica fails, the deployment will be considered a failure.

When to use a recreate deployment:

- When you must run migrations or other data transformations before your new code starts.
- When you do not support having new and old versions of your application code running at the same time.
- When you want to use a RWO volume, which is not supported being shared between multiple replicas.

A recreate deployment incurs downtime because, for a brief period, no instances of your application are running. However, your old code and new code do not run at the same time.

6.3.3. Starting a recreate deployment using the Developer perspective

You can switch the deployment strategy from the default rolling update to a recreate update using the **Developer** perspective in the web console.

Prerequisites

- Ensure that you are in the **Developer** perspective of the web console.
- Ensure that you have created an application using the **Add** view and see it deployed in the **Topology** view.

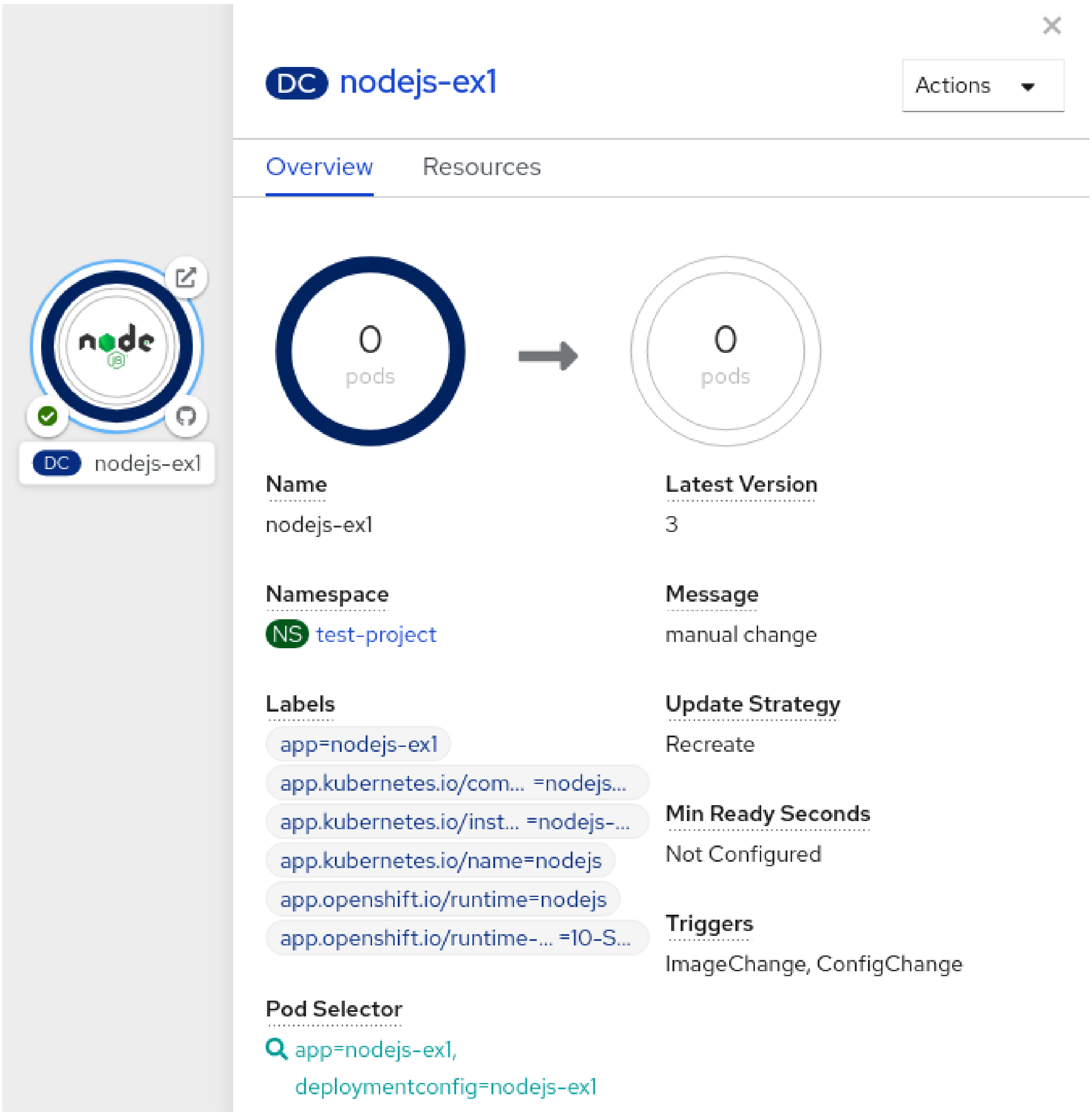
Procedure

To switch to a recreate update strategy and to upgrade an application:

1. In the **Actions** drop-down menu, select **Edit Deployment Config** to see the deployment configuration details of the application.
2. In the YAML editor, change the **spec.strategy.type** to **Recreate** and click **Save**.
3. In the **Topology** view, select the node to see the **Overview** tab in the side panel. The **Update Strategy** is now set to **Recreate**.

4. Use the **Actions** drop-down menu to select **Start Rollout** to start an update using the recreate strategy. The recreate strategy first terminates pods for the older version of the application and then spins up pods for the new version.

Figure 6.2. Recreate update



Name
nodejs-ex1

Latest Version
3

Namespace
NS test-project

Message
manual change

Labels
app=nodejs-ex1
app.kubernetes.io/com... =nodejs...
app.kubernetes.io/inst... =nodejs-...
app.kubernetes.io/name=nodejs
app.openshift.io/runtime=nodejs
app.openshift.io/runtime-... =10-S...

Update Strategy
Recreate

Min Ready Seconds
Not Configured

Triggers
ImageChange, ConfigChange

Pod Selector
app=nodejs-ex1,
deploymentconfig=nodejs-ex1

Additional resources

- Creating and deploying applications on OpenShift Container Platform using the **Developer** perspective
- Viewing the applications in your project, verifying their deployment status, and interacting with them in the **Topology** view

6.3.4. Custom strategy

The custom strategy allows you to provide your own deployment behavior.

Example custom strategy definition

```
strategy:
  type: Custom
  customParams:
    image: organization/strategy
    command: [ "command", "arg1" ]
    environment:
      - name: ENV_1
        value: VALUE_1
```

In the above example, the **organization/strategy** container image provides the deployment behavior. The optional **command** array overrides any **CMD** directive specified in the image's **Dockerfile**. The optional environment variables provided are added to the execution environment of the strategy process.

Additionally, OpenShift Container Platform provides the following environment variables to the deployment process:

Environment variable	Description
OPENSHIFT_DEPLOYMENT_NAME	The name of the new deployment, a replication controller.
OPENSHIFT_DEPLOYMENT_NAMESPACE	The name space of the new deployment.

The replica count of the new deployment will initially be zero. The responsibility of the strategy is to make the new deployment active using the logic that best serves the needs of the user.

Alternatively, use the **customParams** object to inject the custom deployment logic into the existing deployment strategies. Provide a custom shell script logic and call the **openshift-deploy** binary. Users do not have to supply their custom deployer container image; in this case, the default OpenShift Container Platform deployer image is used instead:

```
strategy:
  type: Rolling
  customParams:
    command:
    - /bin/sh
    - -c
    - |
      set -e
      openshift-deploy --until=50%
      echo Halfway there
      openshift-deploy
      echo Complete
```

This results in following deployment:

```
Started deployment #2
--> Scaling up custom-deployment-2 from 0 to 2, scaling down custom-deployment-1 from 2 to 0
(keep 2 pods available, don't exceed 3 pods)
    Scaling custom-deployment-2 up to 1
--> Reached 50% (currently 50%)
Halfway there
```

```
--> Scaling up custom-deployment-2 from 1 to 2, scaling down custom-deployment-1 from 2 to 0
(keep 2 pods available, don't exceed 3 pods)
    Scaling custom-deployment-1 down to 1
    Scaling custom-deployment-2 up to 2
    Scaling custom-deployment-1 down to 0
--> Success
Complete
```

If the custom deployment strategy process requires access to the OpenShift Container Platform API or the Kubernetes API the container that executes the strategy can use the service account token available inside the container for authentication.

6.3.5. Lifecycle hooks

The rolling and recreate strategies support *lifecycle hooks*, or deployment hooks, which allow behavior to be injected into the deployment process at predefined points within the strategy:

Example pre lifecycle hook

```
pre:
  failurePolicy: Abort
  execNewPod: {} 1
```

1 **execNewPod** is a pod-based lifecycle hook.

Every hook has a *failure policy*, which defines the action the strategy should take when a hook failure is encountered:

Abort	The deployment process will be considered a failure if the hook fails.
Retry	The hook execution should be retried until it succeeds.
Ignore	Any hook failure should be ignored and the deployment should proceed.

Hooks have a type-specific field that describes how to execute the hook. Currently, pod-based hooks are the only supported hook type, specified by the **execNewPod** field.

Pod-based lifecycle hook

Pod-based lifecycle hooks execute hook code in a new pod derived from the template in a **DeploymentConfig** object.

The following simplified example deployment uses the rolling strategy. Triggers and some other minor details are omitted for brevity:

```
kind: DeploymentConfig
apiVersion: v1
metadata:
  name: frontend
spec:
  template:
    metadata:
      labels:
        name: frontend
    spec:
      containers:
        - name: helloworld
          image: openshift/origin-ruby-sample
replicas: 5
selector:
  name: frontend
strategy:
  type: Rolling
  rollingParams:
    pre:
      failurePolicy: Abort
      execNewPod:
        containerName: helloworld (1)
        command: [ "/usr/bin/command", "arg1", "arg2" ] (2)
        env: (3)
          - name: CUSTOM_VAR1
            value: custom_value1
        volumes:
          - data (4)
```

1. The **helloworld** name refers to **spec.template.spec.containers[0].name**.
2. This **command** overrides any **ENTRYPOINT** defined by the **openshift/origin-ruby-sample** image.
3. **env** is an optional set of environment variables for the hook container.
4. **volumes** is an optional set of volume references for the hook container.

In this example, the **pre** hook will be executed in a new pod using the **openshift/origin-ruby-sample** image from the **helloworld** container. The hook pod has the following properties:

- The hook command is **/usr/bin/command arg1 arg2**.
- The hook container has the **CUSTOM_VAR1=custom_value1** environment variable.
- The hook failure policy is **Abort**, meaning the deployment process fails if the hook fails.
- The hook pod inherits the **data** volume from the **DeploymentConfig** object pod.

6.3.5.1. Setting lifecycle hooks

You can set lifecycle hooks, or deployment hooks, for a deployment using the CLI.

Procedure

1. Use the **oc set deployment-hook** command to set the type of hook you want: **--pre**, **--mid**, or **--post**. For example, to set a pre-deployment hook:

```
$ oc set deployment-hook dc/frontend \
    --pre -c helloworld -e CUSTOM_VAR1=custom_value1 \
    --volumes data --failure-policy=abort -- /usr/bin/command arg1 arg2
```

6.4. USING ROUTE-BASED DEPLOYMENT STRATEGIES

Deployment strategies provide a way for the application to evolve. Some strategies use **Deployment** objects to make changes that are seen by users of all routes that resolve to the application. Other advanced strategies, such as the ones described in this section, use router features in conjunction with **Deployment** objects to impact specific routes.

The most common route-based strategy is to use a *blue-green deployment*. The new version (the green version) is brought up for testing and evaluation, while the users still use the stable version (the blue version). When ready, the users are switched to the green version. If a problem arises, you can switch back to the blue version.

A common alternative strategy is to use *A/B versions* that are both active at the same time and some users use one version, and some users use the other version. This can be used for experimenting with user interface changes and other features to get user feedback. It can also be used to verify proper operation in a production context where problems impact a limited number of users.

A canary deployment tests the new version but when a problem is detected it quickly falls back to the previous version. This can be done with both of the above strategies.

The route-based deployment strategies do not scale the number of pods in the services. To maintain desired performance characteristics the deployment configurations might have to be scaled.

6.4.1. Proxy shards and traffic splitting

In production environments, you can precisely control the distribution of traffic that lands on a particular shard. When dealing with large numbers of instances, you can use the relative scale of individual shards to implement percentage based traffic. That combines well with a *proxy shard*, which forwards or splits the traffic it receives to a separate service or application running elsewhere.

In the simplest configuration, the proxy forwards requests unchanged. In more complex setups, you can duplicate the incoming requests and send to both a separate cluster as well as to a local instance of the application, and compare the result. Other patterns include keeping the caches of a DR installation warm, or sampling incoming traffic for analysis purposes.

Any TCP (or UDP) proxy could be run under the desired shard. Use the **oc scale** command to alter the relative number of instances serving requests under the proxy shard. For more complex traffic management, consider customizing the OpenShift Container Platform router with proportional balancing capabilities.

6.4.2. N-1 compatibility

Applications that have new code and old code running at the same time must be careful to ensure that data written by the new code can be read and handled (or gracefully ignored) by the old version of the code. This is sometimes called *schema evolution* and is a complex problem.

This can take many forms: data stored on disk, in a database, in a temporary cache, or that is part of a user’s browser session. While most web applications can support rolling deployments, it is important to test and design your application to handle it.

For some applications, the period of time that old code and new code is running side by side is short, so bugs or some failed user transactions are acceptable. For others, the failure pattern may result in the entire application becoming non-functional.

One way to validate N-1 compatibility is to use an A/B deployment: run the old code and new code at the same time in a controlled way in a test environment, and verify that traffic that flows to the new deployment does not cause failures in the old deployment.

6.4.3. Graceful termination

OpenShift Container Platform and Kubernetes give application instances time to shut down before removing them from load balancing rotations. However, applications must ensure they cleanly terminate user connections as well before they exit.

On shutdown, OpenShift Container Platform sends a **TERM** signal to the processes in the container. Application code, on receiving **SIGTERM**, stop accepting new connections. This ensures that load balancers route traffic to other active instances. The application code then waits until all open connections are closed, or gracefully terminate individual connections at the next opportunity, before exiting.

After the graceful termination period expires, a process that has not exited is sent the **KILL** signal, which immediately ends the process. The **terminationGracePeriodSeconds** attribute of a pod or pod template controls the graceful termination period (default 30 seconds) and can be customized per application as necessary.

6.4.4. Blue-green deployments

Blue-green deployments involve running two versions of an application at the same time and moving traffic from the in-production version (the blue version) to the newer version (the green version). You can use a rolling strategy or switch services in a route.

Because many applications depend on persistent data, you must have an application that supports *N-1 compatibility*, which means it shares data and implements live migration between the database, store, or disk by creating two copies of the data layer.

Consider the data used in testing the new version. If it is the production data, a bug in the new version can break the production version.

6.4.4.1. Setting up a blue-green deployment

Blue-green deployments use two **Deployment** objects. Both are running, and the one in production depends on the service the route specifies, with each **Deployment** object exposed to a different service.

NOTE

Routes are intended for web (HTTP and HTTPS) traffic, so this technique is best suited for web applications.

You can create a new route to the new version and test it. When ready, change the service in the production route to point to the new service and the new (green) version is live.

If necessary, you can roll back to the older (blue) version by switching the service back to the previous version.

Procedure

1. Create two independent application components.

a. Create a copy of the example application running the **v1** image under the **example-blue** service:

```
$ oc new-app openshift/deployment-example:v1 --name=example-blue
```

b. Create a second copy that uses the **v2** image under the **example-green** service:

```
$ oc new-app openshift/deployment-example:v2 --name=example-green
```

2. Create a route that points to the old service:

```
$ oc expose svc/example-blue --name=bluegreen-example
```

3. Browse to the application at **bluegreen-example-<project>.<router_domain>** to verify you see the **v1** image.

4. Edit the route and change the service name to **example-green**:

```
$ oc patch route/bluegreen-example -p '{"spec":{"to":{"name":"example-green"}}}'
```

5. To verify that the route has changed, refresh the browser until you see the **v2** image.

6.4.5. A/B deployments

The A/B deployment strategy lets you try a new version of the application in a limited way in the production environment. You can specify that the production version gets most of the user requests while a limited fraction of requests go to the new version.

Because you control the portion of requests to each version, as testing progresses you can increase the fraction of requests to the new version and ultimately stop using the previous version. As you adjust the request load on each version, the number of pods in each service might have to be scaled as well to provide the expected performance.

In addition to upgrading software, you can use this feature to experiment with versions of the user interface. Since some users get the old version and some the new, you can evaluate the user's reaction to the different versions to inform design decisions.

For this to be effective, both the old and new versions must be similar enough that both can run at the same time. This is common with bug fix releases and when new features do not interfere with the old. The versions require N-1 compatibility to properly work together.

OpenShift Container Platform supports N-1 compatibility through the web console as well as the CLI.

6.4.5.1. Load balancing for A/B testing

The user sets up a route with multiple services. Each service handles a version of the application.

Each service is assigned a **weight** and the portion of requests to each service is the **service_weight** divided by the **sum_of_weights**. The **weight** for each service is distributed to the service's endpoints so that the sum of the endpoint **weights** is the service **weight**.

The route can have up to four services. The **weight** for the service can be between **0** and **256**. When the **weight** is **0**, the service does not participate in load-balancing but continues to serve existing persistent connections. When the service **weight** is not **0**, each endpoint has a minimum **weight** of **1**. Because of this, a service with a lot of endpoints can end up with higher **weight** than intended. In this case, reduce the number of pods to get the expected load balance **weight**.

Procedure

To set up the A/B environment:

1. Create the two applications and give them different names. Each creates a **Deployment** object. The applications are versions of the same program; one is usually the current production version and the other the proposed new version.

   a. Create the first application. The following example creates an application called **ab-example-a**:

   ```
   $ oc new-app openshift/deployment-example --name=ab-example-a
   ```

   b. Create the second application:

   ```
   $ oc new-app openshift/deployment-example:v2 --name=ab-example-b
   ```

   Both applications are deployed and services are created.

2. Make the application available externally via a route. At this point, you can expose either. It can be convenient to expose the current production version first and later modify the route to add the new version.

   ```
   $ oc expose svc/ab-example-a
   ```

   Browse to the application at **ab-example-a.<project>.<router_domain>** to verify that you see the expected version.

3. When you deploy the route, the router balances the traffic according to the **weights** specified for the services. At this point, there is a single service with default **weight=1** so all requests go to it. Adding the other service as an **alternateBackends** and adjusting the **weights** brings the A/B setup to life. This can be done by the **oc set route-backends** command or by editing the route. Setting the **oc set route-backend** to **0** means the service does not participate in load-balancing, but continues to serve existing persistent connections.

   NOTE

   Changes to the route just change the portion of traffic to the various services. You might have to scale the deployment to adjust the number of pods to handle the anticipated loads.

   To edit the route, run:

   ```
   $ oc edit route <route_name>
   ```

   #### Example output

   ```
   ...
   metadata:
     name: route-alternate-service
     annotations:
   ```

```
    haproxy.router.openshift.io/balance: roundrobin
spec:
  host: ab-example.my-project.my-domain
  to:
    kind: Service
    name: ab-example-a
    weight: 10
  alternateBackends:
  - kind: Service
    name: ab-example-b
    weight: 15
...
```

6.4.5.1.1. Managing weights of an existing route using the web console

Procedure

1. Navigate to the **Networking** → **Routes** page.
2. Click the Actions menu ⋮ next to the route you want to edit and select **Edit Route**.
3. Edit the YAML file. Update the **weight** to be an integer between **0** and **256** that specifies the relative weight of the target against other target reference objects. The value **0** suppresses requests to this back end. The default is **100**. Run **oc explain routes.spec.alternateBackends** for more information about the options.
4. Click **Save**.

6.4.5.1.2. Managing weights of an new route using the web console

1. Navigate to the **Networking** → **Routes** page.
2. Click **Create Route**.
3. Enter the route **Name**.
4. Select the **Service**.
5. Click **Add Alternate Service**.
6. Enter a value for **Weight** and **Alternate Service Weight**. Enter a number between **0** and **255** that depicts relative weight compared with other targets. The default is **100**.
7. Select the **Target Port**.
8. Click **Create**.

6.4.5.1.3. Managing weights using the CLI

Procedure

1. To manage the services and corresponding weights load balanced by the route, use the **oc set route-backends** command:

```
$ oc set route-backends ROUTENAME \
    [--zero|--equal] [--adjust] SERVICE=WEIGHT[%] [...] [options]
```

For example, the following sets **ab-example-a** as the primary service with **weight=198** and **ab-example-b** as the first alternate service with a **weight=2**:

```
$ oc set route-backends ab-example ab-example-a=198 ab-example-b=2
```

This means 99% of traffic is sent to service **ab-example-a** and 1% to service **ab-example-b**.

This command does not scale the deployment. You might be required to do so to have enough pods to handle the request load.

2. Run the command with no flags to verify the current configuration:

```
$ oc set route-backends ab-example
```

Example output

```
NAME                    KIND     TO            WEIGHT
routes/ab-example       Service  ab-example-a 198 (99%)
routes/ab-example       Service  ab-example-b 2   (1%)
```

3. To alter the weight of an individual service relative to itself or to the primary service, use the **--adjust** flag. Specifying a percentage adjusts the service relative to either the primary or the first alternate (if you specify the primary). If there are other backends, their weights are kept proportional to the changed.
The following example alters the weight of **ab-example-a** and **ab-example-b** services:

```
$ oc set route-backends ab-example --adjust ab-example-a=200 ab-example-b=10
```

Alternatively, alter the weight of a service by specifying a percentage:

```
$ oc set route-backends ab-example --adjust ab-example-b=5%
```

By specifying **+** before the percentage declaration, you can adjust a weighting relative to the current setting. For example:

```
$ oc set route-backends ab-example --adjust ab-example-b=+15%
```

The **--equal** flag sets the **weight** of all services to **100**:

```
$ oc set route-backends ab-example --equal
```

The **--zero** flag sets the **weight** of all services to **0**. All requests then return with a 503 error.

NOTE

Not all routers may support multiple or weighted backends.

6.4.5.1.4. One service, multiple **Deployment** objects

Procedure

1. Create a new application, adding a label **ab-example=true** that will be common to all shards:

   ```
   $ oc new-app openshift/deployment-example --name=ab-example-a --as-deployment-config=true --labels=ab-example=true --env=SUBTITLE\=shardA
   $ oc delete svc/ab-example-a
   ```

   The application is deployed and a service is created. This is the first shard.

2. Make the application available via a route, or use the service IP directly:

   ```
   $ oc expose deployment ab-example-a --name=ab-example --selector=ab-example\=true
   $ oc expose service ab-example
   ```

3. Browse to the application at **ab-example-<project_name>.<router_domain>** to verify you see the **v1** image.

4. Create a second shard based on the same source image and label as the first shard, but with a different tagged version and unique environment variables:

   ```
   $ oc new-app openshift/deployment-example:v2 \
       --name=ab-example-b --labels=ab-example=true \
       SUBTITLE="shard B" COLOR="red" --as-deployment-config=true
   $ oc delete svc/ab-example-b
   ```

5. At this point, both sets of pods are being served under the route. However, because both browsers (by leaving a connection open) and the router (by default, through a cookie) attempt to preserve your connection to a back-end server, you might not see both shards being returned to you.
   To force your browser to one or the other shard:

   a. Use the **oc scale** command to reduce replicas of **ab-example-a** to **0**.

      ```
      $ oc scale dc/ab-example-a --replicas=0
      ```

      Refresh your browser to show **v2** and **shard B** (in red).

   b. Scale **ab-example-a** to **1** replica and **ab-example-b** to **0**:

      ```
      $ oc scale dc/ab-example-a --replicas=1; oc scale dc/ab-example-b --replicas=0
      ```

      Refresh your browser to show **v1** and **shard A** (in blue).

6. If you trigger a deployment on either shard, only the pods in that shard are affected. You can trigger a deployment by changing the **SUBTITLE** environment variable in either **Deployment** object:

   ```
   $ oc edit dc/ab-example-a
   ```

   or

   ```
   $ oc edit dc/ab-example-b
   ```

CHAPTER 7. QUOTAS

7.1. RESOURCE QUOTAS PER PROJECT

A *resource quota*, defined by a **ResourceQuota** object, provides constraints that limit aggregate resource consumption per project. It can limit the quantity of objects that can be created in a project by type, as well as the total amount of compute resources and storage that might be consumed by resources in that project.

This guide describes how resource quotas work, how cluster administrators can set and manage resource quotas on a per project basis, and how developers and cluster administrators can view them.

7.1.1. Resources managed by quotas

The following describes the set of compute resources and object types that can be managed by a quota.

NOTE

A pod is in a terminal state if **status.phase in (Failed, Succeeded)** is true.

Table 7.1. Compute resources managed by quota

Resource Name	Description
cpu	The sum of CPU requests across all pods in a non-terminal state cannot exceed this value. **cpu** and **requests.cpu** are the same value and can be used interchangeably.
memory	The sum of memory requests across all pods in a non-terminal state cannot exceed this value. **memory** and **requests.memory** are the same value and can be used interchangeably.
ephemeral-storage	The sum of local ephemeral storage requests across all pods in a non-terminal state cannot exceed this value. **ephemeral-storage** and **requests.ephemeral-storage** are the same value and can be used interchangeably.
requests.cpu	The sum of CPU requests across all pods in a non-terminal state cannot exceed this value. **cpu** and **requests.cpu** are the same value and can be used interchangeably.
requests.memory	The sum of memory requests across all pods in a non-terminal state cannot exceed this value. **memory** and **requests.memory** are the same value and can be used interchangeably.
requests.ephemeral-storage	The sum of ephemeral storage requests across all pods in a non-terminal state cannot exceed this value. **ephemeral-storage** and **requests.ephemeral-storage** are the same value and can be used interchangeably.

Resource Name	Description
limits.cpu	The sum of CPU limits across all pods in a non-terminal state cannot exceed this value.
limits.memory	The sum of memory limits across all pods in a non-terminal state cannot exceed this value.
limits.ephemeral-storage	The sum of ephemeral storage limits across all pods in a non-terminal state cannot exceed this value.

Table 7.2. Storage resources managed by quota

Resource Name	Description
requests.storage	The sum of storage requests across all persistent volume claims in any state cannot exceed this value.
persistentvolumeclaims	The total number of persistent volume claims that can exist in the project.
<storage-class-name>.storageclass.storage.k8s.io/requests.storage	The sum of storage requests across all persistent volume claims in any state that have a matching storage class, cannot exceed this value.
<storage-class-name>.storageclass.storage.k8s.io/persistentvolumeclaims	The total number of persistent volume claims with a matching storage class that can exist in the project.

Table 7.3. Object counts managed by quota

Resource Name	Description
pods	The total number of pods in a non-terminal state that can exist in the project.
replicationcontrollers	The total number of ReplicationControllers that can exist in the project.
resourcequotas	The total number of resource quotas that can exist in the project.
services	The total number of services that can exist in the project.
services.loadbalancers	The total number of services of type **LoadBalancer** that can exist in the project.
services.nodeports	The total number of services of type **NodePort** that can exist in the project.

Resource Name	Description
secrets	The total number of secrets that can exist in the project.
configmaps	The total number of **ConfigMap** objects that can exist in the project.
persistentvolumeclaims	The total number of persistent volume claims that can exist in the project.
openshift.io/imagestreams	The total number of imagestreams that can exist in the project.

7.1.2. Quota scopes

Each quota can have an associated set of *scopes*. A quota only measures usage for a resource if it matches the intersection of enumerated scopes.

Adding a scope to a quota restricts the set of resources to which that quota can apply. Specifying a resource outside of the allowed set results in a validation error.

Scope	Description
Terminating	Match pods where **spec.activeDeadlineSeconds >= 0**.
NotTerminating	Match pods where **spec.activeDeadlineSeconds** is **nil**.
BestEffort	Match pods that have best effort quality of service for either **cpu** or **memory**.
NotBestEffort	Match pods that do not have best effort quality of service for **cpu** and **memory**.

A **BestEffort** scope restricts a quota to limiting the following resources:

- **pods**

A **Terminating**, **NotTerminating**, and **NotBestEffort** scope restricts a quota to tracking the following resources:

- **pods**
- **memory**
- **requests.memory**
- **limits.memory**
- **cpu**

- **requests.cpu**
- **limits.cpu**
- **ephemeral-storage**
- **requests.ephemeral-storage**
- **limits.ephemeral-storage**

7.1.3. Quota enforcement

After a resource quota for a project is first created, the project restricts the ability to create any new resources that may violate a quota constraint until it has calculated updated usage statistics.

After a quota is created and usage statistics are updated, the project accepts the creation of new content. When you create or modify resources, your quota usage is incremented immediately upon the request to create or modify the resource.

When you delete a resource, your quota use is decremented during the next full recalculation of quota statistics for the project. A configurable amount of time determines how long it takes to reduce quota usage statistics to their current observed system value.

If project modifications exceed a quota usage limit, the server denies the action, and an appropriate error message is returned to the user explaining the quota constraint violated, and what their currently observed usage statistics are in the system.

7.1.4. Requests versus limits

When allocating compute resources, each container might specify a request and a limit value each for CPU, memory, and ephemeral storage. Quotas can restrict any of these values.

If the quota has a value specified for **requests.cpu** or **requests.memory**, then it requires that every incoming container make an explicit request for those resources. If the quota has a value specified for **limits.cpu** or **limits.memory**, then it requires that every incoming container specify an explicit limit for those resources.

7.1.5. Sample resource quota definitions

core-object-counts.yaml

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: core-object-counts
spec:
  hard:
    configmaps: "10" 1
    persistentvolumeclaims: "4" 2
    replicationcontrollers: "20" 3
    secrets: "10" 4
    services: "10" 5
    services.loadbalancers: "2" 6
```

1. The total number of **ConfigMap** objects that can exist in the project.
2. The total number of persistent volume claims (PVCs) that can exist in the project.
3. The total number of replication controllers that can exist in the project.
4. The total number of secrets that can exist in the project.
5. The total number of services that can exist in the project.
6. The total number of services of type **LoadBalancer** that can exist in the project.

openshift-object-counts.yaml

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: openshift-object-counts
spec:
  hard:
    openshift.io/imagestreams: "10" 1
```

1. The total number of image streams that can exist in the project.

compute-resources.yaml

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: compute-resources
spec:
  hard:
    pods: "4" 1
    requests.cpu: "1" 2
    requests.memory: 1Gi 3
    requests.ephemeral-storage: 2Gi 4
    limits.cpu: "2" 5
    limits.memory: 2Gi 6
    limits.ephemeral-storage: 4Gi 7
```

1. The total number of pods in a non-terminal state that can exist in the project.
2. Across all pods in a non-terminal state, the sum of CPU requests cannot exceed 1 core.
3. Across all pods in a non-terminal state, the sum of memory requests cannot exceed 1Gi.
4. Across all pods in a non-terminal state, the sum of ephemeral storage requests cannot exceed 2Gi.
5. Across all pods in a non-terminal state, the sum of CPU limits cannot exceed 2 cores.
6. Across all pods in a non-terminal state, the sum of memory limits cannot exceed 2Gi.

7 Across all pods in a non-terminal state, the sum of ephemeral storage limits cannot exceed 4Gi.

besteffort.yaml

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: besteffort
spec:
  hard:
    pods: "1" 1
  scopes:
  - BestEffort 2
```

1 The total number of pods in a non-terminal state with **BestEffort** quality of service that can exist in the project.

2 Restricts the quota to only matching pods that have **BestEffort** quality of service for either memory or CPU.

compute-resources-long-running.yaml

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: compute-resources-long-running
spec:
  hard:
    pods: "4" 1
    limits.cpu: "4" 2
    limits.memory: "2Gi" 3
    limits.ephemeral-storage: "4Gi" 4
  scopes:
  - NotTerminating 5
```

1 The total number of pods in a non-terminal state.

2 Across all pods in a non-terminal state, the sum of CPU limits cannot exceed this value.

3 Across all pods in a non-terminal state, the sum of memory limits cannot exceed this value.

4 Across all pods in a non-terminal state, the sum of ephemeral storage limits cannot exceed this value.

5 Restricts the quota to only matching pods where **spec.activeDeadlineSeconds** is set to **nil**. Build pods will fall under **NotTerminating** unless the **RestartNever** policy is applied.

compute-resources-time-bound.yaml

```
apiVersion: v1
kind: ResourceQuota
```

```
metadata:
  name: compute-resources-time-bound
spec:
  hard:
    pods: "2" (1)
    limits.cpu: "1" (2)
    limits.memory: "1Gi" (3)
    limits.ephemeral-storage: "1Gi" (4)
  scopes:
  - Terminating (5)
```

1. The total number of pods in a terminating state.
2. Across all pods in a terminating state, the sum of CPU limits cannot exceed this value.
3. Across all pods in a terminating state, the sum of memory limits cannot exceed this value.
4. Across all pods in a terminating state, the sum of ephemeral storage limits cannot exceed this value.
5. Restricts the quota to only matching pods where **spec.activeDeadlineSeconds >=0**. For example, this quota would charge for build or deployer pods, but not long running pods like a web server or database.

storage-consumption.yaml

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: storage-consumption
spec:
  hard:
    persistentvolumeclaims: "10" (1)
    requests.storage: "50Gi" (2)
    gold.storageclass.storage.k8s.io/requests.storage: "10Gi" (3)
    silver.storageclass.storage.k8s.io/requests.storage: "20Gi" (4)
    silver.storageclass.storage.k8s.io/persistentvolumeclaims: "5" (5)
    bronze.storageclass.storage.k8s.io/requests.storage: "0" (6)
    bronze.storageclass.storage.k8s.io/persistentvolumeclaims: "0" (7)
```

1. The total number of persistent volume claims in a project
2. Across all persistent volume claims in a project, the sum of storage requested cannot exceed this value.
3. Across all persistent volume claims in a project, the sum of storage requested in the gold storage class cannot exceed this value.
4. Across all persistent volume claims in a project, the sum of storage requested in the silver storage class cannot exceed this value.
5. Across all persistent volume claims in a project, the total number of claims in the silver storage class cannot exceed this value.

6. Across all persistent volume claims in a project, the sum of storage requested in the bronze storage class cannot exceed this value. When this is set to **0**, it means bronze storage class cannot request

7. Across all persistent volume claims in a project, the sum of storage requested in the bronze storage class cannot exceed this value. When this is set to **0**, it means bronze storage class cannot create claims.

7.1.6. Creating a quota

You can create a quota to constrain resource usage in a given project.

Procedure

1. Define the quota in a file.

2. Use the file to create the quota and apply it to a project:

```
$ oc create -f <file> [-n <project_name>]
```

   For example:

```
$ oc create -f core-object-counts.yaml -n demoproject
```

7.1.6.1. Creating object count quotas

You can create an object count quota for all standard namespaced resource types on OpenShift Container Platform, such as **BuildConfig** and **DeploymentConfig** objects. An object quota count places a defined quota on all standard namespaced resource types.

When using a resource quota, an object is charged against the quota upon creation. These types of quotas are useful to protect against exhaustion of resources. The quota can only be created if there are enough spare resources within the project.

Procedure

To configure an object count quota for a resource:

1. Run the following command:

```
$ oc create quota <name> \
    --hard=count/<resource>.<group>=<quota>,count/<resource>.<group>=<quota> 1
```

   1 The **<resource>** variable is the name of the resource, and **<group>** is the API group, if applicable. Use the **oc api-resources** command for a list of resources and their associated API groups.

   For example:

```
$ oc create quota test \
    --
hard=count/deployments.extensions=2,count/replicasets.extensions=4,count/pods=3,count/secr
ets=4
```

Example output

```
resourcequota "test" created
```

This example limits the listed resources to the hard limit in each project in the cluster.

2. Verify that the quota was created:

```
$ oc describe quota test
```

Example output

```
Name:                    test
Namespace:               quota
Resource                 Used  Hard
--------                 ----  ----
count/deployments.extensions  0     2
count/pods                    0     3
count/replicasets.extensions  0     4
count/secrets                 0     4
```

7.1.6.2. Setting resource quota for extended resources

Overcommitment of resources is not allowed for extended resources, so you must specify **requests** and **limits** for the same extended resource in a quota. Currently, only quota items with the prefix **requests.** is allowed for extended resources. The following is an example scenario of how to set resource quota for the GPU resource **nvidia.com/gpu**.

Procedure

1. Determine how many GPUs are available on a node in your cluster. For example:

```
# oc describe node ip-172-31-27-209.us-west-2.compute.internal | egrep
'Capacity|Allocatable|gpu'
```

Example output

```
                    openshift.com/gpu-accelerator=true
Capacity:
 nvidia.com/gpu:  2
Allocatable:
 nvidia.com/gpu:  2
  nvidia.com/gpu  0           0
```

In this example, 2 GPUs are available.

2. Set a quota in the namespace **nvidia**. In this example, the quota is **1**:

```
# cat gpu-quota.yaml
```

Example output

```
apiVersion: v1
kind: ResourceQuota
metadata:
  name: gpu-quota
  namespace: nvidia
spec:
  hard:
    requests.nvidia.com/gpu: 1
```

3. Create the quota:

```
# oc create -f gpu-quota.yaml
```

Example output

```
resourcequota/gpu-quota created
```

4. Verify that the namespace has the correct quota set:

```
# oc describe quota gpu-quota -n nvidia
```

Example output

```
Name:                    gpu-quota
Namespace:               nvidia
Resource                 Used  Hard
--------                 ----  ----
requests.nvidia.com/gpu  0     1
```

5. Define a pod that asks for a single GPU. The following example definition file is called **gpu-pod.yaml**:

```
apiVersion: v1
kind: Pod
metadata:
  generateName: gpu-pod-
  namespace: nvidia
spec:
  restartPolicy: OnFailure
  containers:
  - name: rhel7-gpu-pod
    image: rhel7
    env:
      - name: NVIDIA_VISIBLE_DEVICES
        value: all
      - name: NVIDIA_DRIVER_CAPABILITIES
        value: "compute,utility"
      - name: NVIDIA_REQUIRE_CUDA
        value: "cuda>=5.0"
    command: ["sleep"]
    args: ["infinity"]
    resources:
      limits:
        nvidia.com/gpu: 1
```

6. Create the pod:

```
# oc create -f gpu-pod.yaml
```

7. Verify that the pod is running:

```
# oc get pods
```

Example output

```
NAME              READY     STATUS      RESTARTS   AGE
gpu-pod-s46h7     1/1       Running     0          1m
```

8. Verify that the quota **Used** counter is correct:

```
# oc describe quota gpu-quota -n nvidia
```

Example output

```
Name:                  gpu-quota
Namespace:             nvidia
Resource               Used  Hard
--------               ----  ----
requests.nvidia.com/gpu  1     1
```

9. Attempt to create a second GPU pod in the **nvidia** namespace. This is technically available on the node because it has 2 GPUs:

```
# oc create -f gpu-pod.yaml
```

Example output

```
Error from server (Forbidden): error when creating "gpu-pod.yaml": pods "gpu-pod-f7z2w" is
forbidden: exceeded quota: gpu-quota, requested: requests.nvidia.com/gpu=1, used:
requests.nvidia.com/gpu=1, limited: requests.nvidia.com/gpu=1
```

This **Forbidden** error message is expected because you have a quota of 1 GPU and this pod tried to allocate a second GPU, which exceeds its quota.

7.1.7. Viewing a quota

You can view usage statistics related to any hard limits defined in a project's quota by navigating in the web console to the project's **Quota** page.

You can also use the CLI to view quota details.

Procedure

1. Get the list of quotas defined in the project. For example, for a project called **demoproject**:

   ```
   $ oc get quota -n demoproject
   ```

   Example output

   ```
   NAME                AGE
   besteffort          11m
   compute-resources   2m
   core-object-counts  29m
   ```

2. Describe the quota you are interested in, for example the **core-object-counts** quota:

   ```
   $ oc describe quota core-object-counts -n demoproject
   ```

   Example output

   ```
   Name:   core-object-counts
   Namespace:  demoproject
   Resource  Used Hard
   --------  ---- ----
   configmaps  3 10
   persistentvolumeclaims 0 4
   replicationcontrollers 3 20
   secrets   9 10
   services  2 10
   ```

7.1.8. Configuring explicit resource quotas

Configure explicit resource quotas in a project request template to apply specific resource quotas in new projects.

Prerequisites

- Access to the cluster as a user with the cluster-admin role.
- Install the OpenShift CLI (**oc**).

Procedure

1. Add a resource quota definition to a project request template:
   - If a project request template does not exist in a cluster:
     a. Create a bootstrap project template and output it to a file called **template.yaml**:

        ```
        $ oc adm create-bootstrap-project-template -o yaml > template.yaml
        ```

     b. Add a resource quota definition to **template.yaml**. The following example defines a resource quota named 'storage-consumption'. The definition must be added before the **parameters:** section in the template:

        ```
        - apiVersion: v1
        ```

```
kind: ResourceQuota
metadata:
  name: storage-consumption
spec:
  hard:
    persistentvolumeclaims: "10" 1
    requests.storage: "50Gi" 2
    gold.storageclass.storage.k8s.io/requests.storage: "10Gi" 3
    silver.storageclass.storage.k8s.io/requests.storage: "20Gi" 4
    silver.storageclass.storage.k8s.io/persistentvolumeclaims: "5" 5
    bronze.storageclass.storage.k8s.io/requests.storage: "0" 6
    bronze.storageclass.storage.k8s.io/persistentvolumeclaims: "0" 7
```

1 The total number of persistent volume claims in a project.

2 Across all persistent volume claims in a project, the sum of storage requested cannot exceed this value.

3 Across all persistent volume claims in a project, the sum of storage requested in the gold storage class cannot exceed this value.

4 Across all persistent volume claims in a project, the sum of storage requested in the silver storage class cannot exceed this value.

5 Across all persistent volume claims in a project, the total number of claims in the silver storage class cannot exceed this value.

6 Across all persistent volume claims in a project, the sum of storage requested in the bronze storage class cannot exceed this value. When this value is set to **0**, the bronze storage class cannot request storage.

7 Across all persistent volume claims in a project, the sum of storage requested in the bronze storage class cannot exceed this value. When this value is set to **0**, the bronze storage class cannot create claims.

c. Create a project request template from the modified **template.yaml** file in the **openshift-config** namespace:

```
$ oc create -f template.yaml -n openshift-config
```

NOTE

To include the configuration as a **kubectl.kubernetes.io/last-applied-configuration** annotation, add the **--save-config** option to the **oc create** command.

By default, the template is called **project-request**.

- If a project request template already exists within a cluster:

NOTE

If you declaratively or imperatively manage objects within your cluster by using configuration files, edit the existing project request template through those files instead.

a. List templates in the **openshift-config** namespace:

```
$ oc get templates -n openshift-config
```

b. Edit an existing project request template:

```
$ oc edit template <project_request_template> -n openshift-config
```

c. Add a resource quota definition, such as the preceding **storage-consumption** example, into the existing template. The definition must be added before the **parameters:** section in the template.

2. If you created a project request template, reference it in the cluster's project configuration resource:

   a. Access the project configuration resource for editing:

   - By using the web console:

     i. Navigate to the **Administration** → **Cluster Settings** page.

     ii. Click **Configuration** to view all configuration resources.

     iii. Find the entry for **Project** and click **Edit YAML**.

   - By using the CLI:

     i. Edit the **project.config.openshift.io/cluster** resource:

     ```
     $ oc edit project.config.openshift.io/cluster
     ```

   b. Update the **spec** section of the project configuration resource to include the **projectRequestTemplate** and **name** parameters. The following example references the default project request template name **project-request**:

   ```
   apiVersion: config.openshift.io/v1
   kind: Project
   metadata:
     ...
   spec:
     projectRequestTemplate:
       name: project-request
   ```

3. Verify that the resource quota is applied when projects are created:

   a. Create a project:

   ```
   $ oc new-project <project_name>
   ```

b. List the project's resource quotas:

```
$ oc get resourcequotas
```

c. Describe the resource quota in detail:

```
$ oc describe resourcequotas <resource_quota_name>
```

7.2. RESOURCE QUOTAS ACROSS MULTIPLE PROJECTS

A multi-project quota, defined by a **ClusterResourceQuota** object, allows quotas to be shared across multiple projects. Resources used in each selected project are aggregated and that aggregate is used to limit resources across all the selected projects.

This guide describes how cluster administrators can set and manage resource quotas across multiple projects.

7.2.1. Selecting multiple projects during quota creation

When creating quotas, you can select multiple projects based on annotation selection, label selection, or both.

Procedure

1. To select projects based on annotations, run the following command:

```
$ oc create clusterquota for-user \
     --project-annotation-selector openshift.io/requester=<user_name> \
     --hard pods=10 \
     --hard secrets=20
```

This creates the following **ClusterResourceQuota** object:

```
apiVersion: quota.openshift.io/v1
kind: ClusterResourceQuota
metadata:
  name: for-user
spec:
  quota: 1
    hard:
      pods: "10"
      secrets: "20"
  selector:
    annotations: 2
      openshift.io/requester: <user_name>
    labels: null 3
status:
  namespaces: 4
  - namespace: ns-one
    status:
      hard:
        pods: "10"
        secrets: "20"
      used:
        pods: "1"
        secrets: "9"
  total: 5
    hard:
      pods: "10"
      secrets: "20"
    used:
      pods: "1"
      secrets: "9"
```

1. The **ResourceQuotaSpec** object that will be enforced over the selected projects.
2. A simple key-value selector for annotations.
3. A label selector that can be used to select projects.
4. A per-namespace map that describes current quota usage in each selected project.
5. The aggregate usage across all selected projects.

This multi-project quota document controls all projects requested by **<user_name>** using the default project request endpoint. You are limited to 10 pods and 20 secrets.

2. Similarly, to select projects based on labels, run this command:

```
$ oc create clusterresourcequota for-name \ 1
    --project-label-selector=name=frontend \ 2
    --hard=pods=10 --hard=secrets=20
```

1. Both **clusterresourcequota** and **clusterquota** are aliases of the same command. **for-name** is the name of the **ClusterResourceQuota** object.
2. To select projects by label, provide a key-value pair by using the format **--project-label-selector=key=value**.

This creates the following **ClusterResourceQuota** object definition:

```
apiVersion: quota.openshift.io/v1
kind: ClusterResourceQuota
metadata:
  creationTimestamp: null
  name: for-name
spec:
  quota:
    hard:
      pods: "10"
      secrets: "20"
  selector:
    annotations: null
    labels:
      matchLabels:
        name: frontend
```

7.2.2. Viewing applicable cluster resource quotas

A project administrator is not allowed to create or modify the multi-project quota that limits his or her project, but the administrator is allowed to view the multi-project quota documents that are applied to his or her project. The project administrator can do this via the **AppliedClusterResourceQuota** resource.

Procedure

1. To view quotas applied to a project, run:

```
$ oc describe AppliedClusterResourceQuota
```

Example output

```
Name:   for-user
Namespace:  <none>
Created:  19 hours ago
Labels:   <none>
Annotations:  <none>
Label Selector: <null>
AnnotationSelector: map[openshift.io/requester:<user-name>]
Resource  Used  Hard
--------  ----  ----
pods        1     10
secrets     9     20
```

7.2.3. Selection granularity

Because of the locking consideration when claiming quota allocations, the number of active projects selected by a multi-project quota is an important consideration. Selecting more than 100 projects under a single multi-project quota can have detrimental effects on API server responsiveness in those projects.

CHAPTER 8. USING CONFIG MAPS WITH APPLICATIONS

Config maps allow you to decouple configuration artifacts from image content to keep containerized applications portable.

The following sections define config maps and how to create and use them.

For information on creating config maps, see Creating and using config maps.

8.1. UNDERSTANDING CONFIG MAPS

Many applications require configuration using some combination of configuration files, command line arguments, and environment variables. In OpenShift Container Platform, these configuration artifacts are decoupled from image content to keep containerized applications portable.

The **ConfigMap** object provides mechanisms to inject containers with configuration data while keeping containers agnostic of OpenShift Container Platform. A config map can be used to store fine-grained information like individual properties or coarse-grained information like entire configuration files or JSON blobs.

The **ConfigMap** API object holds key-value pairs of configuration data that can be consumed in pods or used to store configuration data for system components such as controllers. For example:

ConfigMap Object Definition

```
kind: ConfigMap
apiVersion: v1
metadata:
  creationTimestamp: 2016-02-18T19:14:38Z
  name: example-config
  namespace: default
data: (1)
  example.property.1: hello
  example.property.2: world
  example.property.file: |-
    property.1=value-1
    property.2=value-2
    property.3=value-3
binaryData:
  bar: L3Jvb3QvMTAw (2)
```

1. Contains the configuration data.
2. Points to a file that contains non-UTF8 data, for example, a binary Java keystore file. Enter the file data in Base 64.

NOTE

You can use the **binaryData** field when you create a config map from a binary file, such as an image.

Configuration data can be consumed in pods in a variety of ways. A config map can be used to:

- Populate environment variable values in containers
- Set command-line arguments in a container
- Populate configuration files in a volume

Users and system components can store configuration data in a config map.

A config map is similar to a secret, but designed to more conveniently support working with strings that do not contain sensitive information.

Config map restrictions

A config map must be created before its contents can be consumed in pods.

Controllers can be written to tolerate missing configuration data. Consult individual components configured by using config maps on a case-by-case basis.

ConfigMap objects reside in a project.

They can only be referenced by pods in the same project.

The Kubelet only supports the use of a config map for pods it gets from the API server.

This includes any pods created by using the CLI, or indirectly from a replication controller. It does not include pods created by using the OpenShift Container Platform node's **--manifest-url** flag, its **--config** flag, or its REST API because these are not common ways to create pods.

8.2. USE CASES: CONSUMING CONFIG MAPS IN PODS

The following sections describe some uses cases when consuming **ConfigMap** objects in pods.

8.2.1. Populating environment variables in containers by using config maps

Config maps can be used to populate individual environment variables in containers or to populate environment variables in containers from all keys that form valid environment variable names.

As an example, consider the following config map:

ConfigMap with two environment variables

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: special-config (1)
  namespace: default (2)
data:
  special.how: very (3)
  special.type: charm (4)
```

(1) Name of the config map.

(2) The project in which the config map resides. Config maps can only be referenced by pods in the same project.

(3) (4) Environment variables to inject.

ConfigMap with one environment variable

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: env-config 1
  namespace: default
data:
  log_level: INFO 2
```

1 Name of the config map.

2 Environment variable to inject.

Procedure

- You can consume the keys of this **ConfigMap** in a pod using **configMapKeyRef** sections.

  Sample Pod specification configured to inject specific environment variables

```
apiVersion: v1
kind: Pod
metadata:
  name: dapi-test-pod
spec:
  containers:
    - name: test-container
      image: gcr.io/google_containers/busybox
      command: [ "/bin/sh", "-c", "env" ]
      env: 1
        - name: SPECIAL_LEVEL_KEY 2
          valueFrom:
            configMapKeyRef:
              name: special-config 3
              key: special.how 4
        - name: SPECIAL_TYPE_KEY
          valueFrom:
            configMapKeyRef:
              name: special-config 5
              key: special.type 6
              optional: true 7
      envFrom: 8
        - configMapRef:
            name: env-config 9
  restartPolicy: Never
```

1 Stanza to pull the specified environment variables from a **ConfigMap**.

2 Name of a pod environment variable that you are injecting a key's value into.

3 5 Name of the **ConfigMap** to pull specific environment variables from.

4 6 Environment variable to pull from the **ConfigMap**.

7 Makes the environment variable optional. As optional, the pod will be started even if the specified **ConfigMap** and keys do not exist.

8 Stanza to pull all environment variables from a **ConfigMap**.

9 Name of the **ConfigMap** to pull all environment variables from.

When this pod is run, the pod logs will include the following output:

```
SPECIAL_LEVEL_KEY=very
log_level=INFO
```

NOTE

SPECIAL_TYPE_KEY=charm is not listed in the example output because **optional: true** is set.

8.2.2. Setting command-line arguments for container commands with config maps

A config map can also be used to set the value of the commands or arguments in a container. This is accomplished by using the Kubernetes substitution syntax **$(VAR_NAME)**. Consider the following config map:

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: special-config
  namespace: default
data:
  special.how: very
  special.type: charm
```

Procedure

- To inject values into a command in a container, you must consume the keys you want to use as environment variables, as in the consuming ConfigMaps in environment variables use case. Then you can refer to them in a container's command using the **$(VAR_NAME)** syntax.

  Sample Pod specification configured to inject specific environment variables

```
apiVersion: v1
kind: Pod
metadata:
  name: dapi-test-pod
spec:
  containers:
    - name: test-container
      image: gcr.io/google_containers/busybox
      command: [ "/bin/sh", "-c", "echo $(SPECIAL_LEVEL_KEY) $(SPECIAL_TYPE_KEY)" ]
1
      env:
```

```
      - name: SPECIAL_LEVEL_KEY
        valueFrom:
          configMapKeyRef:
            name: special-config
            key: special.how
      - name: SPECIAL_TYPE_KEY
        valueFrom:
          configMapKeyRef:
            name: special-config
            key: special.type
  restartPolicy: Never
```

1 Inject the values into a command in a container using the keys you want to use as environment variables.

When this Pod is run, the output from the echo command run in the test-container container is as follows:

```
very charm
```

8.2.3. Injecting content into a volume by using config maps

You can inject content into a volume by using config maps.

Example **ConfigMap** custom resource (CR)

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: special-config
  namespace: default
data:
  special.how: very
  special.type: charm
```

Procedure

You have a couple different options for injecting content into a volume by using config maps.

- The most basic way to inject content into a volume by using a config map is to populate the volume with files where the key is the file name and the content of the file is the value of the key:

```
apiVersion: v1
kind: Pod
metadata:
  name: dapi-test-pod
spec:
  containers:
    - name: test-container
      image: gcr.io/google_containers/busybox
      command: [ "/bin/sh", "cat", "/etc/config/special.how" ]
      volumeMounts:
      - name: config-volume
      mountPath: /etc/config
  volumes:
    - name: config-volume
      configMap:
        name: special-config (1)
  restartPolicy: Never
```

(1) File containing key.

When this pod is run, the output of the cat command will be:

```
very
```

- You can also control the paths within the volume where config map keys are projected:

```
apiVersion: v1
kind: Pod
metadata:
  name: dapi-test-pod
spec:
  containers:
    - name: test-container
      image: gcr.io/google_containers/busybox
      command: [ "/bin/sh", "cat", "/etc/config/path/to/special-key" ]
      volumeMounts:
      - name: config-volume
        mountPath: /etc/config
  volumes:
    - name: config-volume
      configMap:
        name: special-config
        items:
        - key: special.how
          path: path/to/special-key (1)
  restartPolicy: Never
```

(1) Path to config map key.

When this pod is run, the output of the cat command will be:

```
very
```

CHAPTER 9. MONITORING PROJECT AND APPLICATION METRICS USING THE DEVELOPER PERSPECTIVE

The **Observe** view in the **Developer** perspective provides options to monitor your project or application metrics, such as CPU, memory, and bandwidth usage, and network related information.

9.1. PREREQUISITES

- You have logged in to the web console and have switched to the **Developer** perspective.
- You have created and deployed applications on OpenShift Container Platform .

9.2. MONITORING YOUR PROJECT METRICS

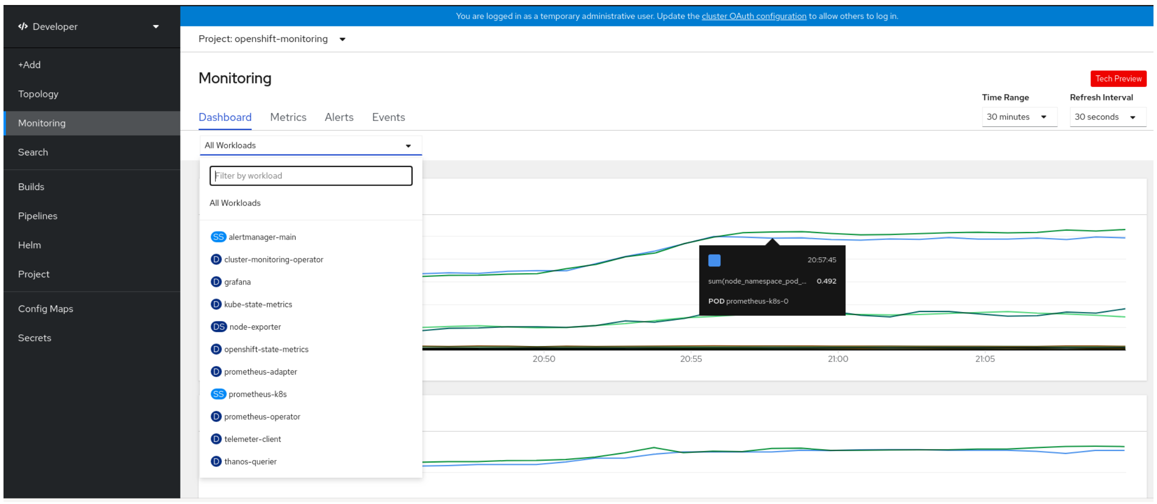
After you create applications in your project and deploy them, you can use the **Developer** perspective in the web console to see the metrics for your project.

Procedure

1. On the left navigation panel of the **Developer** perspective, click **Observe** to see the **Dashboard**, **Metrics**, **Alerts**, and **Events** for your project.

    - Use the **Dashboard** tab to see graphs depicting the CPU, memory, and bandwidth consumption and network related information, such as the rate of transmitted and received packets and the rate of dropped packets.

    Figure 9.1. Monitoring dashboard

    You are logged in as a temporary administrative user. Update the cluster OAuth configuration to allow others to log in.

    Project: openshift-monitoring

    Time Range: 30 minutes

    Refresh Interval: 30 seconds

    sum(node_namespace_pod_... 0.492

    POD prometheus-k8s-0

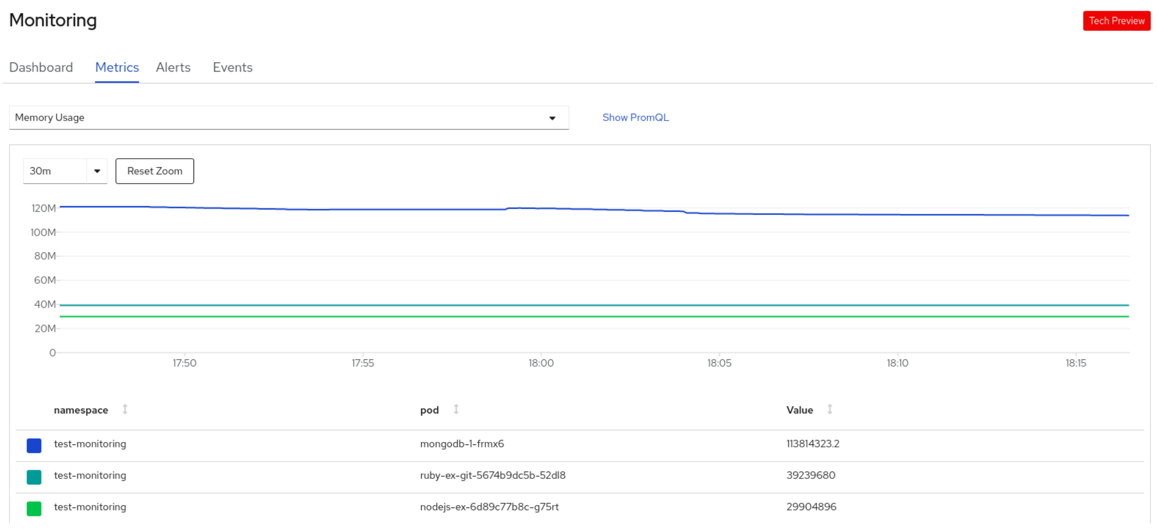
    Use the following options to see further details:

    - Select a workload from the **All Workloads** list to see the filtered metrics for the selected workload.
    - Select an option from the **Time Range** list to determine the time frame for the data being captured.
    - Select an option from the **Refresh Interval** list to determine the time period after which the data is refreshed.
    - Hover your cursor over the graphs to see specific details for your pod.

- Click on any of the graphs displayed to see the details for that particular metric in the **Metrics** page.

- Use the **Metrics** tab to query for the required project metric.

Figure 9.2. Monitoring metrics



	namespace	pod	Value
🟦	test-monitoring	mongodb-1-frmx6	113814323.2
🟦	test-monitoring	ruby-ex-git-5674b9dc5b-52dl8	39239680
🟩	test-monitoring	nodejs-ex-6d89c77b8c-g75rt	29904896

a. In the **Select Query** list, select an option to filter the required details for your project. The filtered metrics for all the application pods in your project are displayed in the graph. The pods in your project are also listed below.

b. From the list of pods, clear the colored square boxes to remove the metrics for specific pods to further filter your query result.

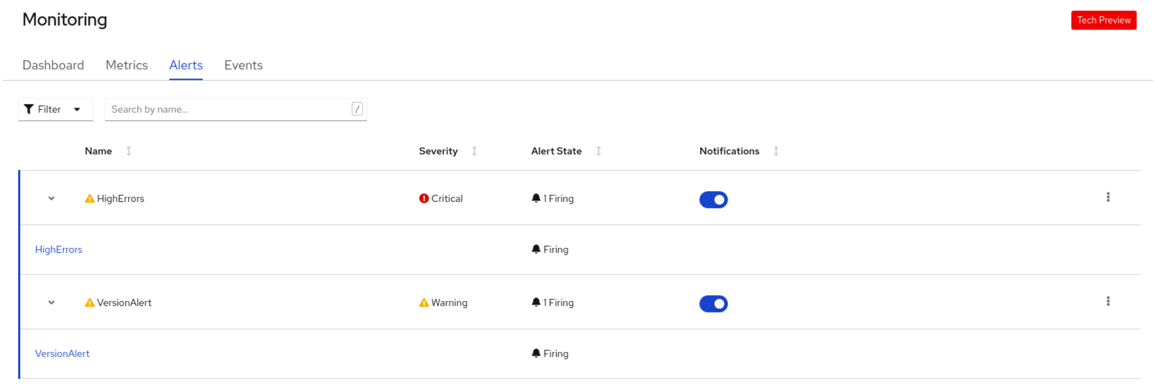
c. Click **Show PromQL** to see the Prometheus query. You can further modify this query with the help of prompts to customize the query and filter the metrics you want to see for that namespace.

d. Use the drop-down list to set a time range for the data being displayed. You can click **Reset Zoom** to reset it to the default time range.

e. Optional: In the **Select Query** list, select **Custom Query** to create a custom Prometheus query and filter relevant metrics.

- Use the **Alerts** tab to see the rules that trigger alerts for the applications in your project, identify the alerts firing in the project, and silence them if required.

Figure 9.3. Monitoring alerts



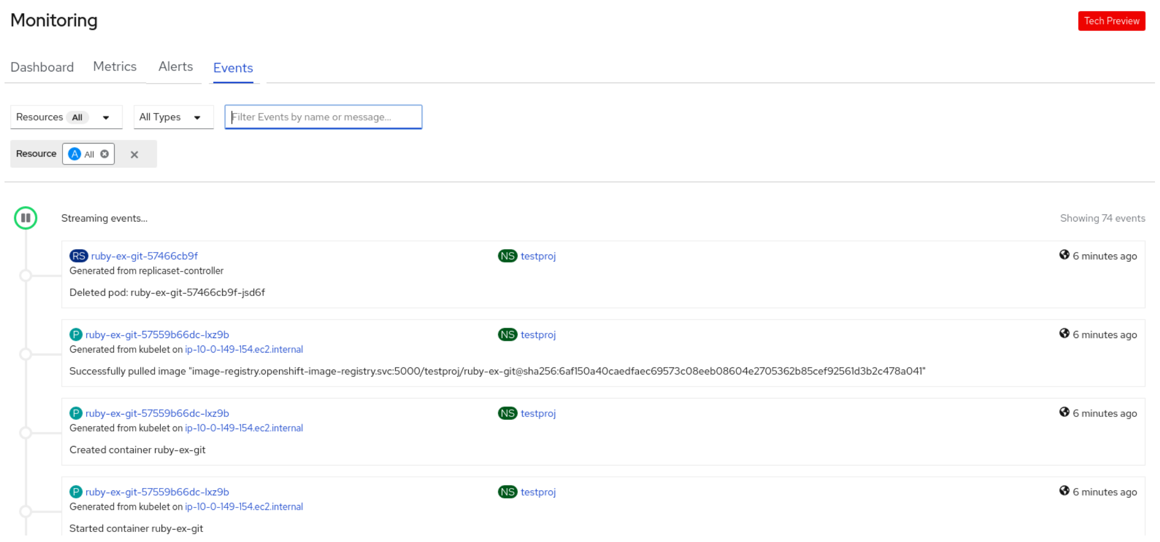
Name	Severity	Alert State	Notifications
HighErrors	Critical	1 Firing	
HighErrors		Firing	
VersionAlert	Warning	1 Firing	
VersionAlert		Firing	

- Use the **Filter** list to filter the alerts by their **Alert State** and **Severity**.

- Click on an alert to go to the details page for that alert. In the **Alerts Details** page, you can click **View Metrics** to see the metrics for the alert.
- Use the **Notifications** toggle adjoining an alert rule to silence all the alerts for that rule, and then select the duration for which the alerts will be silenced from the **Silence for** list. You must have the permissions to edit alerts to see the **Notifications** toggle.
- Use the **Options** menu ⋮ adjoining an alert rule to see the details of the alerting rule.

- Use the **Events** tab to see the events for your project.

Figure 9.4. Monitoring events



RS ruby-ex-git-57466cb9f — NS testproj — 6 minutes ago
Generated from replicaset-controller
Deleted pod: ruby-ex-git-57466cb9f-jsd6f

P ruby-ex-git-57559b66dc-lxz9b — NS testproj — 6 minutes ago
Generated from kubelet on ip-10-0-149-154.ec2.internal
Successfully pulled image "image-registry.openshift-image-registry.svc:5000/testproj/ruby-ex-git@sha256:6af150a40caedfaec69573c08eeb08604e2705362b85cef92561d3b2c478a041"

P ruby-ex-git-57559b66dc-lxz9b — NS testproj — 6 minutes ago
Generated from kubelet on ip-10-0-149-154.ec2.internal
Created container ruby-ex-git

P ruby-ex-git-57559b66dc-lxz9b — NS testproj — 6 minutes ago
Generated from kubelet on ip-10-0-149-154.ec2.internal
Started container ruby-ex-git

You can filter the displayed events using the following options:

- In the **Resources** list, select a resource to see events for that resource.
- In the **All Types** list, select a type of event to see events relevant to that type.
- Search for specific events using the **Filter events by names or messages** field.

9.3. MONITORING YOUR APPLICATION METRICS

After you create applications in your project and deploy them, you can use the **Topology** view in the **Developer** perspective to see the alerts and metrics for your application. Critical and warning alerts for your application are indicated on the workload node in the **Topology** view.

Procedure

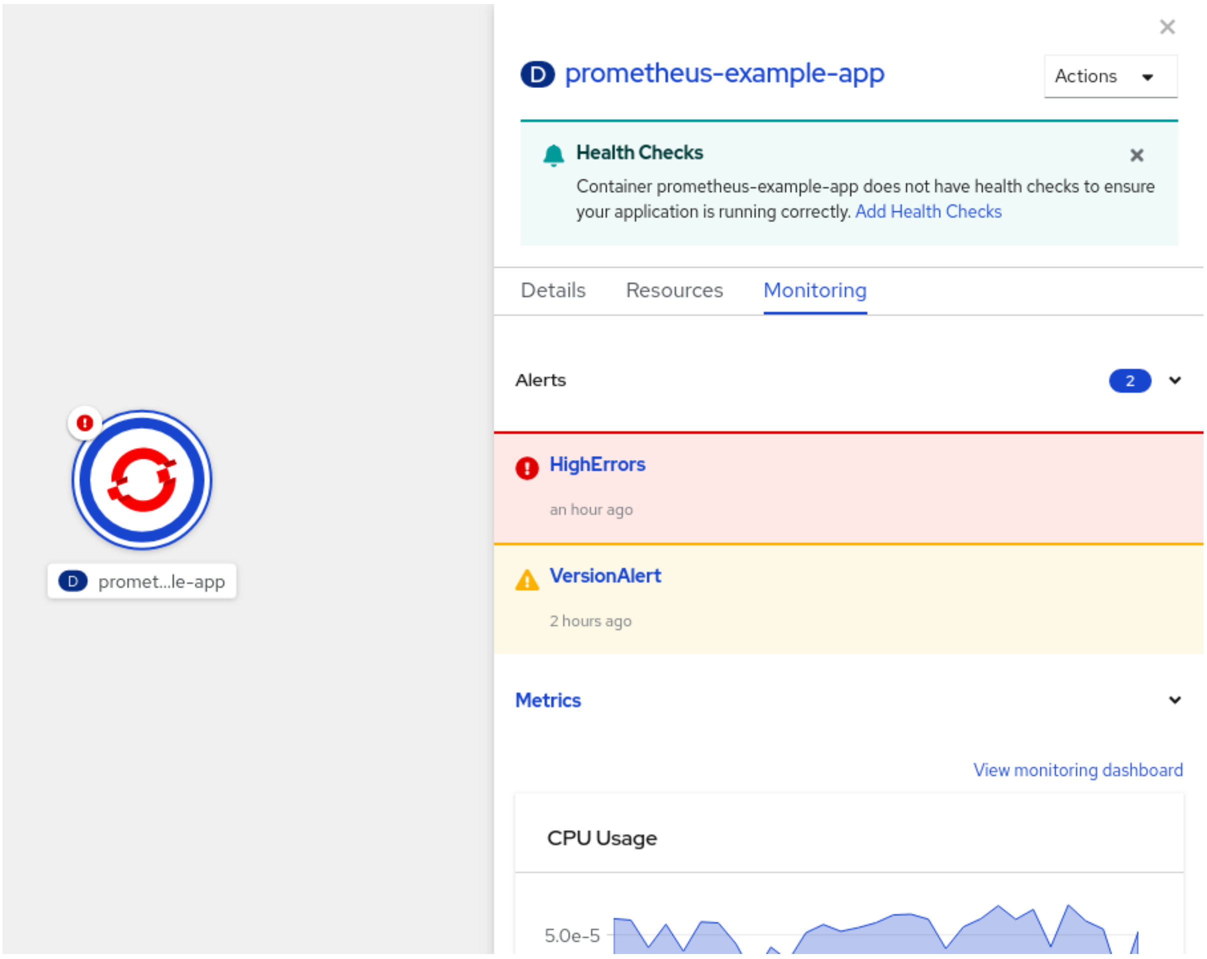
To see the alerts for your workload:

1. In the **Topology** view, click the workload to see the workload details in the right panel.
2. Click the **Observe** tab to see the critical and warning alerts for the application; graphs for metrics, such as CPU, memory, and bandwidth usage; and all the events for the application.

NOTE

Only critical and warning alerts in the **Firing** state are displayed in the **Topology** view. Alerts in the **Silenced**, **Pending** and **Not Firing** states are not displayed.

Figure 9.5. Monitoring application metrics



Container prometheus-example-app does not have health checks to ensure your application is running correctly. Add Health Checks

a. Click the alert listed in the right panel to see the alert details in the **Alert Details** page.

b. Click any of the charts to go to the **Metrics** tab to see the detailed metrics for the application.

c. Click **View monitoring dashboard** to see the monitoring dashboard for that application.

9.4. ADDITIONAL RESOURCES

- Understanding the monitoring stack

CHAPTER 10. MONITORING APPLICATION HEALTH BY USING HEALTH CHECKS

In software systems, components can become unhealthy due to transient issues such as temporary connectivity loss, configuration errors, or problems with external dependencies. OpenShift Container Platform applications have a number of options to detect and handle unhealthy containers.

10.1. UNDERSTANDING HEALTH CHECKS

A health check periodically performs diagnostics on a running container using any combination of the readiness, liveness, and startup health checks.

You can include one or more probes in the specification for the pod that contains the container which you want to perform the health checks.

NOTE

If you want to add or edit health checks in an existing pod, you must edit the pod **DeploymentConfig** object or use the **Developer** perspective in the web console. You cannot use the CLI to add or edit health checks for an existing pod.

Readiness probe

A *readiness probe* determines if a container is ready to accept service requests. If the readiness probe fails for a container, the kubelet removes the pod from the list of available service endpoints. After a failure, the probe continues to examine the pod. If the pod becomes available, the kubelet adds the pod to the list of available service endpoints.

Liveness health check

A *liveness probe* determines if a container is still running. If the liveness probe fails due to a condition such as a deadlock, the kubelet kills the container. The pod then responds based on its restart policy. For example, a liveness probe on a pod with a **restartPolicy** of **Always** or **OnFailure** kills and restarts the container.

Startup probe

A *startup probe* indicates whether the application within a container is started. All other probes are disabled until the startup succeeds. If the startup probe does not succeed within a specified time period, the kubelet kills the container, and the container is subject to the pod **restartPolicy**. Some applications can require additional startup time on their first initialization. You can use a startup probe with a liveness or readiness probe to delay that probe long enough to handle lengthy start-up time using the **failureThreshold** and **periodSeconds** parameters.

For example, you can add a startup probe, with a **failureThreshold** of 30 failures and a **periodSeconds** of 10 seconds (30 * 10s = 300s) for a maximum of 5 minutes, to a liveness probe. After the startup probe succeeds the first time, the liveness probe takes over.

You can configure liveness, readiness, and startup probes with any of the following types of tests:

- HTTP **GET**: When using an HTTP **GET** test, the test determines the healthiness of the container by using a web hook. The test is successful if the HTTP response code is between **200** and **399**. You can use an HTTP **GET** test with applications that return HTTP status codes when completely initialized.

- Container Command: When using a container command test, the probe executes a command inside the container. The probe is successful if the test exits with a **0** status.
- TCP socket: When using a TCP socket test, the probe attempts to open a socket to the container. The container is only considered healthy if the probe can establish a connection. You can use a TCP socket test with applications that do not start listening until initialization is complete.

You can configure several fields to control the behavior of a probe:

- **initialDelaySeconds**: The time, in seconds, after the container starts before the probe can be scheduled. The default is 0.
- **periodSeconds**: The delay, in seconds, between performing probes. The default is **10**. This value must be greater than **timeoutSeconds**.
- **timeoutSeconds**: The number of seconds of inactivity after which the probe times out and the container is assumed to have failed. The default is **1**. This value must be lower than **periodSeconds**.
- **successThreshold**: The number of times that the probe must report success after a failure to reset the container status to successful. The value must be **1** for a liveness probe. The default is **1**.
- **failureThreshold**: The number of times that the probe is allowed to fail. The default is 3. After the specified attempts:
  - for a liveness probe, the container is restarted
  - for a readiness probe, the pod is marked **Unready**
  - for a startup probe, the container is killed and is subject to the pod's **restartPolicy**

Example probes

The following are samples of different probes as they would appear in an object specification.

Sample readiness probe with a container command readiness probe in a pod spec

```
apiVersion: v1
kind: Pod
metadata:
  labels:
    test: health-check
  name: my-application
...
spec:
  containers:
  - name: goproxy-app 1
    args:
    image: k8s.gcr.io/goproxy:0.1 2
    readinessProbe: 3
      exec: 4
        command: 5
        - cat
        - /tmp/healthy
...
```

1 The container name.

2 The container image to deploy.

3 A readiness probe.

4 A container command test.

5 The commands to execute on the container.

Sample container command startup probe and liveness probe with container command tests in a pod spec

```
apiVersion: v1
kind: Pod
metadata:
  labels:
    test: health-check
  name: my-application
...
spec:
  containers:
  - name: goproxy-app (1)
    args:
    image: k8s.gcr.io/goproxy:0.1 (2)
    livenessProbe: (3)
      httpGet: (4)
        scheme: HTTPS (5)
        path: /healthz
        port: 8080 (6)
        httpHeaders:
        - name: X-Custom-Header
          value: Awesome
    startupProbe: (7)
      httpGet: (8)
        path: /healthz
        port: 8080 (9)
      failureThreshold: 30 (10)
      periodSeconds: 10 (11)
...
```

1 The container name.

2 Specify the container image to deploy.

3 A liveness probe.

4 An HTTP **GET** test.

5 The internet scheme: **HTTP** or **HTTPS**. The default value is **HTTP**.

6 The port on which the container is listening.

7 A startup probe.

8 An HTTP **GET** test.

9 The port on which the container is listening.

10 The number of times to try the probe after a failure.

11 The number of seconds to perform the probe.

Sample liveness probe with a container command test that uses a timeout in a pod spec

```
apiVersion: v1
kind: Pod
metadata:
  labels:
    test: health-check
  name: my-application
...
spec:
  containers:
  - name: goproxy-app 1
    args:
    image: k8s.gcr.io/goproxy:0.1 2
    livenessProbe: 3
      exec: 4
        command: 5
        - /bin/bash
        - '-c'
        - timeout 60 /opt/eap/bin/livenessProbe.sh
      periodSeconds: 10 6
      successThreshold: 1 7
      failureThreshold: 3 8
...
```

1 The container name.

2 Specify the container image to deploy.

3 The liveness probe.

4 The type of probe, here a container command probe.

5 The command line to execute inside the container.

6 How often in seconds to perform the probe.

7 The number of consecutive successes needed to show success after a failure.

8 The number of times to try the probe after a failure.

Sample readiness probe and liveness probe with a TCP socket test in a deployment

```
kind: Deployment
apiVersion: apps/v1
...
spec:
...
  template:
    spec:
      containers:
        - resources: {}
          readinessProbe: (1)
            tcpSocket:
              port: 8080
            timeoutSeconds: 1
            periodSeconds: 10
            successThreshold: 1
            failureThreshold: 3
          terminationMessagePath: /dev/termination-log
          name: ruby-ex
          livenessProbe: (2)
            tcpSocket:
              port: 8080
            initialDelaySeconds: 15
            timeoutSeconds: 1
            periodSeconds: 10
            successThreshold: 1
            failureThreshold: 3
...
```

(1) The readiness probe.

(2) The liveness probe.

10.2. CONFIGURING HEALTH CHECKS USING THE CLI

To configure readiness, liveness, and startup probes, add one or more probes to the specification for the pod that contains the container which you want to perform the health checks

NOTE

If you want to add or edit health checks in an existing pod, you must edit the pod **DeploymentConfig** object or use the **Developer** perspective in the web console. You cannot use the CLI to add or edit health checks for an existing pod.

Procedure

To add probes for a container:

1. Create a **Pod** object to add one or more probes:

```
apiVersion: v1
kind: Pod
metadata:
  labels:
    test: health-check
  name: my-application
spec:
  containers:
  - name: my-container (1)
    args:
    image: k8s.gcr.io/goproxy:0.1 (2)
    livenessProbe: (3)
      tcpSocket:  (4)
        port: 8080 (5)
      initialDelaySeconds: 15 (6)
      periodSeconds: 20 (7)
      timeoutSeconds: 10 (8)
    readinessProbe: (9)
      httpGet: (10)
        host: my-host (11)
        scheme: HTTPS (12)
        path: /healthz
        port: 8080 (13)
    startupProbe: (14)
      exec: (15)
        command: (16)
        - cat
        - /tmp/healthy
      failureThreshold: 30 (17)
      periodSeconds: 20 (18)
      timeoutSeconds: 10 (19)
```

1. Specify the container name.
2. Specify the container image to deploy.
3. Optional: Create a Liveness probe.
4. Specify a test to perform, here a TCP Socket test.
5. Specify the port on which the container is listening.
6. Specify the time, in seconds, after the container starts before the probe can be scheduled.
7. Specify the number of seconds to perform the probe. The default is **10**. This value must be greater than **timeoutSeconds**.
8. Specify the number of seconds of inactivity after which the probe is assumed to have failed. The default is **1**. This value must be lower than **periodSeconds**.
9. Optional: Create a Readiness probe.
10. Specify the type of test to perform, here an HTTP test.
11. Specify a host IP address. When **host** is not defined, the **PodIP** is used.
12. Specify **HTTP** or **HTTPS**. When **scheme** is not defined, the **HTTP** scheme is used.

13 Specify the port on which the container is listening.

14 Optional: Create a Startup probe.

15 Specify the type of test to perform, here an Container Execution probe.

16 Specify the commands to execute on the container.

17 Specify the number of times to try the probe after a failure.

18 Specify the number of seconds to perform the probe. The default is **10**. This value must be greater than **timeoutSeconds**.

19 Specify the number of seconds of inactivity after which the probe is assumed to have failed. The default is **1**. This value must be lower than **periodSeconds**.

NOTE

If the **initialDelaySeconds** value is lower than the **periodSeconds** value, the first Readiness probe occurs at some point between the two periods due to an issue with timers.

The **timeoutSeconds** value must be lower than the **periodSeconds** value.

2. Create the **Pod** object:

```
$ oc create -f <file-name>.yaml
```

3. Verify the state of the health check pod:

```
$ oc describe pod health-check
```

Example output

```
Events:
  Type    Reason     Age   From                          Message
  ----    ------     ----  ----                          -------
  Normal  Scheduled  9s    default-scheduler             Successfully assigned openshift-logging/liveness-exec to ip-10-0-143-40.ec2.internal
  Normal  Pulling    2s    kubelet, ip-10-0-143-40.ec2.internal  pulling image "k8s.gcr.io/liveness"
  Normal  Pulled     1s    kubelet, ip-10-0-143-40.ec2.internal  Successfully pulled image "k8s.gcr.io/liveness"
  Normal  Created    1s    kubelet, ip-10-0-143-40.ec2.internal  Created container
  Normal  Started    1s    kubelet, ip-10-0-143-40.ec2.internal  Started container
```

The following is the output of a failed probe that restarted a container:

Sample Liveness check output with unhealthy container

```
$ oc describe pod pod1
```

Example output

```
....

Events:
  Type     Reason          Age              From                                        Message
  ----     ------          ----             ----                                        -------
  Normal   Scheduled       <unknown>                                                    Successfully
assigned aaa/liveness-http to ci-ln-37hz77b-f76d1-wdpjv-worker-b-snzrj
  Normal   AddedInterface  47s              multus                                      Add eth0
[10.129.2.11/23]
  Normal   Pulled          46s              kubelet, ci-ln-37hz77b-f76d1-wdpjv-worker-b-snzrj
Successfully pulled image "k8s.gcr.io/liveness" in 773.406244ms
  Normal   Pulled          28s              kubelet, ci-ln-37hz77b-f76d1-wdpjv-worker-b-snzrj
Successfully pulled image "k8s.gcr.io/liveness" in 233.328564ms
  Normal   Created         10s (x3 over 46s)  kubelet, ci-ln-37hz77b-f76d1-wdpjv-worker-b-snzrj
Created container liveness
  Normal   Started         10s (x3 over 46s)  kubelet, ci-ln-37hz77b-f76d1-wdpjv-worker-b-snzrj
Started container liveness
  Warning  Unhealthy       10s (x6 over 34s)  kubelet, ci-ln-37hz77b-f76d1-wdpjv-worker-b-
snzrj  Liveness probe failed: HTTP probe failed with statuscode: 500
  Normal   Killing         10s (x2 over 28s)  kubelet, ci-ln-37hz77b-f76d1-wdpjv-worker-b-snzrj
Container liveness failed liveness probe, will be restarted
  Normal   Pulling         10s (x3 over 47s)  kubelet, ci-ln-37hz77b-f76d1-wdpjv-worker-b-snzrj
Pulling image "k8s.gcr.io/liveness"
  Normal   Pulled          10s              kubelet, ci-ln-37hz77b-f76d1-wdpjv-worker-b-snzrj
Successfully pulled image "k8s.gcr.io/liveness" in 244.116568ms
```

10.3. MONITORING APPLICATION HEALTH USING THE DEVELOPER PERSPECTIVE

You can use the **Developer** perspective to add three types of health probes to your container to ensure that your application is healthy:

- Use the Readiness probe to check if the container is ready to handle requests.
- Use the Liveness probe to check if the container is running.
- Use the Startup probe to check if the application within the container has started.

You can add health checks either while creating and deploying an application, or after you have deployed an application.

10.4. ADDING HEALTH CHECKS USING THE DEVELOPER PERSPECTIVE

You can use the **Topology** view to add health checks to your deployed application.

Prerequisites:

- You have switched to the **Developer** perspective in the web console.
- You have created and deployed an application on OpenShift Container Platform using the **Developer** perspective.

Procedure

1. In the **Topology** view, click on the application node to see the side panel. If the container does not have health checks added to ensure the smooth running of your application, a **Health Checks** notification is displayed with a link to add health checks.

2. In the displayed notification, click the **Add Health Checks** link.

3. Alternatively, you can also click the **Actions** drop-down list and select **Add Health Checks**. Note that if the container already has health checks, you will see the **Edit Health Checks** option instead of the add option.

4. In the **Add Health Checks** form, if you have deployed multiple containers, use the **Container** drop-down list to ensure that the appropriate container is selected.

5. Click the required health probe links to add them to the container. Default data for the health checks is prepopulated. You can add the probes with the default data or further customize the values and then add them. For example, to add a Readiness probe that checks if your container is ready to handle requests:

   a. Click **Add Readiness Probe**, to see a form containing the parameters for the probe.

   b. Click the **Type** drop-down list to select the request type you want to add. For example, in this case, select **Container Command** to select the command that will be executed inside the container.

   c. In the **Command** field, add an argument **cat**, similarly, you can add multiple arguments for the check, for example, add another argument **/tmp/healthy**.

   d. Retain or modify the default values for the other parameters as required.

   NOTE

   The **Timeout** value must be lower than the **Period** value. The **Timeout** default value is **1**. The **Period** default value is **10**.

   e. Click the check mark at the bottom of the form. The **Readiness Probe Added** message is displayed.

6. Click **Add** to add the health check. You are redirected to the **Topology** view and the container is restarted.

7. In the side panel, verify that the probes have been added by clicking on the deployed Pod under the **Pods** section.

8. In the **Pod Details** page, click the listed container in the **Containers** section.

9. In the **Container Details** page, verify that the Readiness probe - **Exec Command cat /tmp/healthy** has been added to the container.

10.5. EDITING HEALTH CHECKS USING THE DEVELOPER PERSPECTIVE

You can use the **Topology** view to edit health checks added to your application, modify them, or add more health checks.

Prerequisites:

- You have switched to the **Developer** perspective in the web console.
- You have created and deployed an application on OpenShift Container Platform using the **Developer** perspective.
- You have added health checks to your application.

Procedure

1. In the **Topology** view, right-click your application and select **Edit Health Checks**. Alternatively, in the side panel, click the **Actions** drop-down list and select **Edit Health Checks**.
2. In the **Edit Health Checks** page:
   - To remove a previously added health probe, click the minus sign adjoining it.
   - To edit the parameters of an existing probe:
     a. Click the **Edit Probe** link next to a previously added probe to see the parameters for the probe.
     b. Modify the parameters as required, and click the check mark to save your changes.
   - To add a new health probe, in addition to existing health checks, click the add probe links. For example, to add a Liveness probe that checks if your container is running:
     a. Click **Add Liveness Probe**, to see a form containing the parameters for the probe.
     b. Edit the probe parameters as required.

     NOTE

     The **Timeout** value must be lower than the **Period** value. The **Timeout** default value is **1**. The **Period** default value is **10**.

     c. Click the check mark at the bottom of the form. The **Liveness Probe Added** message is displayed.
3. Click **Save** to save your modifications and add the additional probes to your container. You are redirected to the **Topology** view.
4. In the side panel, verify that the probes have been added by clicking on the deployed pod under the **Pods** section.
5. In the **Pod Details** page, click the listed container in the **Containers** section.
6. In the **Container Details** page, verify that the Liveness probe - **HTTP Get 10.129.4.65:8080/** has been added to the container, in addition to the earlier existing probes.

10.6. MONITORING HEALTH CHECK FAILURES USING THE DEVELOPER PERSPECTIVE

In case an application health check fails, you can use the **Topology** view to monitor these health check violations.

Prerequisites:

- You have switched to the **Developer** perspective in the web console.
- You have created and deployed an application on OpenShift Container Platform using the **Developer** perspective.
- You have added health checks to your application.

Procedure

1. In the **Topology** view, click on the application node to see the side panel.
2. Click the **Observe** tab to see the health check failures in the **Events (Warning)** section.
3. Click the down arrow adjoining **Events (Warning)** to see the details of the health check failure.

Additional Resources

- For details on switching to the **Developer** perspective in the web console, see About **Developer** perspective.
- For details on adding health checks while creating and deploying an application, see **Advanced Options** in the Creating applications using the Developer perspective section.

CHAPTER 11. EDITING APPLICATIONS

You can edit the configuration and the source code of the application you create using the **Topology** view.

11.1. PREREQUISITES

- You have logged in to the web console and have switched to the **Developer** perspective.
- You have the appropriate roles and permissions in a project to create and modify applications in OpenShift Container Platform.
- You have created and deployed an application on OpenShift Container Platform using the **Developer** perspective.

11.2. EDITING THE SOURCE CODE OF AN APPLICATION USING THE DEVELOPER PERSPECTIVE

You can use the **Topology** view in the **Developer** perspective to edit the source code of your application.

Procedure

- In the **Topology** view, click the **Edit Source code** icon, displayed at the bottom-right of the deployed application, to access your source code and modify it.

  NOTE

  This feature is available only when you create applications using the **From Git**, **From Catalog**, and the **From Dockerfile** options.

  If the **Eclipse Che** Operator is installed in your cluster, a Che workspace ( ) is created and you are directed to the workspace to edit your source code. If it is not installed, you will be directed to the Git repository ( ) your source code is hosted in.

11.3. EDITING THE APPLICATION CONFIGURATION USING THE DEVELOPER PERSPECTIVE

You can use the **Topology** view in the **Developer** perspective to edit the configuration of your application.

NOTE

Currently, only configurations of applications created by using the **From Git**, **Container Image**, **From Catalog**, or **From Dockerfile** options in the **Add** workflow of the **Developer** perspective can be edited. Configurations of applications created by using the CLI or the **YAML** option from the **Add** workflow cannot be edited.

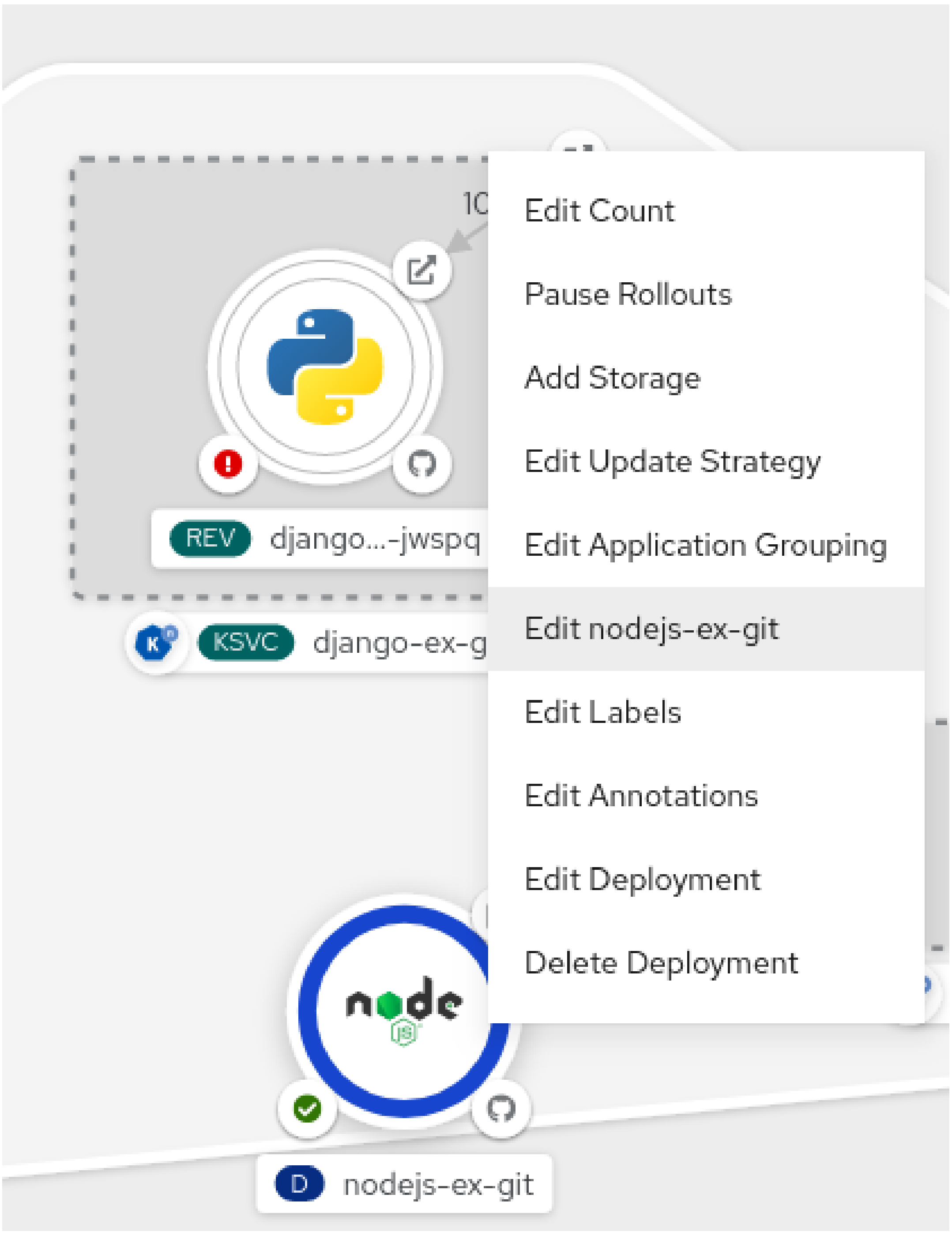
Prerequisites

Ensure that you have created an application using the **From Git**, **Container Image**, **From Catalog**, or **From Dockerfile** options in the **Add** workflow.

Procedure

1. After you have created an application and it is displayed in the **Topology** view, right-click the application to see the edit options available.

Figure 11.1. Edit application



2. Click **Edit** ***application-name*** to see the **Add** workflow you used to create the application. The form is pre-populated with the values you had added while creating the application.

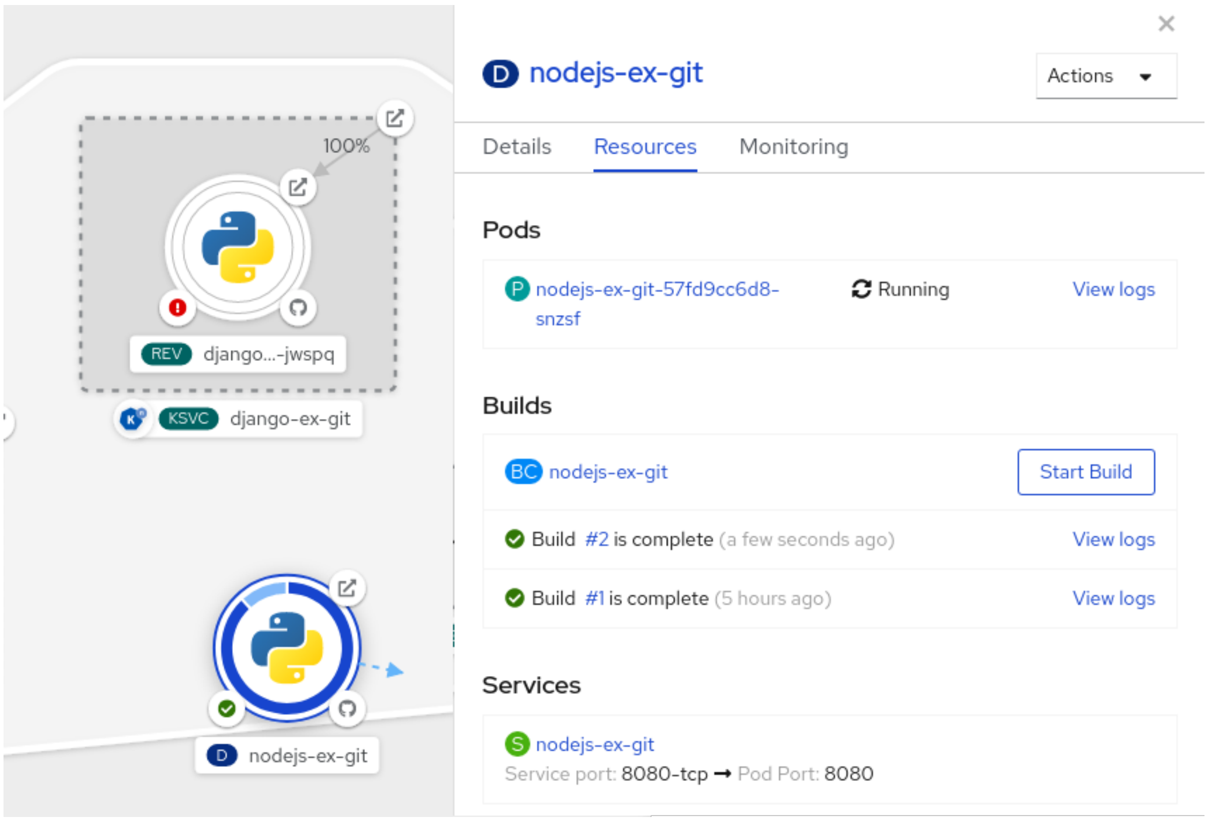
3. Edit the necessary values for the application.

NOTE

You cannot edit the **Name** field in the **General** section, the CI/CD pipelines, or the **Create a route to the application**field in the **Advanced Options** section.

4. Click **Save** to restart the build and deploy a new image.

Figure 11.2. Edit and redeploy application



D nodejs-ex-git

Actions

Details | Resources | Monitoring

Pods

P nodejs-ex-git-57fd9cc6d8-snzsf Running View logs

Builds

BC nodejs-ex-git Start Build

Build #2 is complete (a few seconds ago) View logs

Build #1 is complete (5 hours ago) View logs

Services

S nodejs-ex-git
Service port: 8080-tcp → Pod Port: 8080

CHAPTER 12. PRUNING OBJECTS TO RECLAIM RESOURCES

Over time, API objects created in OpenShift Container Platform can accumulate in the cluster's etcd data store through normal user operations, such as when building and deploying applications.

Cluster administrators can periodically prune older versions of objects from the cluster that are no longer required. For example, by pruning images you can delete older images and layers that are no longer in use, but are still taking up disk space.

12.1. BASIC PRUNING OPERATIONS

The CLI groups prune operations under a common parent command:

```
$ oc adm prune <object_type> <options>
```

This specifies:

- The **<object_type>** to perform the action on, such as **groups**, **builds**, **deployments**, or **images**.
- The **<options>** supported to prune that object type.

12.2. PRUNING GROUPS

To prune groups records from an external provider, administrators can run the following command:

```
$ oc adm prune groups \
    --sync-config=path/to/sync/config [<options>]
```

Table 12.1. Prune groups CLI configuration options

Options	Description
--confirm	Indicate that pruning should occur, instead of performing a dry-run.
--blacklist	Path to the group blacklist file.
--whitelist	Path to the group whitelist file.
--sync-config	Path to the synchronization configuration file.

To see the groups that the prune command deletes:

```
$ oc adm prune groups --sync-config=ldap-sync-config.yaml
```

To perform the prune operation:

```
$ oc adm prune groups --sync-config=ldap-sync-config.yaml --confirm
```

12.3. PRUNING DEPLOYMENTCONFIG OBJECTS

To prune **DeploymentConfig** objects that are no longer required by the system due to age and status, administrators can run the following command:

```
$ oc adm prune deployments [<options>]
```

Table 12.2. Prune deployments CLI configuration options

Option	Description
--confirm	Indicate that pruning should occur, instead of performing a dry-run.
--orphans	Prune all deployments that no longer have a **DeploymentConfig** object, has status of **Complete** or **Failed**, and has a replica count of zero.
--keep-complete=<N>	Per the **DeploymentConfig** object, keep the last **N** deployments that have a status of **Complete** and replica count of zero. (default **5**)
--keep-failed=<N>	Per the **DeploymentConfig** object, keep the last **N** deployments that have a status of **Failed** and replica count of zero. (default **1**)
--keep-younger-than=<duration>	Do not prune any object that is younger than **<duration>** relative to the current time. (default **60m**) Valid units of measurement include nanoseconds (**ns**), microseconds (**us**), milliseconds (**ms**), seconds (**s**), minutes (**m**), and hours (**h**).

To see what a pruning operation would delete:

```
$ oc adm prune deployments --orphans --keep-complete=5 --keep-failed=1 \
    --keep-younger-than=60m
```

To actually perform the prune operation:

```
$ oc adm prune deployments --orphans --keep-complete=5 --keep-failed=1 \
    --keep-younger-than=60m --confirm
```

12.4. PRUNING BUILDS

To prune builds that are no longer required by the system due to age and status, administrators can run the following command:

```
$ oc adm prune builds [<options>]
```

Table 12.3. Prune builds CLI configuration options

Option	Description
--confirm	Indicate that pruning should occur, instead of performing a dry-run.

Option	Description
--orphans	Prune all builds whose build configuration no longer exists, status is complete, failed, error, or canceled.
--keep-complete=<N>	Per build configuration, keep the last **N** builds whose status is complete (default **5**).
--keep-failed=<N>	Per build configuration, keep the last **N** builds whose status is failed, error, or canceled (default **1**).
--keep-younger-than=<duration>	Do not prune any object that is younger than **<duration>** relative to the current time (default **60m**).

To see what a pruning operation would delete:

```
$ oc adm prune builds --orphans --keep-complete=5 --keep-failed=1 \
    --keep-younger-than=60m
```

To actually perform the prune operation:

```
$ oc adm prune builds --orphans --keep-complete=5 --keep-failed=1 \
    --keep-younger-than=60m --confirm
```

NOTE

Developers can enable automatic build pruning by modifying their build configuration.

Additional resources

- Performing advanced builds → Pruning builds

12.5. AUTOMATICALLY PRUNING IMAGES

Images that are no longer required by the system due to age, status, or exceed limits are automatically pruned. Cluster administrators can configure the Pruning Custom Resource, or suspend it.

Prerequisites

- Cluster administrator permissions.
- Install the **oc** CLI.

Procedure

- Verify that the object named **imagepruners.imageregistry.operator.openshift.io/cluster** contains the following **spec** and **status** fields:

```
spec:
  schedule: 0 0 * * * (1)
  suspend: false (2)
  keepTagRevisions: 3 (3)
  keepYoungerThanDuration: 60m (4)
  keepYoungerThan: 3600000000000 (5)
  resources: {} (6)
  affinity: {} (7)
  nodeSelector: {} (8)
  tolerations: [] (9)
  successfulJobsHistoryLimit: 3 (10)
  failedJobsHistoryLimit: 3 (11)
status:
  observedGeneration: 2 (12)
  conditions: (13)
  - type: Available
    status: "True"
    lastTransitionTime: 2019-10-09T03:13:45
    reason: Ready
    message: "Periodic image pruner has been created."
  - type: Scheduled
    status: "True"
    lastTransitionTime: 2019-10-09T03:13:45
    reason: Scheduled
    message: "Image pruner job has been scheduled."
  - type: Failed
    staus: "False"
    lastTransitionTime: 2019-10-09T03:13:45
    reason: Succeeded
    message: "Most recent image pruning job succeeded."
```

1. **schedule**: **CronJob** formatted schedule. This is an optional field, default is daily at midnight.
2. **suspend**: If set to **true**, the **CronJob** running pruning is suspended. This is an optional field, default is **false**. The initial value on new clusters is **false**.
3. **keepTagRevisions**: The number of revisions per tag to keep. This is an optional field, default is **3**. The initial value is **3**.
4. **keepYoungerThanDuration**: Retain images younger than this duration. This is an optional field. If a value is not specified, either **keepYoungerThan** or the default value **60m** (60 minutes) is used.
5. **keepYoungerThan**: Deprecated. The same as **keepYoungerThanDuration**, but the duration is specified as an integer in nanoseconds. This is an optional field. When **keepYoungerThanDuration** is set, this field is ignored.
6. **resources**: Standard Pod resource requests and limits. This is an optional field.
7. **affinity**: Standard Pod affinity. This is an optional field.
8. **nodeSelector**: Standard Pod node selector. This is an optional field.
9. **tolerations**: Standard Pod tolerations. This is an optional field.

10 **successfulJobsHistoryLimit**: The maximum number of successful jobs to retain. Must be **>= 1** to ensure metrics are reported. This is an optional field, default is **3**. The initial value is **3**.

11 **failedJobsHistoryLimit**: The maximum number of failed jobs to retain. Must be **>= 1** to ensure metrics are reported. This is an optional field, default is **3**. The initial value is **3**.

12 **observedGeneration**: The generation observed by the Operator.

13 **conditions**: The standard condition objects with the following types:

- **Available**: Indicates if the pruning job has been created. Reasons can be Ready or Error.
- **Scheduled**: Indicates if the next pruning job has been scheduled. Reasons can be Scheduled, Suspended, or Error.
- **Failed**: Indicates if the most recent pruning job failed.

IMPORTANT

The Image Registry Operator's behavior for managing the pruner is orthogonal to the **managementState** specified on the Image Registry Operator's **ClusterOperator** object. If the Image Registry Operator is not in the **Managed** state, the image pruner can still be configured and managed by the Pruning Custom Resource.

However, the **managementState** of the Image Registry Operator alters the behavior of the deployed image pruner job:

- **Managed**: the **--prune-registry** flag for the image pruner is set to **true**.
- **Removed**: the **--prune-registry** flag for the image pruner is set to **false**, meaning it only prunes image metatdata in etcd.
- **Unmanaged**: the **--prune-registry** flag for the image pruner is set to **false**.

12.6. MANUALLY PRUNING IMAGES

The pruning custom resource enables automatic image pruning. However, administrators can manually prune images that are no longer required by the system due to age, status, or exceed limits. There are two methods to manually prune images:

- Running image pruning as a **Job** or **CronJob** on the cluster.
- Running the **oc adm prune images** command.

Prerequisites

- To prune images, you must first log in to the CLI as a user with an access token. The user must also have the **system:image-pruner** cluster role or greater (for example, **cluster-admin**).
- Expose the image registry.

Procedure

To manually prune images that are no longer required by the system due to age, status, or exceed limits, use one of the following methods:

- Run image pruning as a **Job** or **CronJob** on the cluster by creating a YAML file for the **pruner** service account, for example:

  ```
  $ oc create -f <filename>.yaml
  ```

  Example output

  ```
  kind: List
  apiVersion: v1
  items:
  - apiVersion: v1
    kind: ServiceAccount
    metadata:
      name: pruner
      namespace: openshift-image-registry
  - apiVersion: rbac.authorization.k8s.io/v1
    kind: ClusterRoleBinding
    metadata:
      name: openshift-image-registry-pruner
    roleRef:
      apiGroup: rbac.authorization.k8s.io
      kind: ClusterRole
      name: system:image-pruner
    subjects:
    - kind: ServiceAccount
      name: pruner
      namespace: openshift-image-registry
  - apiVersion: batch/v1
    kind: CronJob
    metadata:
      name: image-pruner
      namespace: openshift-image-registry
    spec:
      schedule: "0 0 * * *"
      concurrencyPolicy: Forbid
      successfulJobsHistoryLimit: 1
      failedJobsHistoryLimit: 3
      jobTemplate:
        spec:
          template:
            spec:
              restartPolicy: OnFailure
              containers:
              - image: "quay.io/openshift/origin-cli:4.1"
                resources:
                  requests:
                    cpu: 1
                    memory: 1Gi
                terminationMessagePolicy: FallbackToLogsOnError
                command:
                - oc
                args:
                - adm
                - prune
                - images
  ```

```
          - --certificate-authority=/var/run/secrets/kubernetes.io/serviceaccount/service-ca.crt
          - --keep-tag-revisions=5
          - --keep-younger-than=96h
          - --confirm=true
          name: image-pruner
        serviceAccountName: pruner
```

- Run the **oc adm prune images [<options>]** command:

```
$ oc adm prune images [<options>]
```

Pruning images removes data from the integrated registry unless **--prune-registry=false** is used.

Pruning images with the **--namespace** flag does not remove images, only image streams. Images are non-namespaced resources. Therefore, limiting pruning to a particular namespace makes it impossible to calculate its current usage.

By default, the integrated registry caches metadata of blobs to reduce the number of requests to storage, and to increase the request-processing speed. Pruning does not update the integrated registry cache. Images that still contain pruned layers after pruning will be broken because the pruned layers that have metadata in the cache will not be pushed. Therefore, you must redeploy the registry to clear the cache after pruning:

```
$ oc rollout restart deployment/image-registry -n openshift-image-registry
```

If the integrated registry uses a Redis cache, you must clean the database manually.

If redeploying the registry after pruning is not an option, then you must permanently disable the cache.

oc adm prune images operations require a route for your registry. Registry routes are not created by default.

The **Prune images CLI configuration options** table describes the options you can use with the **oc adm prune images <options>** command.

Table 12.4. Prune images CLI configuration options

Option	Description
--all	Include images that were not pushed to the registry, but have been mirrored by pullthrough. This is on by default. To limit the pruning to images that were pushed to the integrated registry, pass **--all=false**.
--certificate-authority	The path to a certificate authority file to use when communicating with the OpenShift Container Platform-managed registries. Defaults to the certificate authority data from the current user's configuration file. If provided, a secure connection is initiated.

Option	Description
--confirm	Indicate that pruning should occur, instead of performing a test-run. This requires a valid route to the integrated container image registry. If this command is run outside of the cluster network, the route must be provided using **--registry-url**.
--force-insecure	Use caution with this option. Allow an insecure connection to the container registry that is hosted via HTTP or has an invalid HTTPS certificate.
--keep-tag-revisions=<N>	For each imagestream, keep up to at most **N** image revisions per tag (default **3**).
--keep-younger-than=<duration>	Do not prune any image that is younger than **<duration>** relative to the current time. Alternately, do not prune any image that is referenced by any other object that is younger than **<duration>** relative to the current time (default **60m**).
--prune-over-size-limit	Prune each image that exceeds the smallest limit defined in the same project. This flag cannot be combined with **--keep-tag-revisions** nor **--keep-younger-than**.
--registry-url	The address to use when contacting the registry. The command attempts to use a cluster-internal URL determined from managed images and image streams. In case it fails (the registry cannot be resolved or reached), an alternative route that works needs to be provided using this flag. The registry hostname can be prefixed by **https://** or **http://**, which enforces particular connection protocol.
--prune-registry	In conjunction with the conditions stipulated by the other options, this option controls whether the data in the registry corresponding to the OpenShift Container Platform image API object is pruned. By default, image pruning processes both the image API objects and corresponding data in the registry. This option is useful when you are only concerned with removing etcd content, to reduce the number of image objects but are not concerned with cleaning up registry storage, or if you intend to do that separately by hard pruning the registry during an appropriate maintenance window for the registry.

12.6.1. Image prune conditions

You can apply conditions to your manually pruned images.

- To remove any image managed by OpenShift Container Platform, or images with the annotation **openshift.io/image.managed**:
  - Created at least **--keep-younger-than** minutes ago and are not currently referenced by any:
    - Pods created less than **--keep-younger-than** minutes ago

        - Image streams created less than **--keep-younger-than** minutes ago
        - Running pods
        - Pending pods
        - Replication controllers
        - Deployments
        - Deployment configs
        - Replica sets
        - Build configurations
        - Builds
        - **--keep-tag-revisions** most recent items in **stream.status.tags[].items**
    - That are exceeding the smallest limit defined in the same project and are not currently referenced by any:
        - Running pods
        - Pending pods
        - Replication controllers
        - Deployments
        - Deployment configs
        - Replica sets
        - Build configurations
        - Builds
- There is no support for pruning from external registries.
- When an image is pruned, all references to the image are removed from all image streams that have a reference to the image in **status.tags**.
- Image layers that are no longer referenced by any images are removed.

NOTE

The **--prune-over-size-limit** flag cannot be combined with the **--keep-tag-revisions** flag nor the **--keep-younger-than** flags. Doing so returns information that this operation is not allowed.

Separating the removal of OpenShift Container Platform image API objects and image data from the registry by using **--prune-registry=false**, followed by hard pruning the registry, can narrow timing windows and is safer when compared to trying to prune both through one command. However, timing windows are not completely removed.

For example, you can still create a Pod referencing an image as pruning identifies that image for pruning. You should still keep track of an API object created during the pruning operations that might reference images so that you can mitigate any references to deleted content.

Re-doing the pruning without the **--prune-registry** option or with **--prune-registry=true** does not lead to pruning the associated storage in the image registry for images previously pruned by **--prune-registry=false**. Any images that were pruned with **--prune-registry=false** can only be deleted from registry storage by hard pruning the registry.

12.6.2. Running the image prune operation

Procedure

1. To see what a pruning operation would delete:

   a. Keeping up to three tag revisions, and keeping resources (images, image streams, and pods) younger than 60 minutes:

      ```
      $ oc adm prune images --keep-tag-revisions=3 --keep-younger-than=60m
      ```

   b. Pruning every image that exceeds defined limits:

      ```
      $ oc adm prune images --prune-over-size-limit
      ```

2. To perform the prune operation with the options from the previous step:

   ```
   $ oc adm prune images --keep-tag-revisions=3 --keep-younger-than=60m --confirm
   ```

   ```
   $ oc adm prune images --prune-over-size-limit --confirm
   ```

12.6.3. Using secure or insecure connections

The secure connection is the preferred and recommended approach. It is done over HTTPS protocol with a mandatory certificate verification. The **prune** command always attempts to use it if possible. If it is not possible, in some cases it can fall-back to insecure connection, which is dangerous. In this case, either certificate verification is skipped or plain HTTP protocol is used.

The fall-back to insecure connection is allowed in the following cases unless **--certificate-authority** is specified:

1. The **prune** command is run with the **--force-insecure** option.

2. The provided **registry-url** is prefixed with the **http://** scheme.

3. The provided **registry-url** is a local-link address or **localhost**.

4. The configuration of the current user allows for an insecure connection. This can be caused by the user either logging in using **--insecure-skip-tls-verify** or choosing the insecure connection when prompted.

IMPORTANT

If the registry is secured by a certificate authority different from the one used by OpenShift Container Platform, it must be specified using the **--certificate-authority** flag. Otherwise, the **prune** command fails with an error.

12.6.4. Image pruning problems

Images not being pruned

If your images keep accumulating and the **prune** command removes just a small portion of what you expect, ensure that you understand the image prune conditions that must apply for an image to be considered a candidate for pruning.

Ensure that images you want removed occur at higher positions in each tag history than your chosen tag revisions threshold. For example, consider an old and obsolete image named **sha:abz**. By running the following command in namespace **N**, where the image is tagged, the image is tagged three times in a single image stream named **myapp**:

```
$ oc get is -n N -o go-template='{{range $isi, $is := .items}}{{range $ti, $tag := $is.status.tags}}'\
  '{{range $ii, $item := $tag.items}}{{if eq $item.image ""sha:abz"\
  $"}}{{$is.metadata.name}}:{{$tag.tag}} at position {{$ii}} out of {{len $tag.items}}\n'\
  '{{end}}{{end}}{{end}}{{end}}'
```

Example output

```
myapp:v2 at position 4 out of 5
myapp:v2.1 at position 2 out of 2
myapp:v2.1-may-2016 at position 0 out of 1
```

When default options are used, the image is never pruned because it occurs at position **0** in a history of **myapp:v2.1-may-2016** tag. For an image to be considered for pruning, the administrator must either:

- Specify **--keep-tag-revisions=0** with the **oc adm prune images** command.

  WARNING

  This action removes all the tags from all the namespaces with underlying images, unless they are younger or they are referenced by objects younger than the specified threshold.

- Delete all the **istags** where the position is below the revision threshold, which means **myapp:v2.1** and **myapp:v2.1-may-2016**.

- Move the image further in the history, either by running new builds pushing to the same **istag**, or by tagging other image. This is not always desirable for old release tags.

Tags having a date or time of a particular image's build in their names should be avoided, unless the image must be preserved for an undefined amount of time. Such tags tend to have just one image in their history, which prevents them from ever being pruned.

Using a secure connection against insecure registry

If you see a message similar to the following in the output of the **oc adm prune images** command, then your registry is not secured and the **oc adm prune images** client attempts to use a secure connection:

```
error: error communicating with registry: Get https://172.30.30.30:5000/healthz: http: server gave HTTP response to HTTPS client
```

- The recommended solution is to secure the registry. Otherwise, you can force the client to use an insecure connection by appending **--force-insecure** to the command; however, this is not recommended.

Using an insecure connection against a secured registry

If you see one of the following errors in the output of the **oc adm prune images** command, it means that your registry is secured using a certificate signed by a certificate authority other than the one used by **oc adm prune images** client for connection verification:

```
error: error communicating with registry: Get http://172.30.30.30:5000/healthz: malformed HTTP response "\x15\x03\x01\x00\x02\x02"
error: error communicating with registry: [Get https://172.30.30.30:5000/healthz: x509: certificate signed by unknown authority, Get http://172.30.30.30:5000/healthz: malformed HTTP response "\x15\x03\x01\x00\x02\x02"]
```

By default, the certificate authority data stored in the user's configuration files is used; the same is true for communication with the master API.

Use the **--certificate-authority** option to provide the right certificate authority for the container image registry server.

Using the wrong certificate authority

The following error means that the certificate authority used to sign the certificate of the secured container image registry is different from the authority used by the client:

```
error: error communicating with registry: Get https://172.30.30.30:5000/: x509: certificate signed by unknown authority
```

Make sure to provide the right one with the flag **--certificate-authority**.

As a workaround, the **--force-insecure** flag can be added instead. However, this is not recommended.

Additional resources

- Accessing the registry
- Exposing the registry
- See Image Registry Operator in OpenShift Container Platform for information on how to create a registry route.

12.7. HARD PRUNING THE REGISTRY

The OpenShift Container Registry can accumulate blobs that are not referenced by the OpenShift Container Platform cluster's etcd. The basic pruning images procedure, therefore, is unable to operate on them. These are called *orphaned blobs*.

Orphaned blobs can occur from the following scenarios:

- Manually deleting an image with **oc delete image <sha256:image-id>** command, which only removes the image from etcd, but not from the registry's storage.
- Pushing to the registry initiated by daemon failures, which causes some blobs to get uploaded, but the image manifest (which is uploaded as the very last component) does not. All unique image blobs become orphans.
- OpenShift Container Platform refusing an image because of quota restrictions.
- The standard image pruner deleting an image manifest, but is interrupted before it deletes the related blobs.
- A bug in the registry pruner, which fails to remove the intended blobs, causing the image objects referencing them to be removed and the blobs becoming orphans.

Hard pruning the registry, a separate procedure from basic image pruning, allows cluster administrators to remove orphaned blobs. You should hard prune if you are running out of storage space in your OpenShift Container Registry and believe you have orphaned blobs.

This should be an infrequent operation and is necessary only when you have evidence that significant numbers of new orphans have been created. Otherwise, you can perform standard image pruning at regular intervals, for example, once a day (depending on the number of images being created).

Procedure

To hard prune orphaned blobs from the registry:

1. **Log in.**
   Log in to the cluster with the CLI as **kubeadmin** or another privileged user that has access to the **openshift-image-registry** namespace.
2. **Run a basic image prune**
   Basic image pruning removes additional images that are no longer needed. The hard prune does not remove images on its own. It only removes blobs stored in the registry storage. Therefore, you should run this just before the hard prune.
3. **Switch the registry to read-only mode.**
   If the registry is not running in read-only mode, any pushes happening at the same time as the prune will either:
   - fail and cause new orphans, or
   - succeed although the images cannot be pulled (because some of the referenced blobs were deleted).

   Pushes will not succeed until the registry is switched back to read-write mode. Therefore, the hard prune must be carefully scheduled.

   To switch the registry to read-only mode:

   a. In **configs.imageregistry.operator.openshift.io/cluster**, set **spec.readOnly** to **true**:

   ```
   $ oc patch configs.imageregistry.operator.openshift.io/cluster -p '{"spec":
   {"readOnly":true}}' --type=merge
   ```
4. **Add the system:image-pruner role.**

The service account used to run the registry instances requires additional permissions to list some resources.

a. Get the service account name:

```
$ service_account=$(oc get -n openshift-image-registry \
    -o jsonpath='{.spec.template.spec.serviceAccountName}' deploy/image-registry)
```

b. Add the **system:image-pruner** cluster role to the service account:

```
$ oc adm policy add-cluster-role-to-user \
    system:image-pruner -z \
    ${service_account} -n openshift-image-registry
```

5. **Optional: Run the pruner in dry-run mode.**
To see how many blobs would be removed, run the hard pruner in dry-run mode. No changes are actually made. The following example references an image registry pod called **image-registry-3-vhndw**:

```
$ oc -n openshift-image-registry exec pod/image-registry-3-vhndw -- /bin/sh -c
'/usr/bin/dockerregistry -prune=check'
```

Alternatively, to get the exact paths for the prune candidates, increase the logging level:

```
$ oc -n openshift-image-registry exec pod/image-registry-3-vhndw -- /bin/sh -c
'REGISTRY_LOG_LEVEL=info /usr/bin/dockerregistry -prune=check'
```

Example output

```
time="2017-06-22T11:50:25.066156047Z" level=info msg="start prune (dry-run mode)"
distribution_version="v2.4.1+unknown" kubernetes_version=v1.6.1+$Format:%h$
openshift_version=unknown
time="2017-06-22T11:50:25.092257421Z" level=info msg="Would delete blob:
sha256:00043a2a5e384f6b59ab17e2c3d3a3d0a7de01b2cabeb606243e468acc663fa5"
go.version=go1.7.5 instance.id=b097121c-a864-4e0c-ad6c-cc25f8fdf5a6
time="2017-06-22T11:50:25.092395621Z" level=info msg="Would delete blob:
sha256:0022d49612807cb348cabc562c072ef34d756adfe0100a61952cbcb87ee6578a"
go.version=go1.7.5 instance.id=b097121c-a864-4e0c-ad6c-cc25f8fdf5a6
time="2017-06-22T11:50:25.092492183Z" level=info msg="Would delete blob:
sha256:0029dd4228961086707e53b881e25eba0564fa80033fbbb2e27847a28d16a37c"
go.version=go1.7.5 instance.id=b097121c-a864-4e0c-ad6c-cc25f8fdf5a6
time="2017-06-22T11:50:26.673946639Z" level=info msg="Would delete blob:
sha256:ff7664dfc213d6cc60fd5c5f5bb00a7bf4a687e18e1df12d349a1d07b2cf7663"
go.version=go1.7.5 instance.id=b097121c-a864-4e0c-ad6c-cc25f8fdf5a6
time="2017-06-22T11:50:26.674024531Z" level=info msg="Would delete blob:
sha256:ff7a933178ccd931f4b5f40f9f19a65be5eeeec207e4fad2a5bafd28afbef57e"
go.version=go1.7.5 instance.id=b097121c-a864-4e0c-ad6c-cc25f8fdf5a6
time="2017-06-22T11:50:26.674675469Z" level=info msg="Would delete blob:
sha256:ff9b8956794b426cc80bb49a604a0b24a1553aae96b930c6919a6675db3d5e06"
go.version=go1.7.5 instance.id=b097121c-a864-4e0c-ad6c-cc25f8fdf5a6
...
Would delete 13374 blobs
Would free up 2.835 GiB of disk space
Use -prune=delete to actually delete the data
```

6. **Run the hard prune.**
   Execute the following command inside one running instance of a **image-registry** pod to run the hard prune. The following example references an image registry pod called **image-registry-3-vhndw**:

   ```
   $ oc -n openshift-image-registry exec pod/image-registry-3-vhndw -- /bin/sh -c
   '/usr/bin/dockerregistry -prune=delete'
   ```

   Example output

   ```
   Deleted 13374 blobs
   Freed up 2.835 GiB of disk space
   ```

7. **Switch the registry back to read-write mode.**
   After the prune is finished, the registry can be switched back to read-write mode. In **configs.imageregistry.operator.openshift.io/cluster**, set **spec.readOnly** to **false**:

   ```
   $ oc patch configs.imageregistry.operator.openshift.io/cluster -p '{"spec":{"readOnly":false}}' -
   -type=merge
   ```

12.8. PRUNING CRON JOBS

Cron jobs can perform pruning of successful jobs, but might not properly handle failed jobs. Therefore, the cluster administrator should perform regular cleanup of jobs manually. They should also restrict the access to cron jobs to a small group of trusted users and set appropriate quota to prevent the cron job from creating too many jobs and pods.

Additional resources

- Running tasks in pods using jobs
- Resource quotas across multiple projects
- Using RBAC to define and apply permissions

CHAPTER 13. IDLING APPLICATIONS

Cluster administrators can idle applications to reduce resource consumption. This is useful when the cluster is deployed on a public cloud where cost is related to resource consumption.

If any scalable resources are not in use, OpenShift Container Platform discovers and idles them by scaling their replicas to **0**. The next time network traffic is directed to the resources, the resources are unidled by scaling up the replicas, and normal operation continues.

Applications are made of services, as well as other scalable resources, such as deployment configs. The action of idling an application involves idling all associated resources.

13.1. IDLING APPLICATIONS

Idling an application involves finding the scalable resources (deployment configurations, replication controllers, and others) associated with a service. Idling an application finds the service and marks it as idled, scaling down the resources to zero replicas.

You can use the **oc idle** command to idle a single service, or use the **--resource-names-file** option to idle multiple services.

13.1.1. Idling a single service

Procedure

1. To idle a single service, run:

```
$ oc idle <service>
```

13.1.2. Idling multiple services

Idling multiple services is helpful if an application spans across a set of services within a project, or when idling multiple services in conjunction with a script to idle multiple applications in bulk within the same project.

Procedure

1. Create a file containing a list of the services, each on their own line.
2. Idle the services using the **--resource-names-file** option:

```
$ oc idle --resource-names-file <filename>
```

NOTE

The **idle** command is limited to a single project. For idling applications across a cluster, run the **idle** command for each project individually.

13.2. UNIDLING APPLICATIONS

Application services become active again when they receive network traffic and are scaled back up their previous state. This includes both traffic to the services and traffic passing through routes.

Applications can also be manually unidled by scaling up the resources.

Procedure

1. To scale up a DeploymentConfig, run:

   ```
   $ oc scale --replicas=1 dc <dc_name>
   ```

NOTE

Automatic unidling by a router is currently only supported by the default HAProxy router.

CHAPTER 14. DELETING APPLICATIONS

You can delete applications created in your project.

14.1. DELETING APPLICATIONS USING THE DEVELOPER PERSPECTIVE

You can delete an application and all of its associated components using the **Topology** view in the **Developer** perspective:

1. Click the application you want to delete to see the side panel with the resource details of the application.
2. Click the **Actions** drop-down menu displayed on the upper right of the panel, and select **Delete Application** to see a confirmation dialog box.
3. Enter the name of the application and click **Delete** to delete it.

You can also right-click the application you want to delete and click **Delete Application** to delete it.

CHAPTER 15. USING THE RED HAT MARKETPLACE

The Red Hat Marketplace is an open cloud marketplace that makes it easy to discover and access certified software for container-based environments that run on public clouds and on-premises.

15.1. RED HAT MARKETPLACE FEATURES

Cluster administrators can use the Red Hat Marketplace to manage software on OpenShift Container Platform, give developers self-service access to deploy application instances, and correlate application usage against a quota.

15.1.1. Connect OpenShift Container Platform clusters to the Marketplace

Cluster administrators can install a common set of applications on OpenShift Container Platform clusters that connect to the Marketplace. They can also use the Marketplace to track cluster usage against subscriptions or quotas. Users that they add by using the Marketplace have their product usage tracked and billed to their organization.

During the cluster connection process, a Marketplace Operator is installed that updates the image registry secret, manages the catalog, and reports application usage.

15.1.2. Install applications

Cluster administrators can install Marketplace applications from within OperatorHub in OpenShift Container Platform, or from the Marketplace web application.

You can access installed applications from the web console by clicking **Operators > Installed Operators**.

15.1.3. Deploy applications from different perspectives

You can deploy Marketplace applications from the web console’s Administrator and Developer perspectives.

The Developer perspective
Developers can access newly installed capabilities by using the Developer perspective.

For example, after a database Operator is installed, a developer can create an instance from the catalog within their project. Database usage is aggregated and reported to the cluster administrator.

This perspective does not include Operator installation and application usage tracking.

The Administrator perspective
Cluster administrators can access Operator installation and application usage information from the Administrator perspective.

They can also launch application instances by browsing custom resource definitions (CRDs) in the **Installed Operators** list.