



OpenShift Online 3

Developer Guide

OpenShift Online Developer Reference

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Abstract

These topics help developers set up and configure a workstation to develop and deploy applications in an OpenShift Online cloud environment with a command-line interface (CLI). This guide provides detailed instructions and examples to help developers:

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CHAPTER 1. OVERVIEW

This guide is intended for application developers, and provides instructions for setting up and configuring a workstation to develop and deploy applications in an OpenShift Online cloud environment. This includes detailed instructions and examples to help developers:

1. [Create new applications](#)
2. [Monitor and configure projects](#)
3. [Generate configurations using templates](#)
4. [Manage builds, including build strategy options and webhooks](#)
5. [Define deployments, including deployment strategies](#)
6. [Create and manage routes](#)
7. [Create and configure secrets](#)
8. [Integrate external services, such as databases and SaaS endpoints](#)
9. [Check application health using probes](#)

CHAPTER 2. APPLICATION LIFE CYCLE MANAGEMENT

2.1. PLANNING YOUR DEVELOPMENT PROCESS

2.1.1. Overview

OpenShift Online is designed for building and deploying applications. Depending on how much you want to involve OpenShift Online in your development process, you can choose to:

- focus your development within an OpenShift Online project, using it to build an application from scratch then continuously develop and manage its lifecycle, or
- bring an application (e.g., binary, container image, source code) you have already developed in a separate environment and deploy it onto OpenShift Online.

2.1.2. Using OpenShift Online as Your Development Environment



OPENSIFT_396538_0316

You can begin your application's development from scratch using OpenShift Online directly. Consider the following steps when planning this type of development process:

Initial Planning

- What does your application do?
- What programming language will it be developed in?

Access to OpenShift Online

- Access OpenShift Online by logging in and creating an account at <https://openshift.com/get-started/>.

Develop

- Using your editor or IDE of choice, create a basic skeleton of an application. It should be developed enough to tell OpenShift Online [what kind of application it is](#).
- Push the code to your Git repository.

Generate

- [Create a basic application](#) using the **oc new-app** command. OpenShift Online generates build and deployment configurations.

Manage

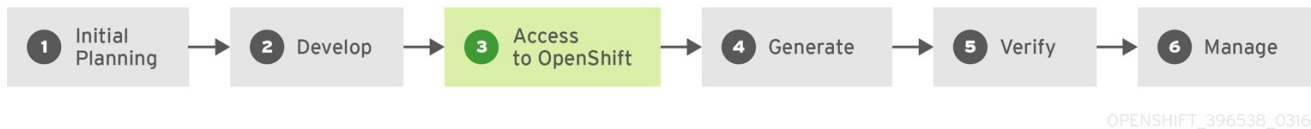
- Start developing your application code.
- Ensure your application builds successfully.
- Continue to locally develop and polish your code.

- Push your code to a Git repository.
- Is any extra configuration needed? Explore the [Developer Guide](#) for more options.

Verify

- You can verify your application in a number of ways. You can push your changes to your application's Git repository, and use OpenShift Online to rebuild and redeploy your application. Alternatively, you can hot deploy using **rsync** to synchronize your code changes into a running pod.

2.1.3. Bringing an Application to Deploy on OpenShift Online



Another possible application development strategy is to develop locally, then use OpenShift Online to deploy your fully developed application. Use the following process if you plan to have application code already, then want to build and deploy onto an OpenShift Online installation when completed:

Initial Planning

- What does your application do?
- What programming language will it be developed in?

Develop

- Develop your application code using your editor or IDE of choice.
- Build and test your application code locally.
- Push your code to a Git repository.

Access to OpenShift Online

- Access OpenShift Online by logging in and creating an account at <https://www.openshift.com/get-started/>.

Generate

- [Create a basic application](#) using the **oc new-app** command. OpenShift Online generates build and deployment configurations.

Verify

- Ensure that the application that you have built and deployed in the above Generate step is successfully running on OpenShift Online.

Manage

- Continue to develop your application code until you are happy with the results.
- Rebuild your application in OpenShift Online to accept any newly pushed code.

- Is any extra configuration needed? Explore the [Developer Guide](#) for more options.

2.2. CREATING NEW APPLICATIONS

2.2.1. Overview

You can create a new OpenShift Online application from components including source or binary code, images and/or templates by using either the OpenShift CLI or web console.

2.2.2. Creating an Application Using the CLI

2.2.2.1. Creating an Application From Source Code

The **new-app** command allows you to create applications from source code in a local or remote Git repository.

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

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



NOTE

If using a local Git repository, the repository should have a remote named **origin** that points to a URL accessible by the OpenShift Online cluster. If there is no recognised remote, **new-app** will create a [binary build](#).

To create an application using a remote Git repository:

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

To create an application using a private remote Git repository:

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



NOTE

If using 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 **BuildConfig** to access the repository.

You can use a subdirectory of your source code repository by specifying a **--context-dir** flag. To create an application using 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
```

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 configuration](#) to deploy the new image, and a [service](#) to provide load-balanced access to the deployment running your image.

OpenShift Online automatically [detects](#) whether the **Pipeline** or **Sourcebuild strategy** should be used, and in the case of **Source** builds, [detects an appropriate language builder image](#) .

Build Strategy Detection

If a **Jenkinsfile** exists in the root or specified context directory of the source repository when creating a new application, OpenShift Online generates a **Pipeline build strategy** . Otherwise, it generates a **Source build strategy** .

You can override the build strategy by setting the **--strategy** flag to either **pipeline** or **source**.

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



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**.

Language Detection

If using 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	<i>project.json, *.csproj</i>
jee	<i>pom.xml</i>
nodejs	<i>app.json, package.json</i>
perl	<i>cpanfile, index.pl</i>
php	<i>composer.json, index.php</i>
python	<i>requirements.txt, setup.py</i>
ruby	<i>Gemfile, Rakefile, config.ru</i>
scala	<i>build.sbt</i>
golang	<i>Godeps, main.go</i>

After a language is detected, **new-app** searches the OpenShift Online 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** image stream with the source in a remote repository:

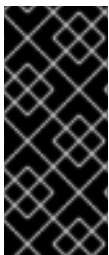
```
$ oc new-app myproject/my-ruby~https://github.com/openshift/ruby-hello-world.git
```

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
```

2.2.2.2. Creating an Application From an Image

You can deploy an application from an existing image. Images can come from image streams in the OpenShift Online server, images in a specific registry or [Docker Hub registry](#), or images in the local Docker server.



IMPORTANT

OpenShift Online runs containers using an arbitrarily assigned user ID. This behavior provides additional security against processes escaping the container due to a container engine vulnerability and thereby achieving escalated permissions on the host node. Due to this restriction, images that run as root will not deploy as expected on OpenShift Online.

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 Docker image (using the **--docker-image** argument) or an image stream (using the **-i|--image** argument).



NOTE

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

For example, to create an application from the DockerHub MySQL image:

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

To create an application using an image in a private registry, specify the full Docker image specification:

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



NOTE

If the registry containing the image is not cluster administrators must ensure that the Docker daemon on the OpenShift Online node hosts is run with the **--insecure-registry** flag pointing to that registry. You must also tell **new-app** that the image comes from an insecure registry with the **--insecure-registry** flag.

You can create an application from an existing [image stream](#) and optional [image stream tag](#):

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

2.2.2.3. 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.

To create an application from a stored template:

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

To directly use a template in your local file system, without first storing it in OpenShift Online, use the **-f|--file** argument:

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

Template Parameters

When creating an application based on a [template](#), use the **-p|--param** argument to set parameter values 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=-**:

```
$ cat helloworld.params
ADMIN_USERNAME=admin
ADMIN_PASSWORD=mypassword
$ oc new-app ruby-helloworld-sample --param-file=helloworld.params
$ cat helloworld.params | oc new-app ruby-helloworld-sample --param-file=-
```

2.2.2.4. Further Modifying Application Creation

The **new-app** command generates OpenShift Online objects that will build, deploy, and run the application being created. Normally, these objects are created in the current project using names derived from the input source repositories or the input images. However, **new-app** allows you to modify this behavior.

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

Table 2.2. `new-app` Output Objects

Object	Description
BuildConfig	A BuildConfig is created for each source repository specified in the command line. The BuildConfig specifies the strategy to use, the source location, and the build output location.
ImageStreams	For BuildConfig , two ImageStreams are usually created. One represents the input image. With Source builds, this is the builder 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 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 .
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. In order to expose a different port, after new-app has completed, simply use the oc expose command to generate additional services.
Other	Other objects may be generated when instantiating templates , according to the template.

2.2.2.4.1. 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
```

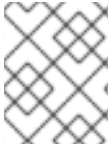
The variables can also be read from file using the **--env-file** argument:

```
$ cat postgresql.env
POSTGRESQL_USER=user
POSTGRESQL_DATABASE=db
POSTGRESQL_PASSWORD=password
$ 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=-
```

See [Managing Environment Variables](#) for more information.



NOTE

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

2.2.2.4.2. 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:

```
$ cat ruby.env
HTTP_PROXY=http://myproxy.net:1337/
GEM_HOME=~/.gem
$ 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=-
```

2.2.2.4.3. 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
```

2.2.2.4.4. Viewing the Output Without Creation

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

To output **new-app** artifacts to a file, edit them, then create them:

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

2.2.2.4.5. 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
```

2.2.2.4.6. Creating Objects in a Different Project

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

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

2.2.2.4.7. 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.

2.2.2.4.8. Grouping Images and Source in a Single Pod

The **new-app** command allows deploying multiple images together in a single pod. In order 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:

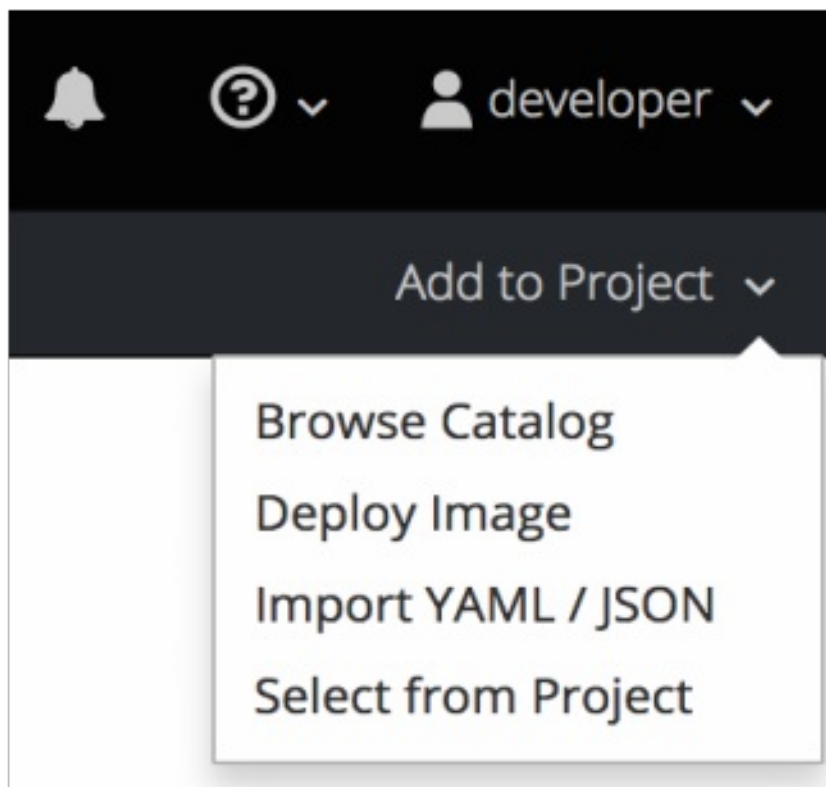
```
$ oc new-app ruby+mysql
```

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

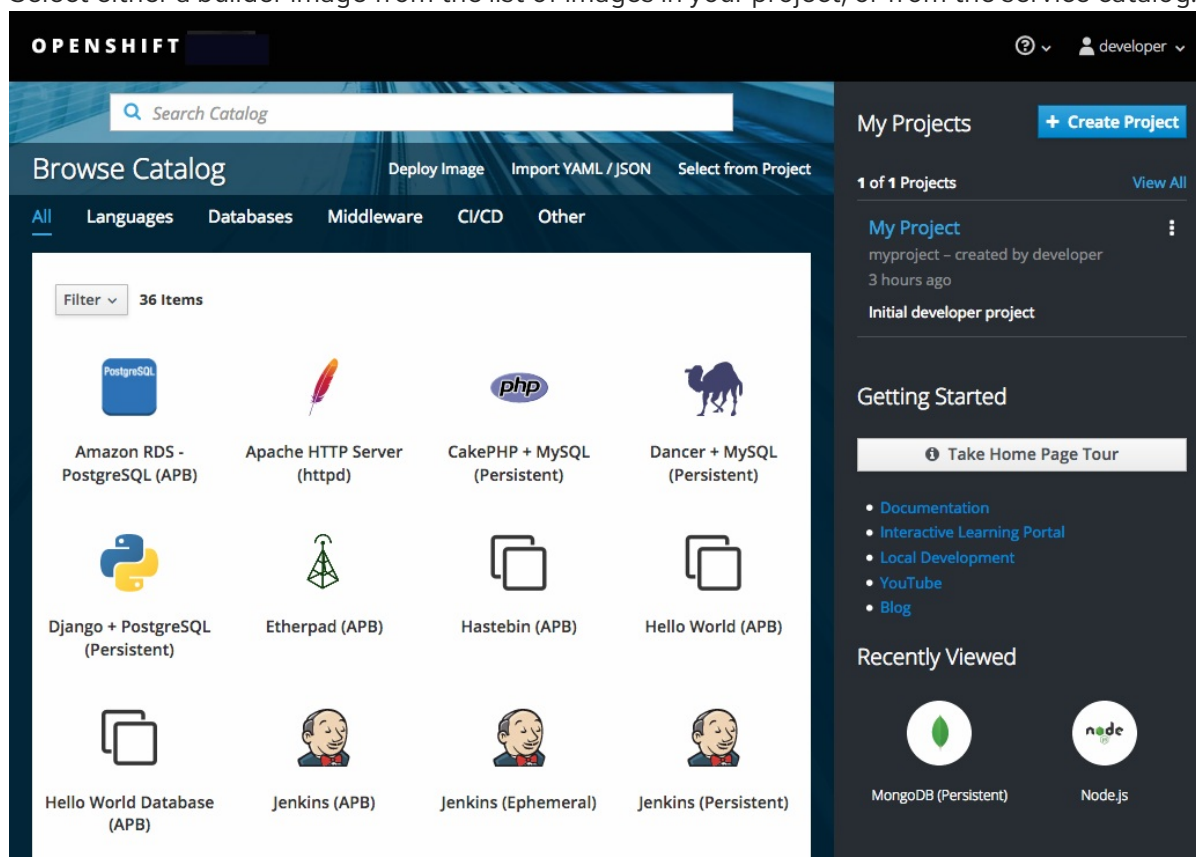
```
$ oc new-app \  
  ruby~https://github.com/openshift/ruby-hello-world \  
  mysql \  
  --group=ruby+mysql
```

2.2.3. Creating an Application Using the Web Console

1. While in the desired project, click **Add to Project**.



2. Select either a builder image from the list of images in your project, or from the service catalog:



NOTE

Only [image stream tags](#) that have the **builder** tag listed in their annotations appear in this list, as demonstrated here:

```
kind: "ImageStream"
```

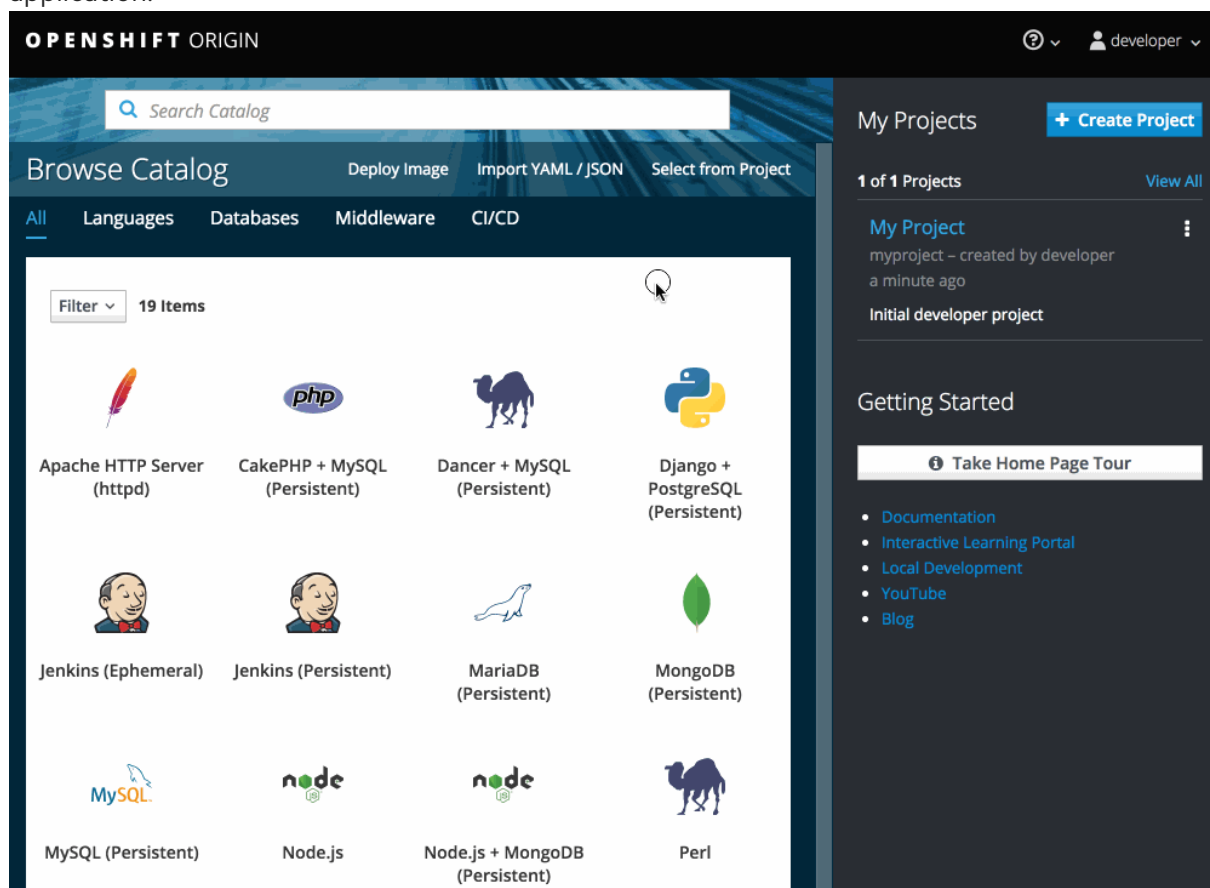
```

apiVersion: "v1"
metadata:
  name: "ruby"
  creationTimestamp: null
spec:
  dockerImageRepository: "registry.access.redhat.com/openshift3/ruby-20-rhel7"
  tags:
  -
    name: "2.0"
    annotations:
      description: "Build and run Ruby 2.0 applications"
      iconClass: "icon-ruby"
      tags: "builder,ruby" 1
      supports: "ruby:2.0,ruby"
      version: "2.0"

```

- 1** Including **builder** here ensures this **ImageStreamTag** appears in the web console as a builder.

3. Modify the settings in the new application screen to configure the objects to support your application:



2.3. PROMOTING APPLICATIONS ACROSS ENVIRONMENTS

2.3.1. Overview

Application promotion means moving an application through various runtime environments, typically with an increasing level of maturity. For example, an application might start out in a development environment, then be promoted to a stage environment for further testing, before finally being

promoted into a production environment. As changes are introduced in the application, again the changes will start in development and be promoted through stage and production.

The "application" today is more than just the source code written in Java, Perl, Python, etc. It is more now than the static web content, the integration scripts, or the associated configuration for the language specific runtimes for the application. It is more than the application specific archives consumed by those language specific runtimes.

In the context of OpenShift Online and its combined foundation of Kubernetes and Docker, additional application artifacts include:

- *Docker container images* with their rich set of metadata and associated tooling.
- *Environment variables* that are injected into containers for application use.
- *API objects* (also known as resource definitions; see [Core Concepts](#)) of OpenShift Online, which:
 - are injected into containers for application use.
 - dictate how OpenShift Online manages containers and pods.

In examining how to promote applications in OpenShift Online, this topic will:

- Elaborate on these new artifacts introduced to the application definition.
- Describe how you can demarcate the different environments for your application promotion pipeline.
- Discuss methodologies and tools for managing these new artifacts.
- Provide examples that apply the various concepts, constructs, methodologies, and tools to application promotion.

2.3.2. Application Components

2.3.2.1. API Objects

With regard to OpenShift Online and Kubernetes resource definitions (the items newly introduced to the application inventory), there are a couple of key design points for these API objects that are relevant to revisit when considering the topic of application promotion.

First, as highlighted throughout OpenShift Online documentation, every API object can be expressed via either JSON or YAML, making it easy to manage these resource definitions via traditional source control and scripting.

Also, the API objects are designed such that there are portions of the object which specify the desired state of the system, and other portions which reflect the status or current state of the system. This can be thought of as inputs and outputs. The input portions, when expressed in JSON or YAML, in particular are items that fit naturally as source control managed (SCM) artifacts.



NOTE

Remember, the input or specification portions of the API objects can be totally static or dynamic in the sense that [variable substitution via template processing](#) is possible on instantiation.

The result of these points with respect to API objects is that with their expression as JSON or YAML files, you can treat the configuration of the application as code.

Conceivably, almost any of the API objects may be considered an application artifact by your organization. Listed below are the objects most commonly associated with deploying and managing an application:

BuildConfigs

This is a special case resource in the context of application promotion. While a **BuildConfig** is certainly a part of the application, especially from a developer's perspective, typically the **BuildConfig** is not promoted through the pipeline. It produces the **Image** that is promoted (along with other items) through the pipeline.

Templates

In terms of application promotion, **Templates** can serve as the starting point for setting up resources in a given staging environment, especially with the parameterization capabilities. Additional post-instantiation modifications are very conceivable though when applications move through a promotion pipeline. See [Scenarios and Examples](#) for more on this.

Routes

These are the most typical resources that differ stage to stage in the application promotion pipeline, as tests against different stages of an application access that application via its **Route**. Also, remember that you have options with regard to manual specification or auto-generation of host names, as well as the HTTP-level security of the **Route**.

Services

If reasons exist to avoid **Routers** and **Routes** at given application promotion stages (perhaps for simplicity's sake for individual developers at early stages), an application can be accessed via the **Cluster** IP address and port. If used, some management of the address and port between stages could be warranted.

Endpoints

Certain application-level services (e.g., database instances in many enterprises) may not be managed by OpenShift Online. If so, then creating those **Endpoints** yourself, along with the necessary modifications to the associated **Service** (omitting the selector field on the **Service**) are activities that are either duplicated or shared between stages (based on how you delineate your environment).

Secrets

The sensitive information encapsulated by **Secrets** are shared between staging environments when the corresponding entity (either a **Service** managed by OpenShift Online or an external service managed outside of OpenShift Online) the information pertains to is shared. If there are different versions of the said entity in different stages of your application promotion pipeline, it may be necessary to maintain a distinct **Secret** in each stage of the pipeline or to make modifications to it as it traverses through the pipeline. Also, take care that if you are storing the **Secret** as JSON or YAML in an SCM, some form of encryption to protect the sensitive information may be warranted.

DeploymentConfigs

This object is the primary resource for defining and scoping the environment for a given application promotion pipeline stage; it controls how your application starts up. While there are aspects of it that will be common across all the different stage, undoubtedly there will be modifications to this object as it progresses through your application promotion pipeline to reflect differences in the environments for each stage, or changes in behavior of the system to facilitate testing of the different scenarios your application must support.

ImageStreams, ImageStreamTags, and ImageStreamImage

Detailed in the [Images](#) and [Image Streams](#) sections, these objects are central to the OpenShift Online additions around managing container images.

ServiceAccounts and RoleBindings

Management of permissions to other API objects within OpenShift Online, as well as the external services, are intrinsic to managing your application. Similar to **Secrets**, the **ServiceAccounts** and **RoleBindings** objects can vary in how they are shared between the different stages of your application promotion pipeline based on your needs to share or isolate those different environments.

PersistentVolumeClaims

Relevant to stateful services like databases, how much these are shared between your different application promotion stages directly correlates to how your organization shares or isolates the copies of your application data.

ConfigMaps

A useful decoupling of **Pod** configuration from the **Pod** itself (think of an environment variable style configuration), these can either be shared by the various staging environments when consistent **Pod** behavior is desired. They can also be modified between stages to alter **Pod** behavior (usually as different aspects of the application are vetted at different stages).

2.3.2.2. Images

As noted earlier, container images are now artifacts of your application. In fact, of the new applications artifacts, images and the management of images are the key pieces with respect to application promotion. In some cases, an image might encapsulate the entirety of your application, and the application promotion flow consists solely of managing the image.

Images are not typically managed in a SCM system, just as application binaries were not in previous systems. However, just as with binaries, installable artifacts and corresponding repositories (that is, RPMs, RPM repositories, Nexus, etc.) arose with similar semantics to SCMs, similar constructs and terminology around image management that are similar to SCMs have arisen:

- Image registry == SCM server
- Image repository == SCM repository

As images reside in registries, application promotion is concerned with ensuring the appropriate image exists in a registry that can be accessed from the environment that needs to run the application represented by that image.

Rather than reference images directly, application definitions typically abstract the reference into an image stream. This means the image stream will be another API object that makes up the application components. For more details on image streams, see [Core Concepts](#).

2.3.2.3. Summary

Now that the application artifacts of note, images and API objects, have been detailed in the context of application promotion within OpenShift Online, the notion of *where* you run your application in the various stages of your promotion pipeline is next the point of discussion.

2.3.3. Deployment Environments

A deployment environment, in this context, describes a distinct space for an application to run during a particular stage of a CI/CD pipeline. Typical environments include **development**, **test**, **stage**, and **production**, for example. The boundaries of an environment can be defined in different ways, such as:

- Via labels and unique naming within a single project.
- Via distinct projects within a cluster.

- Via distinct clusters.

And it is conceivable that your organization leverages all three.

2.3.3.1. Considerations

Typically, you will consider the following heuristics in how you structure the deployment environments:

- How much resource sharing the various stages of your promotion flow allow
- How much isolation the various stages of your promotion flow require
- How centrally located (or geographically dispersed) the various stages of your promotion flow are

Also, some important reminders on how OpenShift Online clusters and projects relate to image registries:

- Multiple project in the same cluster can access the same image streams.
- Multiple clusters can access the same external registries.
- Clusters can only share a registry if the OpenShift Online internal image registry is exposed via a route.

2.3.3.2. Summary

After deployment environments are defined, promotion flows with delineation of stages within a pipeline can be implemented. The methods and tools for constructing those promotion flow implementations are the next point of discussion.

2.3.4. Methods and Tools

Fundamentally, application promotion is a process of moving the aforementioned application components from one environment to another. The following subsections outline tools that can be used to move the various components by hand, before advancing to discuss holistic solutions for automating application promotion.



NOTE

There are a number of insertion points available during both the build and deployment processes. They are defined within **BuildConfig** and **DeploymentConfig** API objects. These hooks allow for the invocation of custom scripts which can interact with deployed components such as databases, and with the OpenShift Online cluster itself.

Therefore, it is possible to use these hooks to perform component management operations that effectively move applications between environments, for example by performing an image tag operation from within a hook. However, the various hook points are best suited to managing an application's lifecycle within a given environment (for example, using them to perform database schema migrations when a new version of the application is deployed), rather than to move application components between environments.

2.3.4.1. Managing API Objects

Resources, as defined in one environment, will be exported as JSON or YAML file content in preparation for importing it into a new environment. Therefore, the expression of API objects as JSON or YAML serves as the unit of work as you promote API objects through your application pipeline. The **oc** CLI is used to export and import this content.

TIP

While not required for promotion flows with OpenShift Online, with the JSON or YAML stored in files, you can consider storing and retrieving the content from a SCM system. This allows you to leverage the versioning related capabilities of the SCM, including the creation of branches, and the assignment of and query on various labels or tags associated to versions.

2.3.4.1.1. Exporting API Object State

API object specifications should be captured with **oc export**. This operation removes environment specific data from the object definitions (e.g., current namespace or assigned IP addresses), allowing them to be recreated in different environments (unlike **oc get** operations, which output an unfiltered state of the object).

Use of **oc label**, which allows for adding, modifying, or removing labels on API objects, can prove useful as you organize the set of object collected for promotion flows, because labels allow for selection and management of groups of pods in a single operation. This makes it easier to export the correct set of objects and, because the labels will carry forward when the objects are created in a new environment, they also make for easier management of the application components in each environment.



NOTE

API objects often contain references such as a **DeploymentConfig** that references a **Secret**. When moving an API object from one environment to another, you must ensure that such references are also moved to the new environment.

Similarly, API objects such as a **DeploymentConfig** often contain references to **ImageStreams** that reference an external registry. When moving an API object from one environment to another, you must ensure such references are resolvable within the new environment, meaning that the reference must be resolvable and the **ImageStream** must reference an accessible registry in the new environment. See [Moving Images](#) and [Promotion Caveats](#) for more detail.

2.3.4.1.2. Importing API Object State

2.3.4.1.2.1. Initial Creation

The first time an application is being introduced into a new environment, it is sufficient to take the JSON or YAML expressing the specifications of your API objects and run **oc create** to create them in the appropriate environment. When using **oc create**, keep the **--save-config** option in mind. Saving configuration elements on the object in its annotation list facilitates the later use of **oc apply** to modify the object.

2.3.4.1.2.2. Iterative Modification

After the various staging environments are initially established, as promotion cycles commence and the application moves from stage to stage, the updates to your application can include modification of the API objects that are part of the application. Changes in these API objects are conceivable since they represent the configuration for the OpenShift Online system. Motivations for such changes include:

- Accounting for environmental differences between staging environments.
- Verifying various scenarios your application supports.

Transfer of the API objects to the next stage's environment is accomplished via use of the **oc** CLI. While a rich set of **oc** commands which modify API objects exist, this topic focuses on **oc apply**, which computes and applies differences between objects.

Specifically, you can view **oc apply** as a three-way merge that takes in files or stdin as the input along with an existing object definition. It performs a three-way merge between:

1. the input into the command,
2. the current version of the object, and
3. the most recent user specified object definition stored as an annotation in the current object.

The existing object is then updated with the result.

If further customization of the API objects is necessary, as in the case when the objects are not expected to be identical between the source and target environments, **oc** commands such as **oc set** can be used to modify the object after applying the latest object definitions from the upstream environment.

Some specific usages are cited in [Scenarios and Examples](#).

2.3.4.2. Managing Images and Image Streams

Images in OpenShift Online are managed via a series of API objects as well. However, managing images are so central to application promotion that discussion of the tools and API objects most directly tied to images warrant separate discussion. Both manual and automated forms exist to assist you in managing image promotion (the propagation of images through your pipeline).

2.3.4.2.1. Moving Images



NOTE

For all the detailed caveats around managing images, refer to the [Managing Images](#) topic.

2.3.4.2.1.1. When Staging Environments Share a Registry

When your staging environments share the same OpenShift Online registry, for example if they are all on the same OpenShift Online cluster, there are two operations that are the basic means of *moving* your images between the stages of your application promotion pipeline:

1. First, analogous to **docker tag** and **git tag**, the **oc tag** command allows you to update an OpenShift Online image stream with a reference to a specific image. It also allows you to copy references to specific versions of an image from one image stream to another, even across different projects in a cluster.
2. Second, the **oc import-image** serves as a bridge between external registries and image streams. It imports the metadata for a given image from the registry and stores it into the image stream as an [image stream tag](#). Various **BuildConfigs** and **DeploymentConfigs** in your project can reference those specific images.

2.3.4.2.1.2. When Staging Environments Use Different Registries

More advanced usage occurs when your staging environments leverage different OpenShift Online registries. [Accessing the Internal Registry](#) spells out the steps in detail, but in summary you can:

1. Use the **docker** command in conjunction with obtaining the OpenShift Online access token to supply into your **docker login** command.
2. After being logged into the OpenShift Online registry, use **docker pull**, **docker tag** and **docker push** to transfer the image.
3. After the image is available in the registry of the next environment of your pipeline, use **oc tag** as needed to populate any image streams.

2.3.4.2.2. Deploying

Whether changing the underlying application image or the API objects that configure the application, a deployment is typically necessary to pick up the promoted changes. If the images for your application change (for example, due to an **oc tag** operation or a **docker push** as part of promoting an image from an upstream environment), **ImageChangeTriggers** on your **DeploymentConfig** can trigger the new deployment. Similarly, if the **DeploymentConfig** API object itself is being changed, a **ConfigChangeTrigger** can initiate a deployment when the API object is updated by the promotion step (for example, **oc apply**).

Otherwise, the **oc** commands that facilitate manual deployment include:

- **oc rollout**: The new approach to manage deployments, including pause and resume semantics and richer features around managing history.
- **oc rollback**: Allows for reversion to a previous deployment; in the promotion scenario, if testing of a new version encounters issues, confirming it still works with the previous version could be warranted.

2.3.4.2.3. Automating Promotion Flows with Jenkins

After you understand the components of your application that need to be moved between environments when promoting it and the steps required to move the components, you can start to orchestrate and automate the workflow. OpenShift Online provides a Jenkins image and plug-ins to help with this process.

The OpenShift Online Jenkins image is detailed in [Using Images](#), including the set of OpenShift Online-centric plug-ins that facilitate the integration of Jenkins, and Jenkins Pipelines. Also, the [Pipeline build strategy](#) facilitates the integration between Jenkins Pipelines and OpenShift Online. All of these focus on enabling various aspects of CI/CD, including application promotion.

When moving beyond manual execution of application promotion steps, the Jenkins-related features provided by OpenShift Online should be kept in mind:

- OpenShift Online provides a Jenkins image that is heavily customized to greatly ease deployment in an OpenShift Online cluster.
- The Jenkins image contains the OpenShift Pipeline plug-in, which provides building blocks for implementing promotion workflows. These building blocks include the triggering of Jenkins jobs as image streams change, as well as the triggering of builds and deployments within those jobs.
- **BuildConfigs** employing the OpenShift Online Jenkins Pipeline build strategy enable execution of Jenkinsfile-based Jenkins Pipeline jobs. Pipeline jobs are the strategic direction within

Jenkins for complex promotion flows and can leverage the steps provided by the OpenShift Pipeline Plug-in.

2.3.4.2.4. Promotion Caveats

2.3.4.2.4.1. API Object References

API objects can reference other objects. A common use for this is to have a **DeploymentConfig** that references an image stream, but other reference relationships may also exist.

When copying an API object from one environment to another, it is critical that all references can still be resolved in the target environment. There are a few reference scenarios to consider:

- The reference is "local" to the project. In this case, the referenced object resides in the same project as the object that references it. Typically the correct thing to do is to ensure that you copy the referenced object into the target environment in the same project as the object referencing it.
- The reference is to an object in another project. This is typical when an image stream in a shared project is used by multiple application projects (see [Managing Images](#)). In this case, when copying the referencing object to the new environment, you must update the reference as needed so it can be resolved in the target environment. That may mean:
 - Changing the project the reference points to, if the shared project has a different name in the target environment.
 - Moving the referenced object from the shared project into the local project in the target environment and updating the reference to point to the local project when moving the primary object into the target environment.
 - Some other combination of copying the referenced object into the target environment and updating references to it.

In general, the guidance is to consider objects referenced by the objects being copied to a new environment and ensure the references are resolvable in the target environment. If not, take appropriate action to fix the references and make the referenced objects available in the target environment.

2.3.4.2.4.2. Image Registry References

Image streams point to image repositories to indicate the source of the image they represent. When an image stream is moved from one environment to another, it is important to consider whether the registry and repository reference should also change:

- If different image registries are used to assert isolation between a test environment and a production environment.
- If different image repositories are used to separate test and production-ready images.

If either of these are the case, the image stream must be modified when it is copied from the source environment to the target environment so that it resolves to the correct image. This is in addition to performing the steps described in [Scenarios and Examples](#) to copy the image from one registry and repository to another.

2.3.4.3. Summary

At this point, the following have been defined:

- New application artifacts that make up a deployed application.
- Correlation of application promotion activities to tools and concepts provided by OpenShift Online.
- Integration between OpenShift Online and the CI/CD pipeline engine Jenkins.

Putting together examples of application promotion flows within OpenShift Online is the final step for this topic.

2.3.5. Scenarios and Examples

Having defined the new application artifact components introduced by the Docker, Kubernetes, and OpenShift Online ecosystems, this section covers how to promote those components between environments using the mechanisms and tools provided by OpenShift Online.

Of the components making up an application, the image is the primary artifact of note. Taking that premise and extending it to application promotion, the core, fundamental application promotion pattern is image promotion, where the unit of work is the image. The vast majority of application promotion scenarios entails management and propagation of the image through the promotion pipeline.

Simpler scenarios solely deal with managing and propagating the image through the pipeline. As the promotion scenarios broaden in scope, the other application artifacts, most notably the API objects, are included in the inventory of items managed and propagated through the pipeline.

This topic lays out some specific examples around promoting images as well as API objects, using both manual and automated approaches. But first, note the following on setting up the environment(s) for your application promotion pipeline.

2.3.5.1. Setting up for Promotion

After you have completed development of the initial revision of your application, the next logical step is to package up the contents of the application so that you can transfer to the subsequent staging environments of your promotion pipeline.

1. First, group all the API objects you view as transferable and apply a common **label** to them:

```
labels:
  promotion-group: <application_name>
```

As previously described, the **oc label** command facilitates the management of labels with your various API objects.

TIP

If you initially define your API objects in a OpenShift Online template, you can easily ensure all related objects have the common label you will use to query on when exporting in preparation for a promotion.

2. You can leverage that label on subsequent queries. For example, consider the following set of **oc** command invocations that would then achieve the transfer of your application's API objects:

```
$ oc login <source_environment>
$ oc project <source_project>
$ oc export dc,is,svc,route,secret,sa -l promotion-group=<application_name> -o yaml >
```

```
export.yaml
$ oc login <target_environment>
$ oc new-project <target_project> 1
$ oc create -f export.yaml
```

- 1 Alternatively, **oc project <target_project>** if it already exists.



NOTE

On the **oc export** command, whether or not you include the **is** type for image streams depends on how you choose to manage images, image streams, and registries across the different environments in your pipeline. The caveats around this are discussed below. See also the [Managing Images](#) topic.

3. You must also get any tokens necessary to operate against each registry used in the different staging environments in your promotion pipeline. For each environment:

- a. Log in to the environment:

```
$ oc login <each_environment_with_a_unique_registry>
```

- b. Get the access token with:

```
$ oc whoami -t
```

- c. Copy and paste the token value for later use.

2.3.5.2. Repeatable Promotion Process

After the initial setup of the different staging environments for your pipeline, a set of repeatable steps to validate each iteration of your application through the promotion pipeline can commence. These basic steps are taken each time the image or API objects in the source environment are changed:

Move updated images → Move updated API objects → Apply environment specific customizations

1. Typically, the first step is promoting any updates to the image(s) associated with your application to the next stage in the pipeline. As noted above, the key differentiator in promoting images is whether the OpenShift Online registry is shared or not between staging environments.

- a. If the registry is shared, simply leverage **oc tag**:

```
$ oc tag <project_for_stage_N>/<imagestream_name_for_stage_N>:<tag_for_stage_N>
<project_for_stage_N+1>/<imagestream_name_for_stage_N+1>:<tag_for_stage_N+1>
```

- b. If the registry is not shared, you can leverage the access tokens for each of your promotion pipeline registries as you log into both the source and destination registries, pulling, tagging, and pushing your application images accordingly:

- i. Log in to the source environment registry:

```
$ docker login -u <username> -e <any_email_address> -p <token_value>
<src_env_registry_ip>:<port>
```

- ii. Pull your application's image:

```
$ docker pull <src_env_registry_ip>:<port>/<namespace>/<image name>:<tag>
```

- iii. Tag your application's image to the destination registry's location, updating namespace, name, and tag as needed to conform to the destination staging environment:

```
$ docker tag <src_env_registry_ip>:<port>/<namespace>/<image name>:<tag>  
<dest_env_registry_ip>:<port>/<namespace>/<image name>:<tag>
```

- iv. Log into the destination staging environment registry:

```
$ docker login -u <username> -e <any_email_address> -p <token_value>  
<dest_env_registry_ip>:<port>
```

- v. Push the image to its destination:

```
$ docker push <dest_env_registry_ip>:<port>/<namespace>/<image name>:<tag>
```

TIP

To automatically import new versions of an image from an external registry, the **oc tag** command has a **--scheduled** option. If used, the image the **ImageStreamTag** references will be periodically pulled from the registry hosting the image.

2. Next, there are the cases where the evolution of your application necessitates fundamental changes to your API objects or additions and deletions from the set of API objects that make up the application. When such evolution in your application's API objects occurs, the OpenShift Online CLI provides a broad range of options to transfer to changes from one staging environment to the next.

- a. Start in the same fashion as you did when you initially set up your promotion pipeline:

```
$ oc login <source_environment>  
$ oc project <source_project>  
$ oc export dc,is,svc,route,secret,sa -l promotion-group=<application_name> -o yaml >  
export.yaml  
$ oc login <target_environment>  
$ oc <target_project>
```

- b. Rather than simply creating the resources in the new environment, update them. You can do this a few different ways:

- i. The more conservative approach is to leverage **oc apply** and merge the new changes to each API object in the target environment. In doing so, you can **--dry-run=true** option and examine the resulting objects prior to actually changing the objects:

```
$ oc apply -f export.yaml --dry-run=true
```

If satisfied, actually run the **apply** command:

```
$ oc apply -f export.yaml
```

The **apply** command optionally takes additional arguments that help with more complicated scenarios. See **oc apply --help** for more details.

- ii. Alternatively, the simpler but more aggressive approach is to leverage **oc replace**. There is no dry run with this update and replace. In the most basic form, this involves executing:

```
$ oc replace -f export.yaml
```

As with **apply**, **replace** optionally takes additional arguments for more sophisticated behavior. See **oc replace --help** for more details.

3. The previous steps automatically handle new API objects that were introduced, but if API objects were deleted from the source environment, they must be manually deleted from the target environment using **oc delete**.
4. Tuning of the environment variables cited on any of the API objects may be necessary as the desired values for those may differ between staging environments. For this, use **oc set env**:

```
$ oc set env <api_object_type>/<api_object_ID> <env_var_name>=<env_var_value>
```

5. Finally, trigger a new deployment of the updated application using the **oc rollout** command or one of the other mechanisms discussed in the [Deployments](#) section above.

2.3.5.3. Repeatable Promotion Process Using Jenkins

The [OpenShift Sample](#) job defined in the [Jenkins Docker Image](#) for OpenShift Online is an example of image promotion within OpenShift Online within the constructs of Jenkins. Setup for this sample is located in the [OpenShift Origin source repository](#).

This sample includes:

- Use of **Jenkins as the CI/CD engine**
- Use of the **OpenShift Pipeline plug-in for Jenkins** This plug-in provides a subset of the functionality provided by the **oc** CLI for OpenShift Online packaged as Jenkins Freestyle and DSL Job steps. Note that the **oc** binary is also included in the Jenkins Docker Image for OpenShift Online, and can also be used to interact with OpenShift Online in Jenkins jobs.
- The OpenShift Online–provided **templates for Jenkins**. There is a template for both ephemeral and persistent storage.
- A **sample application**: defined in the [OpenShift Origin source repository](#), this application leverages **ImageStreams**, **ImageChangeTriggers**, **ImageStreamTags**, **BuildConfigs**, and separate **DeploymentConfigs** and **Services** corresponding to different stages in the promotion pipeline.

The following examines the various pieces of the OpenShift Sample job in more detail:

1. [The first step](#) is the equivalent of an **oc scale dc frontend --replicas=0** call. This step is intended to bring down any previous versions of the application image that may be running.
2. [The second step](#) is the equivalent of an **oc start-build frontend** call.
3. [The third step](#) is the equivalent of an **oc rollout latest dc/frontend** call.

4. [The fourth step](#) is the "test" for this sample. It ensures that the associated service for this application is in fact accessible from a network perspective. Under the covers, a socket connection is attempted against the IP address and port associated with the OpenShift Online service. Of course, additional tests can be added (if not via OpenShift Pipeline plug-in steps, then via use of the Jenkins Shell step to leverage OS-level commands and scripts to test your application).
5. [The fifth step](#) commences under that assumption that the testing of your application passed and hence intends to mark the image as "ready". In this step, a new **prod** tag is created for the application image off of the **latest** image. With the **frontend DeploymentConfig** having an **ImageChangeTrigger**[defined for that tag](#), the corresponding "production" deployment is launched.
6. [The sixth and last step](#) is a verification step, where the plug-in confirms that OpenShift Online launched the desired number of replicas for the "production" deployment.

CHAPTER 3. AUTHENTICATION

3.1. WEB CONSOLE AUTHENTICATION

When accessing the [web console](#) from a browser, you are automatically redirected to a login page.

Review the [browser versions and operating systems](#) that can be used to access the web console.

You can provide your login credentials on this page to obtain a token to make API calls. After logging in, you can navigate your projects using the [web console](#).

3.2. CLI AUTHENTICATION

You can authenticate from the command line using the CLI command **oc login**. You can [get started with the CLI](#) by running this command

with the url of the online cluster you are using:

```
$ oc login https://<online_cluster_url>
```

The command's interactive flow helps you establish a session to an OpenShift Online server with the provided credentials. If any information required to successfully log in to an OpenShift Online server is not provided, the command prompts for user input as required. The [configuration](#) is automatically saved and is then used for every subsequent command.

All configuration options for the **oc login** command, listed in the **oc login --help** command output, are optional. The following example shows usage with some common options:

```
$ oc login [-u=<username>] \  
  [-p=<password>] \  
  [-s=<server>] \  
  [-n=<project>] \  
  [--certificate-authority=</path/to/file.crt>|--insecure-skip-tls-verify]
```

The following table describes these common options:

Table 3.1. Common CLI Configuration Options

Option	Syntax	Description
-s, --server	<pre>\$ oc login -s= <server></pre>	Specifies the host name of the OpenShift Online server. If a server is provided through this flag, the command does not ask for it interactively. This flag can also be used if you already have a CLI configuration file and want to log in and switch to another server.
-u, --username and -p, -password	<pre>\$ oc login -u= <username> -p= <password></pre>	Allows you to specify the credentials to log in to the OpenShift Online server. If user name or password are provided through these flags, the command does not ask for it interactively. These flags can also be used if you already have a configuration file with a session token established and want to log in and switch to another user name.

Option	Syntax	Description
-n, --namespace	<pre>\$ oc login -u= <username> -p= <password> -n= <project></pre>	A global CLI option which, when used with oc login , allows you to specify the project to switch to when logging in as a given user.
--certificate-authority	<pre>\$ oc login -- certificate- authority= <path/to/file.crt></pre>	Correctly and securely authenticates with an OpenShift Online server that uses HTTPS. The path to a certificate authority file must be provided.
--insecure-skip-tls-verify	<pre>\$ oc login -- insecure-skip-tls- verify</pre>	Allows interaction with an HTTPS server bypassing the server certificate checks; however, note that it is not secure. If you try to oc login to a HTTPS server that does not provide a valid certificate, and this or the --certificate-authority flags were not provided, oc login will prompt for user input to confirm (y/N kind of input) about connecting insecurely.

CLI configuration files allow you to easily [manage multiple CLI profiles](#).

CHAPTER 4. AUTHORIZATION

4.1. OVERVIEW

This topic contains [authorization tasks](#) for application developers and their capabilities, as dictated by the cluster administrator.

4.2. CHECKING IF USERS CAN CREATE PODS

Using the **scc-review** and **scc-subject-review** options, you can see if an individual user, or a user under a specific service account, can create or update a pod.

Using the **scc-review** option, you can check if a service account can create or update a pod. The command outputs the security context constraints that admit the resource.

For example, to check if a user with the **system:serviceaccount:projectname:default** service account can create a pod:

```
$ oc policy scc-review -z system:serviceaccount:projectname:default -f my_resource.yaml
```

You can also use the **scc-subject-review** option to check whether a specific user can create or update a pod:

```
$ oc policy scc-subject-review -u <username> -f my_resource.yaml
```

To check if a user belonging to a specific group can create a pod in a specific file:

```
$ oc policy scc-subject-review -u <username> -g <groupname> -f my_resource.yaml
```

4.3. DETERMINING WHAT YOU CAN DO AS AN AUTHENTICATED USER

From within your OpenShift Online project, you can determine what [verbs](#) you can perform against all namespace-scoped resources (including third-party resources).

The **can-i** command option tests scopes in terms of the user and role.

```
$ oc policy can-i --list --loglevel=8
```

The output helps you to determine what API request to make to gather the information.

To receive information back in a user-readable format, run:

```
$ oc policy can-i --list
```

The output provides a full list.

To determine if you can perform specific verbs, run:

```
$ oc policy can-i <verb> <resource>
```

User scopes can provide more information about a given scope. For example:

`$ oc policy can-i <verb> <resource> --scopes=user:info`

CHAPTER 5. PROJECTS

5.1. OVERVIEW

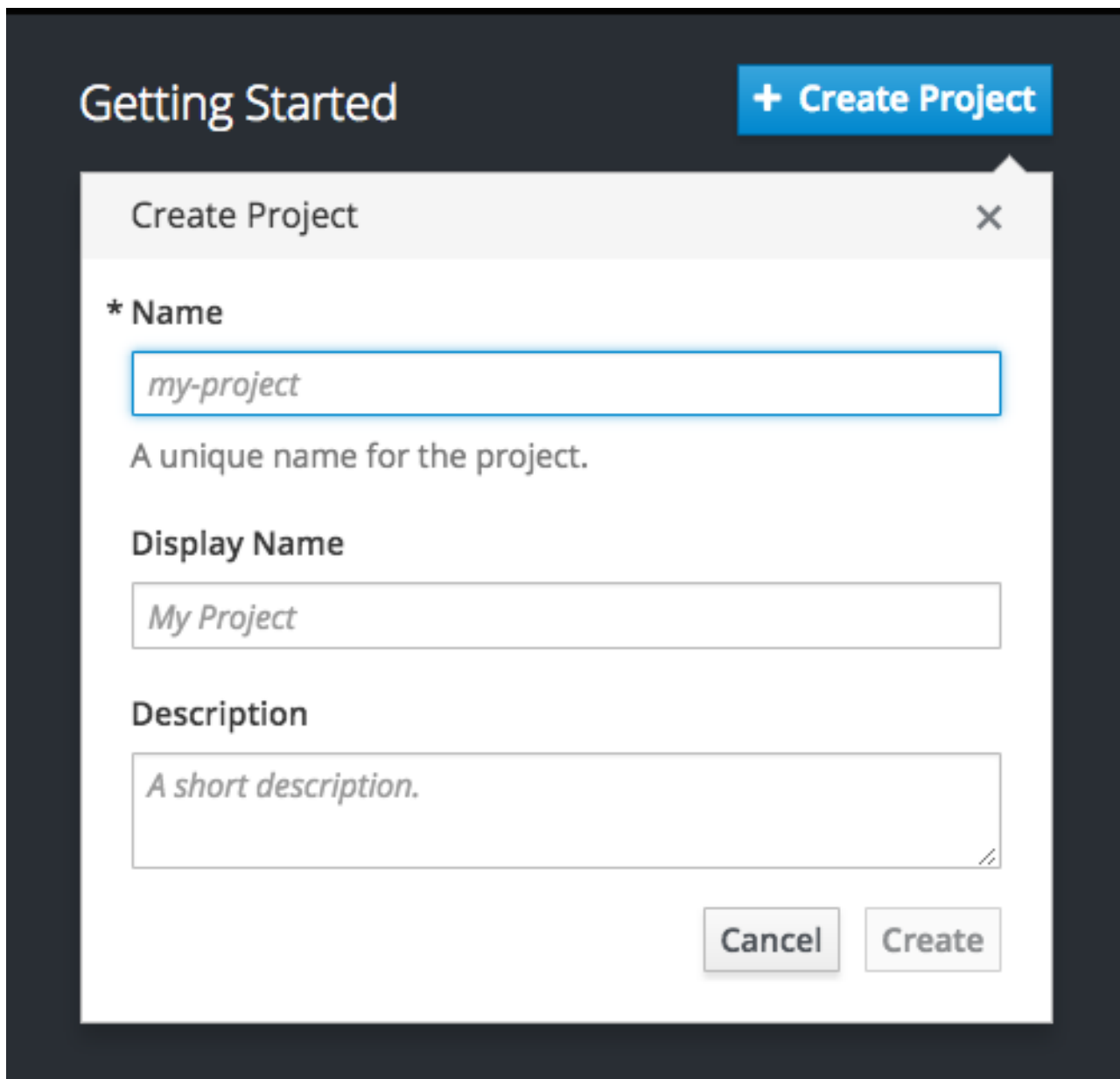
A [project](#) allows a community of users to organize and manage their content in isolation from other communities.

5.2. CREATING A PROJECT

If allowed, you can create a new project using [the CLI](#) or the [web console](#).

5.2.1. Using the Web Console

To create a new project using the web console, click the **Create Project** button on the Projects panel or the Projects page.



The screenshot shows a 'Getting Started' dialog box for creating a project. The dialog has a title bar 'Create Project' with a close button. It contains three input fields: 'Name' (required, with placeholder 'my-project'), 'Display Name' (with placeholder 'My Project'), and 'Description' (with placeholder 'A short description.'). At the bottom are 'Cancel' and 'Create' buttons. A '+ Create Project' button is visible in the top right of the background interface.

The **Create Project** button is displayed by default, but can be optionally hidden or customized.

5.2.2. Using the CLI

To create a new project using the CLI:

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

For example:

```
$ oc new-project hello-openshift \
  --description="This is an example project to demonstrate OpenShift v3" \
  --display-name="Hello OpenShift"
```



NOTE

The number of projects you are allowed to create is limited. Once your limit is reached, you may need to delete an existing project in order to create a new one.

5.3. VIEWING PROJECTS

When viewing projects, you are restricted to seeing only the projects you have access to view based on the [authorization policy](#).

To view a list of projects:

```
$ oc get projects
```

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>
```

You can also use the [web console](#) to view and change between projects. After [authenticating](#) and logging in, you are presented with a list of projects that you have access to.

The right panel shown with the service catalog provides quick access to the most recently accessed projects (up to five projects). For the full list of projects, use the **View All** link provided at the top of the right panel.

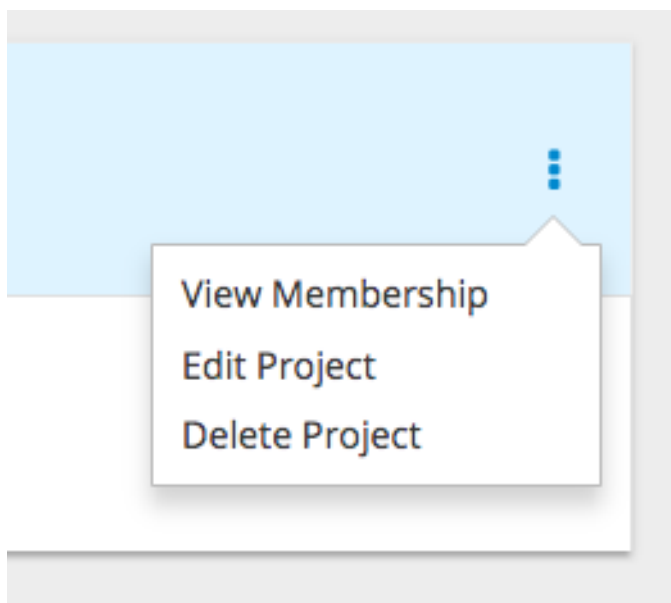
The screenshot shows the 'My Projects' interface in OpenShift. At the top left is the 'OPENSIFT' logo. At the top right, there is a help icon, a user profile for 'developer', and a '+ Create Project' button. Below the header, there is a search bar labeled 'Filter by keyword', a 'Sort by' dropdown set to 'Display Name', and a sort icon. The main content area displays a list of projects:

Project Name	Description	Created by	Time Ago
Ben's Top Secret Project	Ben's top secret project to make us huge profits next year.	ben	26 minutes ago
My Project	Initial developer project	myproject	7 hours ago
Nodes + MongoDB dev	A short description of what this project is for and how it will function.	node	30 minutes ago
Robb H. javascript development	Short term development environment while he's getting up to speed on current UI team dev	robb	24 minutes ago
Ruby on Rails example application	Developer template for Ruby on Rails project.	ruby	29 minutes ago
Test Integration enironment		test	29 minutes ago

If you use [the CLI to create a new project](#), you can then refresh the page in the browser to see the new project.

Selecting a project brings you to the [project overview](#) for that project.

Clicking on the kebab menu for a particular project presents you with the following options:



5.4. CHECKING PROJECT STATUS

The **oc status** command provides a high-level overview of the current project, with its components and their relationships. This command takes no argument:

-

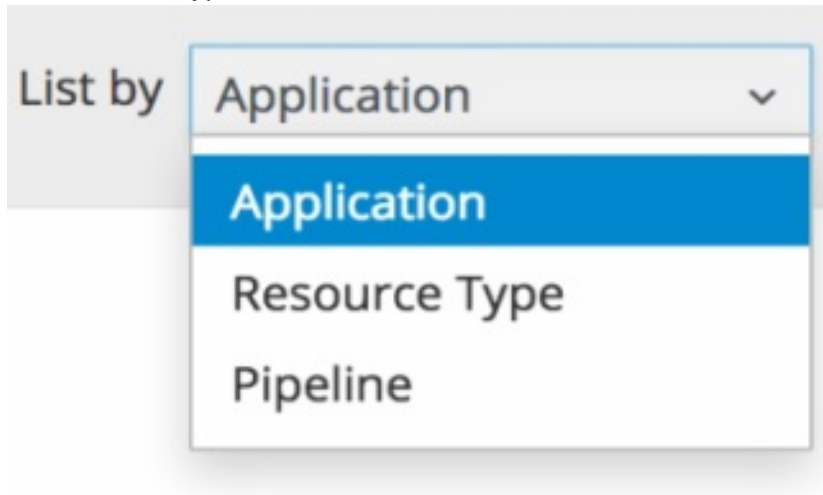
\$ oc status

5.5. FILTERING BY LABELS

You can filter the contents of a project page in the [web console](#) by using the [labels](#) of a resource. You can pick from a suggested label name and values, or type in your own. Multiple filters can be added. When multiple filters are applied, resources must match all of the filters to remain visible.

To filter by labels:

1. Select a label type:

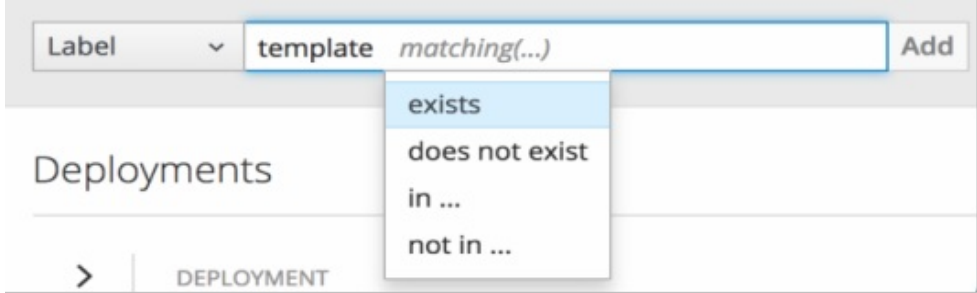


2. Select one of the following:

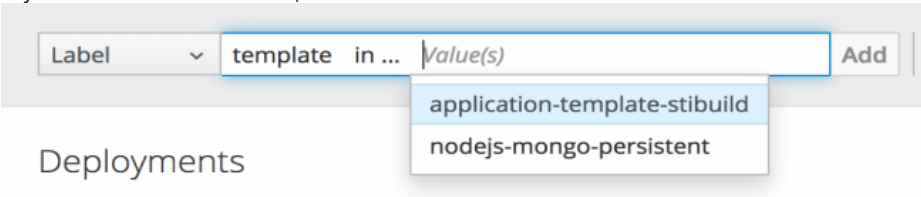
exists	Verify that the label name exists, but ignore its value.
does not exist	Verify that the label name does not exist, but ignore its value.
in	Verify that the label name exists and is equal to one of the selected values.

not in

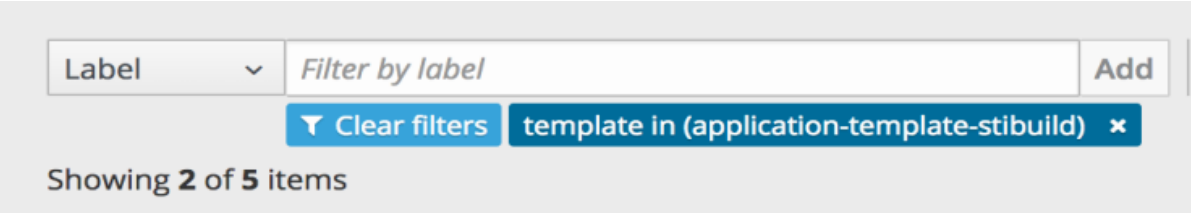
Verify that the label name does not exist, or is not equal to any of the selected values.



a. If you selected **in** or **not in**, select a set of values then select **Filter**:



- After adding filters, you can stop filtering by selecting **Clear all filters** or by clicking individual filters to remove them:



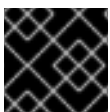
5.6. DELETING A PROJECT

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

To delete a project using the CLI:

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

5.7. PROJECT COLLABORATION IN OPENSIFT ONLINE PRO



IMPORTANT

Collaboration is not available in OpenShift Online Starter.

Every OpenShift Online Pro account has the ability to add up to 50 collaborator users per subscription. These collaborator users are granted cluster access from OpenShift Online Pro account subscribers so that they can collaborate on projects hosted with OpenShift Online. This allows multiple users to gain access to projects under a single subscription, without having to pay a monthly fee for every account.

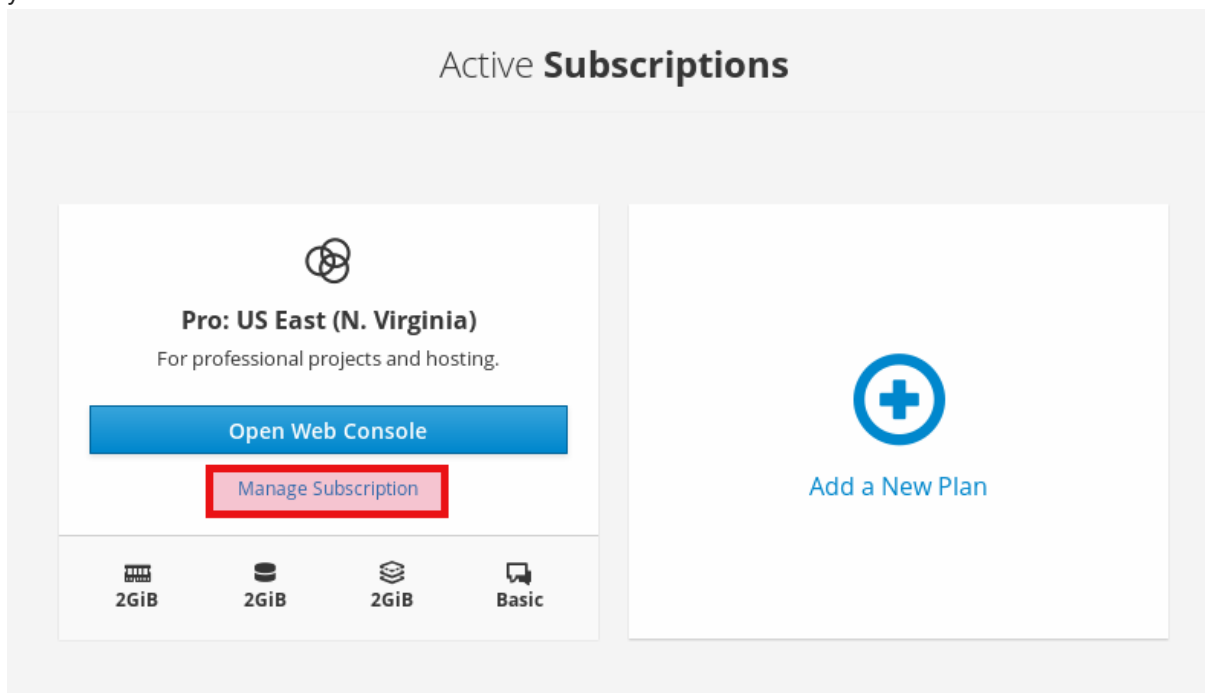
5.7.1. Collaboration Restrictions

Collaborators can only access the resources within the projects that they have been granted access. Also, their ability to view, edit, and manage the project resources will depend on the specific role that they have been granted within the project.

5.7.2. Adding Collaborators

OpenShift Online Pro subscribers can add collaborators by following these steps:

1. Each user you want to add as a collaborator must create a free account at developers.redhat.com. Once your collaborator has confirmed their Red Hat Developers account, you can add them to your subscription.
2. Each collaborator must sign into developers.redhat.com and click on their name in the upper-right corner to access their account details. Make note of the **Red Hat Login ID** on this page, as it is the user name you will be required to enter in order to associate the collaborator with your subscription.
3. Sign in to manage.openshift.com and click on **Manage Subscription** under the cluster where you want to add the collaborator.



4. Once you are in the subscription management console, click the **Manage** link under the **Collaborators** heading, which brings you to the **Collaboration** page.

Subscription to Pro: US East (N. Virginia)

[Go to OpenShift console](#)

Current Plan [Change](#)

The **pro-us-east-1** Plan includes:

- **2GiB** memory for your applications
- **2GiB** Terminating memory for your applications
- **2GiB** storage for your applications
- **10** projects
- **Basic** support
- Always on, unlimited usage
- Option to invite collaborators to projects
- Supports custom domains
- Ability to schedule jobs

Your plan has been customized with:

- **Basic** support provided through Red Hat

Primary Contact [Edit](#)

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[Back to Account Overview](#)

Billing Contact [Edit](#)

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Payment Method [Edit](#)

The current credit card on file has a number ending with ██████████ and expires ██████████. The type of card **Visa**.

Collaborators [Manage](#)

Invite other users to work on your projects

5. On the **Collaboration** page, enter the **Red Hat Login ID** for the user in the user name field and click **Add Collaborator**.

You should now see the user listed under your collaborators, the time the user was added, and an option to remove the user from your subscription.

This does not automatically grant the user any access to your projects. Access must be granted manually by the project owner using [oc policy commands](#) or the [web console](#).

5.7.3. Granting Project Access Using the Web Console

After [adding the collaborator](#) to your OpenShift Online Pro subscription, you can grant project access to the collaborator using the web console.

1. From within a project, click **Resources**, then **Membership**.
2. Add roles (for example, **view**, **edit**, or **admin**) to the user you want to grant access. See [Authorization](#) for more information on access roles.

Now, when the collaborator user signs in to [manage.openshift.com](#), they will see a card to log in to the web console for the same cluster as your subscription and, if the collaborator was granted access to your projects on the cluster, they will have access just like any other user.

5.7.4. Granting Project Access Using the CLI

After [adding the collaborator](#) to your OpenShift Online Pro subscription, you can grant project access to the collaborator using the CLI.

1. Log in to the cluster through the CLI using your access token.
2. Grant the user a role using the same user name listed on the **Collaboration** page using:

```
$ oc policy add-role-to-user <role-name> <username>
```

For example:

```

~$ oc login https://api.openshift.com --token=<...>
Logged into "https://api.openshift.com:443" as "exampleuser" using the token provided.

You have one project on this server: "exampleuser-collab"

Using project "exampleuser-collab".
~$ oc policy add-role-to-user view collaborator-1234
role "view" added: "collaborator-1234"

```

This example grants **view** access to the project for user **collaborator-1234**. See [Authorization](#) for more information on access roles.

Now, when the collaborator user signs in to manage.openshift.com, they will see a card to log in to the web console for the same cluster as your subscription and, if the collaborator was granted access to your projects on the cluster, they will have access just like any other user.

5.7.5. Removing Collaborators

If at any time you wish to remove the user as a collaborator from your subscription, you can do so on the same **Collaboration** page you used to add them. It is important to note, however, that this will not automatically remove any roles you have assigned the user in your projects. These will need to be manually deleted, or the user may still have access to your projects.

5.7.5.1. Removing Project Access Using the Web Console

You can remove project access from the collaborator using the web console.

1. From within a project, click **Resources**, then **Membership**.
2. Remove roles (for example, **view**, **edit**, or **admin**) from the user.

5.7.5.2. Removing Project Access Using the CLI

You can remove project access from the collaborator using the CLI.

1. Log in to the cluster through the CLI using your access token.
2. Remove a role (for example, **view**, **edit**, or **admin**) from a specific collaborator using the same user name listed on the **Collaboration** page by running:

```
$ oc policy remove-role-from-user <role-name> <username>
```

CHAPTER 6. MIGRATING APPLICATIONS

6.1. OVERVIEW

This topic covers the migration procedure of OpenShift version 2 (v2) applications to OpenShift version 3 (v3).

To migrate OpenShift v2 applications to OpenShift Online v3, all cartridges in the v2 application must be recorded as each v2 cartridge is equivalent with a corresponding image or template in OpenShift Online v3 and they must be migrated individually. For each cartridge, all dependencies or required packages also must be recorded, as they must be included in the v3 images.

The general migration procedure is:

1. Back up the v2 application.
 - Web cartridge: The source code can be backed up to a Git repository such as by pushing to a repository on GitHub.
 - Database cartridge: The database can be backed up using a dump command (**mongodump**, **mysqldump**, **pg_dump**) to back up the database.
 - Web and database cartridges: **rhc** client tool provides snapshot ability to back up multiple cartridges:

```
$ rhc snapshot save <app_name>
```

The snapshot is a tar file that can be unzipped, and its content is application source code and the database dump.

2. If the application has a database cartridge, create a v3 database application, sync the database dump to the pod of the new v3 database application, then restore the v2 database in the v3 database application with database restore commands.
3. For a web framework application, edit the application source code to make it v3 compatible. Then, add any dependencies or packages required in appropriate files in the Git repository. Convert v2 environment variables to corresponding v3 environment variables.
4. Create a v3 application from source (your Git repository) or from a quickstart with your Git URL. Also, add the database service parameters to the new application to link the database application to the web application.
5. In v2, there is an integrated Git environment and your applications automatically rebuild and restart whenever a change is pushed to your v2 Git repository. In v3, in order to have a build automatically triggered by source code changes pushed to your public Git repository, you must set up a [webhook](#) after the initial build in v3 is completed.

6.2. MIGRATING DATABASE APPLICATIONS

6.2.1. Overview

This topic reviews how to migrate MySQL, PostgreSQL, and MongoDB database applications from OpenShift version 2 (v2) to OpenShift version 3 (v3).

6.2.2. Supported Databases

v2	v3
MongoDB: 2.4	MongoDB: 2.4, 2.6
MySQL: 5.5	MySQL: 5.5, 5.6
PostgreSQL: 9.2	PostgreSQL: 9.2, 9.4

6.2.3. MySQL

1. Export all databases to a dump file and copy it to a local machine (into the current directory):

```
$ rhc ssh <v2_application_name>
$ mysqldump --skip-lock-tables -h $OPENSIFT_MYSQL_DB_HOST -P
${OPENSIFT_MYSQL_DB_PORT:-3306} -u ${OPENSIFT_MYSQL_DB_USERNAME:-
'admin'} \
--password="$OPENSIFT_MYSQL_DB_PASSWORD" --all-databases > ~/app-
root/data/all.sql
$ exit
```

2. Download **dbdump** to your local machine:

```
$ mkdir mysqldumpdir
$ rhc scp -a <v2_application_name> download mysqldumpdir app-root/data/all.sql
```

3. Create a v3 **mysql-persistent** pod from template:

```
$ oc new-app mysql-persistent -p \
  MYSQL_USER=<your_v2_mysql_username> -p \
  MYSQL_PASSWORD=<your_v2_mysql_password> -p MYSQL_DATABASE=
<your_v2_database_name>
```

4. Check to see if the pod is ready to use:

```
$ oc get pods
```

5. When the pod is up and running, copy database archive files to your v3 MySQL pod:

```
$ oc rsync /local/mysqldumpdir <mysql_pod_name>:/var/lib/mysql/data
```

6. Restore the database in the v3 running pod:

```
$ oc rsh <mysql_pod>
$ cd /var/lib/mysql/data/mysqldumpdir
```

In v3, to restore databases you need to access MySQL as **root** user.

In v2, the **\$OPENSIFT_MYSQL_DB_USERNAME** had full privileges on all databases. In v3, you must grant privileges to **\$MYSQL_USER** for each database.

```
$ mysql -u root
$ source all.sql
```

Grant all privileges on <dbname> to <your_v2_username>@localhost, then flush privileges.

- Remove the dump directory from the pod:

```
$ cd ../; rm -rf /var/lib/mysql/data/mysqldumpdir
```

Supported MySQL Environment Variables

v2	v3
OPENSIFT_MYSQL_DB_HOST	[service_name]_SERVICE_HOST
OPENSIFT_MYSQL_DB_PORT	[service_name]_SERVICE_PORT
OPENSIFT_MYSQL_DB_USERNAME	MYSQL_USER
OPENSIFT_MYSQL_DB_PASSWORD	MYSQL_PASSWORD
OPENSIFT_MYSQL_DB_URL	
OPENSIFT_MYSQL_DB_LOG_DIR	
OPENSIFT_MYSQL_VERSION	
OPENSIFT_MYSQL_DIR	
OPENSIFT_MYSQL_DB_SOCKET	
OPENSIFT_MYSQL_IDENT	
OPENSIFT_MYSQL_AIO	MYSQL_AIO
OPENSIFT_MYSQL_MAX_ALLOWED_PACKET	MYSQL_MAX_ALLOWED_PACKET
OPENSIFT_MYSQL_TABLE_OPEN_CACHE	MYSQL_TABLE_OPEN_CACHE
OPENSIFT_MYSQL_SORT_BUFFER_SIZE	MYSQL_SORT_BUFFER_SIZE
OPENSIFT_MYSQL_LOWER_CASE_TABLE_NAMES	MYSQL_LOWER_CASE_TABLE_NAMES
OPENSIFT_MYSQL_MAX_CONNECTIONS	MYSQL_MAX_CONNECTIONS
OPENSIFT_MYSQL_FT_MIN_WORD_LEN	MYSQL_FT_MIN_WORD_LEN

v2	v3
OPENSIFT_MYSQL_FT_MAX_WORD_LEN	MYSQL_FT_MAX_WORD_LEN
OPENSIFT_MYSQL_DEFAULT_STORAGE_ENGINE	
OPENSIFT_MYSQL_TIMEZONE	
	MYSQL_DATABASE
	MYSQL_ROOT_PASSWORD
	MYSQL_MASTER_USER
	MYSQL_MASTER_PASSWORD

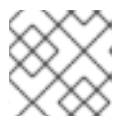
6.2.4. PostgreSQL

1. Back up the v2 PostgreSQL database from the gear:

```
$ rhc ssh -a <v2-application_name>
$ mkdir ~/app-root/data/tmp
$ pg_dump <database_name> | gzip > ~/app-root/data/tmp/<database_name>.gz
```

2. Extract the backup file back to your local machine:

```
$ rhc scp -a <v2_application_name> download <local_dest> app-root/data/tmp/<db-
name>.gz
$ gzip -d <database-name>.gz
```



NOTE

Save the backup file to a separate folder for step 4.

3. Create the PostgreSQL service using the v2 application database name, user name and password to create the new service:

```
$ oc new-app postgresql-persistent -p POSTGRESQL_DATABASE=dbname -p
POSTGRESQL_PASSWORD=password -p POSTGRESQL_USER=username
```

4. Check to see if the pod is ready to use:

```
$ oc get pods
```

5. When the pod is up and running, sync the backup directory to pod:

```
$ oc rsync /local/path/to/dir <postgresql_pod_name>:/var/lib/pgsql/data
```

6. Remotely access the pod:

```
$ oc rsh <pod_name>
```

7. Restore the database:

```
psql dbname < /var/lib/pgsql/data/<database_backup_file>
```

8. Remove all backup files that are no longer needed:

```
$ rm /var/lib/pgsql/data/<database-backup-file>
```

Supported PostgreSQL Environment Variables

v2	v3
OPENSIFT_POSTGRESQL_DB_HOST	[service_name]_SERVICE_HOST
OPENSIFT_POSTGRESQL_DB_PORT	[service_name]_SERVICE_PORT
OPENSIFT_POSTGRESQL_DB_USERNAME	POSTGRESQL_USER
OPENSIFT_POSTGRESQL_DB_PASSWORD	POSTGRESQL_PASSWORD
OPENSIFT_POSTGRESQL_DB_LOG_DIR	
OPENSIFT_POSTGRESQL_DB_PID	
OPENSIFT_POSTGRESQL_DB_SOCKET_DIR	
OPENSIFT_POSTGRESQL_DB_URL	
OPENSIFT_POSTGRESQL_VERSION	
OPENSIFT_POSTGRESQL_SHARED_BUFFERS	
OPENSIFT_POSTGRESQL_MAX_CONNECTIONS	
OPENSIFT_POSTGRESQL_MAX_PREPARED_TRANSACTIONS	
OPENSIFT_POSTGRESQL_DATESTYLE	
OPENSIFT_POSTGRESQL_LOCALE	

v2	v3
OPENSIFT_POSTGRESQL_CONFIG	
OPENSIFT_POSTGRESQL_SSL_ENABLED	
	POSTGRESQL_DATABASE
	POSTGRESQL_ADMIN_PASSWORD

6.2.5. MongoDB



NOTE

- For OpenShift v3: MongoDB shell version 3.2.6
- For OpenShift v2: MongoDB shell version 2.4.9

1. Remotely access the v2 application via the **ssh** command:

```
$ rhc ssh <v2_application_name>
```

2. Run **mongodump**, specifying a single database with **-d <database_name> -c <collections>**. Without those options, dump all databases. Each database is dumped in its own directory:

```
$ mongodump -h $OPENSIFT_MONGODB_DB_HOST -o app-root/repo/mydbdump -u
'admin' -p $OPENSIFT_MONGODB_DB_PASSWORD
$ cd app-root/repo/mydbdump/<database_name>; tar -cvzf dbname.tar.gz
$ exit
```

3. Download **dbdump** to a local machine in the **mongodump** directory:

```
$ mkdir mongodump
$ rhc scp -a <v2_appname> download mongodump \
app-root/repo/mydbdump/<dbname>/dbname.tar.gz
```

4. Start a MongoDB pod in v3. Because the latest image (3.2.6) does not include **mongo-tools**, to use **mongorestore** or **mongoimport** commands you need to edit the default **mongodb-persistent** template to specify the image tag that contains the **mongo-tools**, "**mongodb:2.4**". For that reason, the following **oc export** command and edit are necessary:

```
$ oc export template mongodb-persistent -n openshift -o json > mongodb-24persistent.json
```

Edit L80 of *mongodb-24persistent.json*; replace **mongodb:latest** with **mongodb:2.4**.

```
$ oc new-app --template=mongodb-persistent -n <project-name-that-template-was-created-in> \
MONGODB_USER=user_from_v2_app -p \
MONGODB_PASSWORD=password_from_v2_db -p \
```

```
MONGODB_DATABASE=v2_dbname -p \
MONGODB_ADMIN_PASSWORD=password_from_v2_db
$ oc get pods
```

- When the mongodb pod is up and running, copy the database archive files to the v3 MongoDB pod:

```
$ oc rsync local/path/to/mongodump <mongodb_pod_name>:/var/lib/mongodb/data
$ oc rsh <mongodb_pod>
```

- In the MongoDB pod, complete the following for each database you want to restore:

```
$ cd /var/lib/mongodb/data/mongodump
$ tar -xzf dbname.tar.gz
$ mongorestore -u $MONGODB_USER -p $MONGODB_PASSWORD -d dbname -v
/var/lib/mongodb/data/mongodump
```

- Check if the database is restored:

```
$ mongo admin -u $MONGODB_USER -p $MONGODB_ADMIN_PASSWORD
$ use dbname
$ show collections
$ exit
```

- Remove the **mongodump** directory from the pod:

```
$ rm -rf /var/lib/mongodb/data/mongodump
```

Supported MongoDB Environment Variables

v2	v3
OPENSIFT_MONGODB_DB_HOST	[service_name]_SERVICE_HOST
OPENSIFT_MONGODB_DB_PORT	[service_name]_SERVICE_PORT
OPENSIFT_MONGODB_DB_USERNAME	MONGODB_USER
OPENSIFT_MONGODB_DB_PASSWORD	MONGODB_PASSWORD
OPENSIFT_MONGODB_DB_URL	
OPENSIFT_MONGODB_DB_LOG_DIR	
	MONGODB_DATABASE
	MONGODB_ADMIN_PASSWORD
	MONGODB_NOPREALLOC

v2	v3
	MONGODB_SMALLFILES
	MONGODB_QUIET
	MONGODB_REPLICA_NAME
	MONGODB_KEYFILE_VALUE

6.3. MIGRATING WEB FRAMEWORK APPLICATIONS

6.3.1. Overview

This topic reviews how to migrate Python, Ruby, PHP, Perl, Node.js, WordPress, Ghost, JBoss EAP, JBoss WS (Tomcat), and Wildfly 10 (JBoss AS) web framework applications from OpenShift version 2 (v2) to OpenShift version 3 (v3).

6.3.2. Python

1. Set up a new GitHub repository and add it as a remote branch to the current, local v2 Git repository:

```
$ git remote add <remote-name> https://github.com/<github-id>/<repo-name>.git
```

2. Push the local v2 source code to the new repository:

```
$ git push -u <remote-name> master
```

3. Ensure that all important files such as *setup.py*, *wsgi.py*, *requirements.txt*, and *etc* are pushed to new repository.

- Ensure all required packages for your application are included in *requirements.txt*.

4. Use the **oc** command to launch a new Python application from the builder image and source code:

```
$ oc new-app --strategy=source
python:3.3~https://github.com/<github-id>/<repo-name> --name=<app-name> -e
<ENV_VAR_NAME>=<env_var_value>
```

Supported Python Versions

See [Supported Container Images](#).

6.3.3. Ruby

1. Set up a new GitHub repository and add it as a remote branch to the current, local v2 Git repository:

```
$ git remote add <remote-name> https://github.com/<github-id>/<repo-name>.git
```

2. Push the local v2 source code to the new repository:

```
$ git push -u <remote-name> master
```

3. If you do not have a Gemfile and are running a simple rack application, copy this Gemfile into the root of your source:

```
https://github.com/sclorg/ruby-ex/blob/master/Gemfile
```



NOTE

The latest version of the **rack** gem that supports Ruby 2.0 is 1.6.4, so the Gemfile needs to be modified to **gem 'rack', "1.6.4"**.

For Ruby 2.2 or later, use the **rack** gem 2.0 or later.

4. Use the **oc** command to launch a new Ruby application from the builder image and source code:

```
$ oc new-app --strategy=source  
ruby:2.0~https://github.com/<github-id>/<repo-name>.git
```

Supported Ruby Versions

See [Supported Container Images](#).

6.3.4. PHP

1. Set up a new GitHub repository and add it as a remote branch to the current, local v2 Git repository:

```
$ git remote add <remote-name> https://github.com/<github-id>/<repo-name>
```

2. Push the local v2 source code to the new repository:

```
$ git push -u <remote-name> master
```

3. Use the **oc** command to launch a new PHP application from the builder image and source code:

```
$ oc new-app https://github.com/<github-id>/<repo-name>.git  
--name=<app-name> -e <ENV_VAR_NAME>=<env_var_value>
```

Supported PHP Versions

See [Supported Container Images](#).

6.3.5. Perl

1. Set up a new GitHub repository and add it as a remote branch to the current, local v2 Git repository:



```
$ git remote add <remote-name> https://github.com/<github-id>/<repo-name>
```

2. Push the local v2 source code to the new repository:

```
$ git push -u <remote-name> master
```

3. Edit the local Git repository and push changes upstream to make it v3 compatible:

- a. In v2, CPAN modules reside in `.openshift/cpan.txt`. In v3, the s2i builder looks for a file named `cpanfile` in the root directory of the source.

```
$ cd <local-git-repository>
$ mv .openshift/cpan.txt cpanfile
```

Edit `cpanfile`, as it has a slightly different format:

format of <code>cpanfile</code>	format of <code>cpan.txt</code>
requires 'cpan::mod';	cpan::mod
requires 'Dancer';	Dancer
requires 'YAML';	YAML

- b. Remove `.openshift` directory



NOTE

In v3, `action_hooks` and `cron` tasks are not supported in the same way. See [Action Hooks](#) for more information.

4. Use the `oc` command to launch a new Perl application from the builder image and source code:

```
$ oc new-app https://github.com/<github-id>/<repo-name>.git
```

Supported Perl Versions

See [Supported Container Images](#).

6.3.6. Node.js

1. Set up a new GitHub repository and add it as a remote branch to the current, local Git repository:

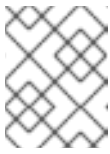
```
$ git remote add <remote-name> https://github.com/<github-id>/<repo-name>
```

2. Push the local v2 source code to the new repository:

```
$ git push -u <remote-name> master
```

3. Edit the local Git repository and push changes upstream to make it v3 compatible:

- a. Remove the `.openshift` directory.

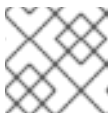


NOTE

In v3, `action_hooks` and `cron` tasks are not supported in the same way. See [Action Hooks](#) for more information.

- b. Edit `server.js`.

- L116 `server.js`: `'self.app = express();'`
- L25 `server.js`: `self.ipaddress = '0.0.0.0';`
- L26 `server.js`: `self.port = 8080;`



NOTE

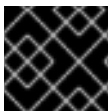
Lines(L) are from the base V2 cartridge `server.js`.

4. Use the `oc` command to launch a new Node.js application from the builder image and source code:

```
$ oc new-app https://github.com/<github-id>/<repo-name>.git
--name=<app-name> -e <ENV_VAR_NAME>=<env_var_value>
```

Supported Node.js Versions

See [Supported Container Images](#).



IMPORTANT

In OpenShift Online v3, version 0.10 is deprecated and no longer available to use.

6.3.7. WordPress

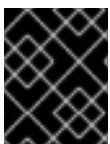


IMPORTANT

Currently, support for migrating WordPress applications is offered by the community only and not by Red Hat support.

For guidance on migrating WordPress applications to OpenShift Online v3, see the [OpenShift blog](#).

6.3.8. Ghost



IMPORTANT

Currently, support for migrating Ghost applications is offered by the community only and not by Red Hat support.

For guidance on migrating Ghost applications to OpenShift Online v3, see the [OpenShift blog](#).

6.3.9. JBoss EAP



IMPORTANT

Currently, JBoss EAP is not available for OpenShift Online Starter. It is only available for OpenShift Online Pro.

1. Set up a new GitHub repository and add it as a remote branch to the current, local Git repository:

```
$ git remote add <remote-name> https://github.com/<github-id>/<repo-name>
```

2. Push the local v2 source code to the new repository:

```
$ git push -u <remote-name> master
```

3. If the repository includes pre-built **.war** files, they need to reside in the **deployments** directory off the root directory of the repository.
4. Create the new application using the JBoss EAP 7 builder image (jboss-eap70-openshift) and the source code repository from GitHub:

```
$ oc new-app --strategy=source jboss-eap70-openshift:1.6~https://github.com/<github-id>/<repo-name>.git
```

6.3.10. JBoss WS (Tomcat)

1. Set up a new GitHub repository and add it as a remote branch to the current, local Git repository:

```
$ git remote add <remote-name> https://github.com/<github-id>/<repo-name>
```

2. Push the local v2 source code to the new repository:

```
$ git push -u <remote-name> master
```

3. If the repository includes pre-built **.war** files, they need to reside in the **deployments** directory off the root directory of the repository.
4. Create the new application using the JBoss Web Server 3 (Tomcat 7) builder image (jboss-webserver30-tomcat7) and the source code repository from GitHub:

```
$ oc new-app --strategy=source
jboss-webserver30-tomcat7-openshift~https://github.com/<github-id>/<repo-name>.git
--name=<app-name> -e <ENV_VAR_NAME>=<env_var_value>
```

6.3.11. JBoss AS (Wildfly 10)

1. Set up a new GitHub repository and add it as a remote branch to the current, local Git repository:

```
$ git remote add <remote-name> https://github.com/<github-id>/<repo-name>
```

2. Push the local v2 source code to the new repository:

```
$ git push -u <remote-name> master
```

3. Edit the local Git repository and push the changes upstream to make it v3 compatible:
 - a. Remove **.openshift** directory.

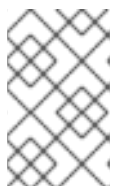


NOTE

In v3, **action_hooks** and **cron** tasks are not supported in the same way. See [Action Hooks](#) for more information.

- b. Add the **deployments** directory to the root of the source repository. Move the **.war** files to 'deployments' directory.
4. Use the **oc** command to launch a new Wildfly application from the builder image and source code:

```
$ oc new-app https://github.com/<github-id>/<repo-name>.git
--image-stream="openshift/wildfly:10.0" --name=<app-name> -e
<ENV_VAR_NAME>=<env_var_value>
```



NOTE

The argument **--name** is optional to specify the name of your application. The argument **-e** is optional to add environment variables that are needed for build and deployment processes, such as **OPENSIFT_PYTHON_DIR**.

6.3.12. Supported JBoss Versions

See [Supported Container Images](#).

6.4. QUICKSTART EXAMPLES

6.4.1. Overview

Although there is no clear-cut migration path for v2 quickstart to v3 quickstart, the following quickstarts are currently available in v3. If you have an application with a database, rather than using **oc new-app** to create your application, then **oc new-app** again to start a separate database service and linking the two with common environment variables, you can use one of the following to instantiate the linked application and database at once, from your GitHub repository containing your source code. You can list all available templates with **oc get templates -n openshift**:

- CakePHP MySQL <https://github.com/sclorg/cakephp-ex>
 - template: cakephp-mysql-example
- Node.js MongoDB <https://github.com/sclorg/nodejs-ex>
 - template: nodejs-mongodb-example
- Django PostgreSQL <https://github.com/sclorg/django-ex>

- template: django-psql-example
- Dancer MySQL <https://github.com/sclorg/dancer-ex>
 - template: dancer-mysql-example
- Rails PostgreSQL <https://github.com/sclorg/rails-ex>
 - template: rails-postgresql-example

6.4.2. Workflow

Run a **git clone** of one of the above template URLs locally. Add and commit your application source code and push a GitHub repository, then start a v3 quickstart application from one of the templates listed above:

1. Create a GitHub repository for your application.
2. Clone a quickstart template and add your GitHub repository as a remote:

```
$ git clone <one-of-the-template-URLs-listed-above>
$ cd <your local git repository>
$ git remote add upstream <https://github.com/<git-id>/<quickstart-repo>.git>
$ git push -u upstream master
```

3. Commit and push your source code to GitHub:

```
$ cd <your local repository>
$ git commit -am "added code for my app"
$ git push origin master
```

4. Create a new application in v3:

```
$ oc new-app --template=<template> \
-p SOURCE_REPOSITORY_URL=<https://github.com/<git-id>/<quickstart_repo>.git> \
-p DATABASE_USER=<your_db_user> \
-p DATABASE_NAME=<your_db_name> \
-p DATABASE_PASSWORD=<your_db_password> \
-p DATABASE_ADMIN_PASSWORD=<your_db_admin_password> 1
```

- 1** Only applicable for MongoDB.

You should now have 2 pods running, a web framework pod, and a database pod. The web framework pod environment should match the database pod environment. You can list the environment variables with **oc set env pod/<pod_name> --list**:

- **DATABASE_NAME** is now **<DB_SERVICE>_DATABASE**
- **DATABASE_USER** is now **<DB_SERVICE>_USER**
- **DATABASE_PASSWORD** is now **<DB_SERVICE>_PASSWORD**
- **DATABASE_ADMIN_PASSWORD** is now **MONGODB_ADMIN_PASSWORD** (only applicable for MongoDB)

If no **SOURCE_REPOSITORY_URL** is specified, the template will use the template URL (<https://github.com/openshift/<quickstart>-ex>) listed above as the source repository, and a **hello-welcome** application will be started.

5. If you are migrating a database, export databases to a dump file and restore the database in the new v3 database pod. Refer to the steps outlined in [Database Applications](#), skipping the **oc new-app** step as the database pod is already up and running.

6.5. CONTINUOUS INTEGRATION AND DEPLOYMENT (CI/CD)

6.5.1. Overview

This topic reviews the differences in continuous integration and deployment (CI/CD) applications between OpenShift version 2 (v2) and OpenShift version 3 (v3) and how to migrate these applications into the v3 environment.

6.5.2. Jenkins

The Jenkins applications in OpenShift version 2 (v2) and OpenShift version 3 (v3) are configured differently due to fundamental differences in architecture. For example, in v2, the application uses an integrated Git repository that is hosted in the gear to store the source code. In v3, the source code is located in a public or private Git repository that is hosted outside of the pod.

Furthermore, in OpenShift v3, Jenkins jobs can not only be triggered by source code changes, but also by changes in ImageStream, which are changes on the images that are used to build the application along with its source code. As a result, it is highly recommended that you migrate the Jenkins application manually by creating a new Jenkins application in v3, and then re-creating jobs with the configurations that are suitable to OpenShift v3 environment.

Consult these resources for more information on how to create a Jenkins application, configure jobs, and use Jenkins plug-ins properly:

- <https://github.com/openshift/origin/blob/master/examples/jenkins/README.md>
- <https://github.com/openshift/jenkins-plugin/blob/master/README.md>
- <https://github.com/openshift/origin/blob/master/examples/sample-app/README.md>

6.6. WEBHOOKS AND ACTION HOOKS

6.6.1. Overview

This topic reviews the differences in webhooks and action hooks between OpenShift version 2 (v2) and OpenShift version 3 (v3) and how to migrate these applications into the v3 environment.

6.6.2. Webhooks

1. After creating a **BuildConfig** from a GitHub repository, run:

```
$ oc describe bc/<name-of-your-BuildConfig>
```

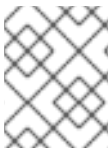
This will output a webhook GitHub URL that looks like:

```
<https://api.starter-us-east-
1.openshift.com:443/oapi/v1/namespaces/nsname/buildconfigs/bcname/webhooks/secret/github
>.
```

2. Cut and paste this URL into GitHub, from the GitHub web console.
3. In your GitHub repository, select **Add Webhook** from **Settings → Webhooks & Services**
4. Paste the URL output (similar to above) into the **Payload URL** field.
5. Set the **Content Type** to **application/json**.
6. Click **Add webhook**.

You should see a message from GitHub stating that your webhook was successfully configured.

Now, whenever you push a change to your GitHub repository, a new build will automatically start, and upon a successful build a new deployment will start.



NOTE

If you delete or recreate your application, you will have to update the **Payload URL** field in GitHub with the new **BuildConfig** webhook url.

6.6.3. Action Hooks

In OpenShift version 2 (v2), there are `build`, `deploy`, `post_deploy`, and `pre_build` scripts or `action_hooks` that are located in the `.openshift/action_hooks` directory. While there is no one-to-one mapping of function for these in v3, the [S2I tool](#) in v3 does have the option of adding [customizable scripts](#), either in a designated URL or in the `.s2i/bin` directory of your source repository.

OpenShift version 3 (v3) also offers a [post-build hook](#) for running basic testing of an image after it is built and before it is pushed to the registry. [Deployment hooks](#) are configured in the deployment configuration.

In v2, `action_hooks` are commonly used to set up environment variables. In v2, any environment variables should be passed with:

```
$ oc new-app <source-url> -e ENV_VAR=env_var
```

or:

```
$ oc new-app <template-name> -p ENV_VAR=env_var
```

Also, environment variables can be added or changed using:

```
$ oc set env dc/<name-of-dc>
ENV_VAR1=env_var1 ENV_VAR2=env_var2'
```

6.7. S2I TOOL

6.7.1. Overview

The [Source-to-Image \(S2I\) tool](#) injects application source code into a container image and the final product is a new and ready-to-run container image that incorporates the builder image and built source code. The S2I tool can be installed on your local machine without OpenShift Online from [the repository](#).

The S2I tool is a very powerful tool to test and verify your application and images locally before using them on OpenShift Online.

6.7.2. Creating a Container Image

1. Identify the builder image that is needed for the application. Red Hat offers multiple builder images for different languages including [Python](#), [Ruby](#), [Perl](#), [PHP](#), and [Node.js](#). Other images are available from [the community space](#).
2. S2I can build images from source code in a local file system or from a Git repository. To build a new container image from the builder image and the source code:

```
$ s2i build <source-location> <builder-image-name> <output-image-name>
```



NOTE

<source-location> can either be a Git repository URL or a directory to source code in a local file system.

3. Test the built image with the Docker daemon:

```
$ docker run -d --name <new-name> -p <port-number>:<port-number> <output-image-name>
$ curl localhost:<port-number>
```

6.8. SUPPORT GUIDE

6.8.1. Overview

This topic reviews supported languages, frameworks, databases, and markers for OpenShift version 2 (v2) and OpenShift version 3 (v3).

See [OpenShift Online tested integrations](#) for more information about common combinations that OpenShift Online customers are using.

6.8.2. Supported Databases

See the [Supported Databases](#) section of the Database Applications topic.

6.8.3. Supported Languages

- [PHP](#)
- [Python](#)
- [Perl](#)
- [Node.js](#)

- [Ruby](#)
- [JBoss/xPaaS](#)

6.8.4. Supported Frameworks

Table 6.1. Supported Frameworks

v2	v3
Jenkins Server	jenkins-persistent
Drupal 7	
Ghost 0.7.5	
WordPress 4	
Ceylon	
Go	
MEAN	

6.8.5. Supported Markers

Table 6.2. Python

v2	v3
pip_install	If your repository contains <i>requirements.txt</i> , then pip is invoked by default. Otherwise, pip is not used.

Table 6.3. Ruby

v2	v3
disable_asset_compilation	This can be done by setting DISABLE_ASSET_COMPILATION environment variable to true on the buildconfig strategy definition.

Table 6.4. Perl

v2	v3
----	----

v2	v3
enable_cpan_tests	This can be done by setting ENABLE_CPAN_TEST environment variable to true on the build configuration .

Table 6.5. PHP

v2	v3
use_composer	composer is always used if the source repository includes a composer.json in the root directory.

Table 6.6. Node.js

v2	v3
NODEJS_VERSION	N/A
use_npm	npm is always used to start the application, unless DEV_MODE is set to true , in which casenodemon is used instead.

Table 6.7. JBoss EAP, JBoss WS, WildFly

v2	v3
enable_debugging	This option is controlled via the ENABLE_JPDA environment variable set on the deployment configuration by setting it to any non-empty value.
skip_maven_build	If pom.xml is present, maven will be run.
java7	N/A
java8	JavaEE is using JDK8.

Table 6.8. Jenkins

v2	v3
enable_debugging	N/A

Table 6.9. All

v2	v3
force_clean_build	There is a similar concept in v3, as noCache field in buildconfig forces the container build to rerun each layer. In the S2I build, the incremental flag is false by default, which indicates a clean build .
hot_deploy	Ruby , Python , Perl , PHP , Node.js
enable_public_server_status	N/A
disable_auto_scaling	Autoscaling is off by default and it can be turn on via pod auto-scaling .

6.8.6. Supported Environment Variables

- [MySQL](#)
- [MongoDB](#)
- [PostgreSQL](#)

CHAPTER 7. TUTORIALS

7.1. OVERVIEW

This topic group includes information on how to get your application up and running in OpenShift Online and covers different languages and their frameworks.

7.2. QUICKSTART TEMPLATES

7.2.1. Overview

A quickstart is a basic example of an application running on OpenShift Online. Quickstarts come in a variety of languages and frameworks, and are defined in a [template](#), which is constructed from a set of services, build configurations, and deployment configurations. This template references the necessary images and source repositories to build and deploy the application.

To explore a quickstart, create an application from a template. Your administrator may have already installed these templates in your OpenShift Online cluster, in which case you can simply select it from the web console. See the [template](#) documentation for more information on how to upload, create from, and modify a template.

Quickstarts refer to a source repository that contains the application source code. To customize the quickstart, fork the repository and, when creating an application from the template, substitute the default source repository name with your forked repository. This results in builds that are performed using your source code instead of the provided example source. You can then update the code in your source repository and launch a new build to see the changes reflected in the deployed application.

7.2.2. Web Framework Quickstart Templates

These quickstarts provide a basic application of the indicated framework and language:

- CakePHP: a PHP web framework (includes a MySQL database)
 - [Template definition](#)
 - [Source repository](#)
- Dancer: a Perl web framework (includes a MySQL database)
 - [Template definition](#)
 - [Source repository](#)
- Django: a Python web framework (includes a PostgreSQL database)
 - [Template definition](#)
 - [Source repository](#)
- NodeJS: a NodeJS web application (includes a MongoDB database)
 - [Template definition](#)
 - [Source repository](#)

- Rails: a Ruby web framework (includes a PostgreSQL database)
 - [Template definition](#)
 - [Source repository](#)

7.3. RUBY ON RAILS

7.3.1. Overview

Ruby on Rails is a popular web framework written in [Ruby](#). This guide covers using Rails 4 on OpenShift Online.



WARNING

We strongly advise going through the whole tutorial to have an overview of all the steps necessary to run your application on the OpenShift Online. If you experience a problem try reading through the entire tutorial and then going back to your issue. It can also be useful to review your previous steps to ensure that all the steps were executed correctly.

For this guide you will need:

- Basic Ruby/Rails knowledge
- Locally installed version of Ruby 2.0.0+, Rubygems, Bundler
- Basic Git knowledge
- Provisioned account in OpenShift Online

7.3.2. Local Workstation Setup

First make sure that an instance of OpenShift Online is running and is available. Also make sure that your [oc CLI client is installed](#) and the command is accessible from your command shell, so you can use it to [log in](#) using your email address and password.

7.3.2.1. Setting Up the Database

Rails applications are almost always used with a database. For the local development we chose the PostgreSQL database. To install it type:

```
$ sudo yum install -y postgresql postgresql-server postgresql-devel
```

Next you need to initialize the database with:

```
$ sudo postgresql-setup initdb
```

This command will create the **/var/lib/pgsql/data** directory, in which the data will be stored.

Start the database by typing:

```
$ sudo systemctl start postgresql.service
```

When the database is running, create your **rails** user:

```
$ sudo -u postgres createuser -s rails
```

Note that the user we created has no password.

7.3.3. Writing Your Application

If you are starting your Rails application from scratch, you need to install the Rails gem first.

```
$ gem install rails
Successfully installed rails-4.2.0
1 gem installed
```

After you install the Rails gem create a new application, with PostgreSQL as your database:

```
$ rails new rails-app --database=postgresql
```

Then change into your new application directory.

```
$ cd rails-app
```

If you already have an application, make sure the **pg** (postgresql) gem is present in your **Gemfile**. If not edit your **Gemfile** by adding the gem:

```
gem 'pg'
```

To generate a new **Gemfile.lock** with all your dependencies run:

```
$ bundle install
```

In addition to using the **postgresql** database with the **pg** gem, you'll also need to ensure the **config/database.yml** is using the **postgresql** adapter.

Make sure you updated **default** section in the **config/database.yml** file, so it looks like this:

```
default: &default
  adapter: postgresql
  encoding: unicode
  pool: 5
  host: localhost
  username: rails
  password:
```

Create your application's development and test databases by using this **rake** command:

```
$ rake db:create
```

This will create **development** and **test** database in your PostgreSQL server.

7.3.3.1. Creating a Welcome Page

Since Rails 4 no longer serves a static **public/index.html** page in production, we need to create a new root page.

In order to have a custom welcome page we need to do following steps:

- Create a **controller** with an index action
- Create a **view** page for the **welcome** controller **index** action
- Create a **route** that will serve applications root page with the created **controller** and **view**

Rails offers a generator that will do all this necessary steps for you.

```
$ rails generate controller welcome index
```

All the necessary files have been created, now we just need to edit line 2 in **config/routes.rb** file to look like:

```
root 'welcome#index'
```

Run the rails server to verify the page is available.

```
$ rails server
```

You should see your page by visiting <http://localhost:3000> in your browser. If you don't see the page, check the logs that are output to your server to debug.

7.3.3.2. Configuring the Application for OpenShift Online

In order to have your application communicating with the PostgreSQL database service that will be running in OpenShift Online, you will need to edit the **default** section in your **config/database.yml** to use [environment variables](#), which you will define later, upon the database service creation.

The **default** section in your edited **config/database.yml** together with pre-defined variables should look like:

```
<% user = ENV.key?("POSTGRESQL_ADMIN_PASSWORD") ? "root" :
ENV["POSTGRESQL_USER"] %>
<% password = ENV.key?("POSTGRESQL_ADMIN_PASSWORD") ?
ENV["POSTGRESQL_ADMIN_PASSWORD"] : ENV["POSTGRESQL_PASSWORD"] %>
<% db_service = ENV.fetch("DATABASE_SERVICE_NAME", "").upcase %>

default: &default
  adapter: postgresql
  encoding: unicode
  # For details on connection pooling, see rails configuration guide
  # http://guides.rubyonrails.org/configuring.html#database-pooling
  pool: <%= ENV["POSTGRESQL_MAX_CONNECTIONS"] || 5 %>
  username: <%= user %>
  password: <%= password %>
```

```
host: <%= ENV["#{db_service}_SERVICE_HOST"] %>
port: <%= ENV["#{db_service}_SERVICE_PORT"] %>
database: <%= ENV["POSTGRESQL_DATABASE"] %>
```

For an example of how the final file should look, see [Ruby on Rails example application config/database.yml](#).

7.3.3.3. Storing Your Application in Git

OpenShift Online requires [git](#), if you don't have it installed you will need to install it.

Building an application in OpenShift Online usually requires that the source code be stored in a [git](#) repository, so you will need to install **git** if you do not already have it.

Make sure you are in your Rails application directory by running the **ls -1** command. The output of the command should look like:

```
$ ls -1
app
bin
config
config.ru
db
Gemfile
Gemfile.lock
lib
log
public
Rakefile
README.rdoc
test
tmp
vendor
```

Now run these commands in your Rails app directory to initialize and commit your code to git:

```
$ git init
$ git add .
$ git commit -m "initial commit"
```

Once your application is committed you need to push it to a remote repository. For this you would need a [GitHub account](#), in which you [create a new repository](#).

Set the remote that points to your **git** repository:

```
$ git remote add origin git@github.com:<namespace/repository-name>.git
```

After that, push your application to your remote git repository.

```
$ git push
```

7.3.4. Deploying Your Application to OpenShift Online

After creating the **rails-app** [project](#), you will be automatically switched to the new project namespace.

Deploying your application in OpenShift Online involves three steps:

- Creating a database [service](#) from OpenShift Online's [PostgreSQL image](#)
- Creating a frontend [service](#) from OpenShift Online's [Ruby 2.0 builder image](#) and your Ruby on Rails source code, which we wire with the database service
- Creating a route for your application.

7.3.4.1. Creating the Database Service

Your Rails application expects a running database [service](#). For this service use [PostgreSQL database image](#).

To create the database [service](#) you will use the `oc new-app` command. To this command you will need to pass some necessary [environment variables](#) which will be used inside the database container. These [environment variables](#) are required to set the username, password, and name of the database. You can change the values of these [environment variables](#) to anything you would like. The variables we are going to be setting are as follows:

- `POSTGRESQL_DATABASE`
- `POSTGRESQL_USER`
- `POSTGRESQL_PASSWORD`

Setting these variables ensures:

- A database exists with the specified name
- A user exists with the specified name
- The user can access the specified database with the specified password

For example:

```
$ oc new-app postgresql -e POSTGRESQL_DATABASE=db_name -e
POSTGRESQL_USER=username -e POSTGRESQL_PASSWORD=password
```

To also set the password for the database administrator, append to the previous command with:

```
-e POSTGRESQL_ADMIN_PASSWORD=admin_pw
```

To watch the progress of this command:

```
$ oc get pods --watch
```

7.3.4.2. Creating the Frontend Service

To bring your application to OpenShift Online, you need to specify a repository in which your application lives, using once again the `oc new-app` command, in which you will need to specify database related [environment variables](#) we setup in the [Creating the Database Service](#):

```
$ oc new-app path/to/source/code --name=rails-app -e POSTGRESQL_USER=username -e
POSTGRESQL_PASSWORD=password -e POSTGRESQL_DATABASE=db_name -e
DATABASE_SERVICE_NAME=postgresql
```

With this command, OpenShift Online fetches the source code, sets up the builder image, [builds](#) your application image, and deploys the newly created image together with the specified [environment variables](#). The application is named **rails-app**.

You can verify the environment variables have been added by viewing the JSON document of the **rails-app** [DeploymentConfig](#):

```
$ oc get dc rails-app -o json
```

You should see the following section:

```
env": [
  {
    "name": "POSTGRESQL_USER",
    "value": "username"
  },
  {
    "name": "POSTGRESQL_PASSWORD",
    "value": "password"
  },
  {
    "name": "POSTGRESQL_DATABASE",
    "value": "db_name"
  },
  {
    "name": "DATABASE_SERVICE_NAME",
    "value": "postgresql"
  }
],
```

To check the build process:

```
$ oc logs -f build rails-app-1
```

Once the build is complete, you can look at the running pods in OpenShift Online.

```
$ oc get pods
```

You should see a line starting with **myapp-<number>-<hash>**, and that is your application running in OpenShift Online.

Before your application will be functional, you need to initialize the database by running the database migration script. There are two ways you can do this:

- Manually from the running frontend container:

First you need to exec into frontend container with [rsh](#) command:

```
$ oc rsh <FRONTEND_POD_ID>
```


Run the migration from inside the container:

```
$ RAILS_ENV=production bundle exec rake db:migrate
```

If you are running your Rails application in a **development** or **test** environment you don't have to specify the **RAILS_ENV** environment variable.

- By adding pre-deployment [lifecycle hooks](#) in your template. For example check the [hooks example](#) in our [Rails example](#) application.

7.3.4.3. Creating a Route for Your Application

Expose the frontend service by typing:

```
$ oc expose service rails-app
```

7.4. SETTING UP A NEXUS MIRROR FOR MAVEN

7.4.1. Introduction

While developing your application with Java and Maven, you will most likely be building many times. In order to shorten the build times of your pods, Maven dependencies can be cached in a local Nexus repository. This tutorial will guide you through creating a Nexus repository on your cluster.

This tutorial assumes that you are working with a project that is already set up for use with Maven. If you are interested in using Maven with your Java project, it is highly recommended that you look at [their guide](#).

In addition, be sure to check your application's image for Maven mirror capabilities. Many images that use Maven have a **MAVEN_MIRROR_URL** environment variable that you can use to simplify this process. If it does not have this capability, read [the Nexus documentation](#) to configure your build properly.

Furthermore, make sure that you give each pod enough resources to function. You may have to [edit the pod template](#) in the Nexus deployment configuration to request more resources.

7.4.2. Setting up Nexus

1. Download and deploy the official Nexus container image:

```
oc new-app sonatype/nexus
```

2. Create a route by exposing the newly created Nexus service:

```
oc expose svc/nexus
```

3. Use **oc get routes** to find the pod's new external address.

```
oc get routes
```

The output should resemble:

NAME	HOST/PORT	PATH	SERVICES	PORT	TERMINATION
nexus	nexus-myproject.192.168.1.173.xip.io		nexus	8081-tcp	

- Confirm that Nexus is running by navigating your browser to the URL under **HOST/PORT**. To sign in to Nexus, the default administrator username is **admin**, and the password is **admin123**.



NOTE

Nexus comes pre-configured for the Central Repository, but you may need others for your application. For many Red Hat images, it is recommended to [add the jboss-ga repository](#) at [Maven repository](#).

7.4.2.1. Using Probes to Check for Success

This is a good time to set up [readiness and liveness probes](#). These will periodically check to see that Nexus is running properly.

```
$ oc set probe dc/nexus \
--liveness \
--failure-threshold 3 \
--initial-delay-seconds 30 \
-- echo ok
$ oc set probe dc/nexus \
--readiness \
--failure-threshold 3 \
--initial-delay-seconds 30 \
--get-url=http://:8081/nexus/content/groups/public
```

7.4.2.2. Adding Persistence to Nexus



NOTE

If you do not want persistent storage, continue to [Connecting to Nexus](#). However, your cached dependencies and any configuration customization will be lost if the pod is restarted for any reason.

Create a persistent volume claim (PVC) for Nexus, so that the cached dependencies are not lost when the pod running the server terminates. PVCs require available persistent volumes (PV) in the cluster. If there are no PVs available and you do not have administrator access on your cluster, ask your system administrator to create a Read/Write Persistent Volume for you.

Add a PVC to the Nexus deployment configuration.

```
$ oc volumes dc/nexus --add \
--name 'nexus-volume-1' \
--type 'pvc' \
--mount-path '/sonatype-work' \
--claim-name 'nexus-pv' \
--claim-size '1G' \
--overwrite
```

This removes the previous **emptyDir** volume for the deployment config and adds a claim for one gigabyte of persistent storage mounted at **/sonatype-work**, which is where the dependencies will be stored. Due to the change in configuration, the Nexus pod will be redeployed automatically.

To verify that Nexus is running, refresh the Nexus page in your browser. You can monitor the deployment's progress using:

```
$ oc get pods -w
```

7.4.3. Connecting to Nexus

The next steps demonstrate defining a build that uses the new Nexus repository. The rest of the tutorial uses [this example repository](#) with **wildfly-100-centos7** as a builder, but these changes should work for any project.

The [example builder image](#) supports **MAVEN_MIRROR_URL** as part of its environment, so we can use this to point our builder image to our Nexus repository. If your image does not support consuming an environment variable to configure a Maven mirror, you may need to modify the builder image to provide the correct Maven settings to point to the Nexus mirror.

```
$ oc new-build openshift/wildfly-100-centos7:latest~https://github.com/openshift/jee-ex.git \
-e MAVEN_MIRROR_URL='http://nexus.<Nexus_Project>:8081/nexus/content/groups/public'
$ oc logs build/jee-ex-1 --follow
```

Replace **<Nexus_Project>** with the project name of the Nexus repository. If it is in the same project as the application that is using it, you can remove the **<Nexus_Project>**. [Learn more about DNS resolution in OpenShift Online](#).

7.4.4. Confirming Success

In your web browser, navigate to **http://<NexusIP>:8081/nexus/content/groups/public** to confirm that it has stored your application's dependencies. You can also check the build logs to see if Maven is using the Nexus mirror. If successful, you should see output referencing the URL **http://nexus:8081**.

7.4.5. Additional Resources

- [Managing Volumes in OpenShift Online](#)
- [Improving Build Time of Java Builds on OpenShift Online](#)
- [Nexus Repository Documentation](#)

7.5. OPENSIFT PIPELINE BUILDS

7.5.1. Introduction

Whether you are creating a simple website or a complex web of microservices, use OpenShift Pipelines to build, test, deploy, and promote your applications on OpenShift.

In addition to standard Jenkins Pipeline Syntax, the OpenShift Jenkins image provides the OpenShift Domain Specific Language (DSL) (through the OpenShift Jenkins Client Plug-in), which aims to provide a readable, concise, comprehensive, and fluent syntax for rich interactions with an OpenShift API server, allowing for even more control over the build, deployment, and promotion of applications on your OpenShift cluster.

This example demonstrates how to create an OpenShift Pipeline that will build, deploy, and verify a **Node.js/MongoDB** application using the [nodejs-mongodb.json](#) template.

7.5.2. Creating the Jenkins Master

To create the Jenkins master, run:

```
$ oc project <project_name> 1
$ oc new-app jenkins-ephemeral 2
```

1 Select the project that you want to use or create a new project with **oc new-project <project_name>**.

2 If you want to use persistent storage, use **jenkins-persistent** instead.



NOTE

If Jenkins auto-provisioning is enabled on your cluster, and you do not need to make any customizations to the Jenkins master, you can skip the previous step.

7.5.3. The Pipeline Build Configuration

Now that the Jenkins master is up and running, create a BuildConfig that employs the Jenkins pipeline strategy to build, deploy, and scale the **Node.js/MongoDB** example application.

Create a file named **nodejs-sample-pipeline.yaml** with the following content:

```
kind: "BuildConfig"
apiVersion: "v1"
metadata:
  name: "nodejs-sample-pipeline"
spec:
  strategy:
    jenkinsPipelineStrategy:
      jenkinsfile: <pipeline content from below>
    type: JenkinsPipeline
```

For more information about configuring the Pipeline Build Strategy, see [Pipeline Strategy Options](#).

7.5.4. The Jenkinsfile

Once you create a BuildConfig with a **jenkinsPipelineStrategy**, tell the pipeline what to do by using an inline **jenkinsfile**. This example does not set up a Git repository for the application.

The following **jenkinsfile** content is written in Groovy using the OpenShift DSL. For this example, include inline content in the BuildConfig using the [YAML Literal Style](#), though including a **jenkinsfile** in your source repository is the preferred method.

The completed BuildConfig can be viewed in the OpenShift Origin repository in the examples directory, [nodejs-sample-pipeline.yaml](#).

```
def templatePath = 'https://raw.githubusercontent.com/openshift/nodejs-
ex/master/openshift/templates/nodejs-mongodb.json' 1
```

```

def templateName = 'nodejs-mongodb-example' 2
pipeline {
  agent {
    node {
      label 'nodejs' 3
    }
  }
  options {
    timeout(time: 20, unit: 'MINUTES') 4
  }
  stages {
    stage('preamble') {
      steps {
        script {
          openshift.withCluster() {
            openshift.withProject() {
              echo "Using project: ${openshift.project()}"
            }
          }
        }
      }
    }
    stage('cleanup') {
      steps {
        script {
          openshift.withCluster() {
            openshift.withProject() {
              openshift.selector("all", [ template : templateName ]).delete() 5
              if (openshift.selector("secrets", templateName).exists()) { 6
                openshift.selector("secrets", templateName).delete()
              }
            }
          }
        }
      }
    }
    stage('create') {
      steps {
        script {
          openshift.withCluster() {
            openshift.withProject() {
              openshift.newApp(templatePath) 7
            }
          }
        }
      }
    }
    stage('build') {
      steps {
        script {
          openshift.withCluster() {
            openshift.withProject() {
              def builds = openshift.selector("bc", templateName).related('builds')
              timeout(5) { 8
                builds.untilEach(1) {

```


- 10 If everything else succeeded, tag the `${templateName}:latest` image as `${templateName}-staging:latest`. A pipeline BuildConfig for the staging environment can watch for the `$`



NOTE

The previous example was written using the **declarative pipeline** style, but the older **scripted pipeline** style is also supported.

7.5.5. Creating the Pipeline

You can create the BuildConfig in your OpenShift cluster by running:

```
$ oc create -f nodejs-sample-pipeline.yaml
```

If you do not want to create your own file, you can use the sample from the Origin repository by running:

```
$ oc create -f
https://raw.githubusercontent.com/openshift/origin/master/examples/jenkins/pipeline/nodejs-sample-pipeline.yaml
```

For more information about the OpenShift DSL syntax used here, see [OpenShift Jenkins Client Plug-in](#).

7.5.6. Starting the Pipeline

Start the pipeline with the following command:

```
$ oc start-build nodejs-sample-pipeline
```



NOTE

Alternatively, you can start your pipeline with the OpenShift Web Console by navigating to the Builds → Pipeline section and clicking **Start Pipeline**, or by visiting the Jenkins Console, navigating to the Pipeline that you created, and clicking **Build Now**.

Once the pipeline is started, you should see the following actions performed within your project:

- A job instance is created on the Jenkins server.
- A slave pod is launched, if your pipeline requires one.
- The pipeline runs on the slave pod, or the master if no slave is required.
 - Any previously created resources with the **template=nodejs-mongodb-example** label will be deleted.
 - A new application, and all of its associated resources, will be created from the **nodejs-mongodb-example** template.
 - A build will be started using the **nodejs-mongodb-example** BuildConfig.
 - The pipeline will wait until the build has completed to trigger the next stage.

- A deployment will be started using the **nodejs-mongodb-example** deployment configuration.
 - The pipeline will wait until the deployment has completed to trigger the next stage.
- If the build and deploy are successful, the **nodejs-mongodb-example:latest** image will be tagged as **nodejs-mongodb-example:stage**.
- The slave pod is deleted, if one was required for the pipeline.



NOTE

The best way to visualize the pipeline execution is by viewing it in the OpenShift Web Console. You can view your pipelines by logging into the web console and navigating to Builds → Pipelines.

7.6. BINARY BUILDS

7.6.1. Introduction

The binary build feature in OpenShift allows developers to upload source or artifacts directly to a build instead of having the build pull source from a Git repository URL. Any BuildConfig with a strategy of source, Docker, or custom may be started as a binary build. When starting a build from local artifacts, the existing source reference is replaced with the source coming from the local user's machine.

The source may be supplied in several ways which correspond to arguments available when using the start-build command:

- From a file (**--from-file**): This is the case when the entire source of the build consists of a single file. For example, it may be a **Dockerfile** for a Docker build, **pom.xml** for a Wildfly build, or **Gemfile** for a Ruby build.
- From a directory (**--from-directory**): Use this when the source is in a local directory and is not committed to a Git repository. The **start-build** command will create an archive of the given directory and upload it to the builder as source.
- From an archive (**--from-archive**): Use this when an archive with the source already exists. The archive may be in either **tar**, **tar.gz**, or **zip** format.
- From a Git repository (**--from-repo**): This is for source that is currently part of a Git repository on the user's local machine. The HEAD commit of the current repository will be archived and sent to OpenShift for building.

7.6.1.1. Use Cases

Binary builds remove the requirement for a build to pull source from an existing Git repository. Reasons to use binary builds include:

- Building and testing local code changes. Source from a public repository can be cloned and local changes can be uploaded to OpenShift for building. Local changes do not have to be committed or pushed anywhere.
- Building private code. New builds can be started from scratch as binary builds. The source can then be uploaded directly from your local workstation to OpenShift without having to check it in to an SCM.

- Building images with artifacts from other sources. With Jenkins pipelines, binary builds are useful to combine artifacts built with tools such as Maven or C compiler, and runtime images that make use of those builds.

7.6.1.2. Limitations

- Binary builds are not repeatable. Because binary builds rely on the user uploading artifacts at build start, OpenShift cannot repeat the same build without the user repeating the same upload every time.
- Binary builds cannot be triggered automatically. They can only be started manually when the user uploads the required binary artifacts.



NOTE

Builds that are started as binary builds may also have a configured source URL. If that's the case, triggers will successfully launch the build but source will come from the configured source URL and not from what was supplied by the user the last time the build ran.

7.6.2. Tutorials Overview

The following tutorials assume that you have an OpenShift cluster available and that you have a project where you can create artifacts. It requires that you have both **git** and **oc** available locally.

7.6.2.1. Tutorial: Building local code changes

1. Create a new application based on an existing source repository and create a route for it:

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

2. Wait for the initial build to complete and view the application's page by navigating to the route's host. You should get a welcome page:

```
$ oc get route ruby-hello-world
```

3. Clone the repository locally:

```
$ git clone https://github.com/openshift/ruby-hello-world.git
$ cd ruby-hello-world
```

4. Make a change to the application's view. Using your favorite editor, edit **views/main.rb**: Change the **<body>** tag to **<body style="background-color:blue">**.
5. Start a new build with your locally-modified source. From the repository's local directory, run:

```
----
$ oc start-build ruby-hello-world --from-dir="." --follow
----
```

Once your build has completed and the application has redeployed, navigating to the application's route host should result in a page with a blue background.

You can keep making changes locally and building your code with **oc start-build --from-dir**.

You can also create a branch of the code, commit your changes locally, and use the repository's HEAD as the source for your build:

```
$ git checkout -b my_branch
$ git add .
$ git commit -m "My changes"
$ oc start-build ruby-hello-world --from-repo="." --follow
```

7.6.2.2. Tutorial: Building private code

1. Create a local directory to hold your code:

```
$ mkdir myapp
$ cd myapp
```

2. In the directory create a file named **Dockerfile** with the following content:

```
FROM centos:centos7

EXPOSE 8080

COPY index.html /var/run/web/index.html

CMD cd /var/run/web && python -m SimpleHTTPServer 8080
```

3. Create a file named **index.html** with the following content:

```
<html>
  <head>
    <title>My local app</title>
  </head>
  <body>
    <h1>Hello World</h1>
    <p>This is my local application</p>
  </body>
</html>
```

4. Create a new build for your application:

```
$ oc new-build --strategy docker --binary --docker-image centos:centos7 --name myapp
```

5. Start a binary build using the local directory's content:

```
$ oc start-build myapp --from-dir . --follow
```

6. Deploy the application using **new-app**, then create a route for it:

```
$ oc new-app myapp
$ oc expose svc/myapp
```

7. Get the host name for your route and navigate to it:

```
$ oc get route myapp
```

After having built and deployed your code, you can iterate by making changes to your local files and starting new builds by invoking **oc start-build myapp --from-dir**. Once built, the code will be automatically deployed and the changes will be reflected in your browser when you refresh the page.

7.6.2.3. Tutorial: Binary artifacts from pipeline

Jenkins on OpenShift allows using slave images with the appropriate tools to build your code. For example, you can use the **maven** slave to build a WAR from your code repository. However, once this artifact is built, you need to commit it to an image that contains the right runtime artifacts to run your code. A binary build may be used to add these artifacts to your runtime image. In the following tutorial, we'll create a Jenkins pipeline that makes use of the **maven** slave to build a WAR, and then uses a binary build with a **Dockerfile** to add that WAR to a wildfly runtime image.

1. Create a new directory for your application:

```
$ mkdir mavenapp
$ cd mavenapp
```

2. Create a **Dockerfile** that copies a WAR to the appropriate location inside a wildfly image for execution. Copy the following to a local file named **Dockerfile**:

```
FROM wildfly:latest
COPY ROOT.war /wildfly/standalone/deployments/ROOT.war
CMD $STI_SCRIPTS_PATH/run
```

3. Create a new BuildConfig for that Dockerfile:



NOTE

This will automatically start a build that will initially fail because the **ROOT.war** artifact is not yet available. The pipeline below will pass that WAR to the build using a binary build.

```
$ cat Dockerfile | oc new-build -D - --name mavenapp
```

4. Create a BuildConfig with the Jenkins pipeline that will build a WAR and then use that WAR to build an image using the previously created **Dockerfile**. The same pattern can be used for other platforms where a binary artifact is built by a set of tools and is then combined with a different runtime image for the final package. Save the following code to **mavenapp-pipeline.yml**:

```
apiVersion: v1
kind: BuildConfig
metadata:
  name: mavenapp-pipeline
spec:
  strategy:
    jenkinsPipelineStrategy:
      jenkinsfile: |-
        pipeline {
          agent { label "maven" }
          stages {
```

```

stage("Clone Source") {
  steps {
    checkout([$class: 'GitSCM',
              branches: [[name: '*/master']],
              extensions: [
                [$class: 'RelativeTargetDirectory', relativeTargetDir: 'mavenapp']
              ],
              userRemoteConfigs: [[url: 'https://github.com/openshift/openshift-jee-
sample.git']]
    ])
  }
}
stage("Build WAR") {
  steps {
    dir('mavenapp') {
      sh 'mvn clean package -Popenshift'
    }
  }
}
stage("Build Image") {
  steps {
    dir('mavenapp/target') {
      sh 'oc start-build mavenapp --from-dir . --follow'
    }
  }
}
}
type: JenkinsPipeline
triggers: []

```

5. Create the pipeline build. If Jenkins is not deployed to your project, creating the BuildConfig with the pipeline will result in Jenkins getting deployed. It may take a couple of minutes before Jenkins is ready to build your pipeline. You can check the status of the Jenkins rollout by invoking, **oc rollout status dc/jenkins**:

```
$ oc create -f ./mavenapp-pipeline.yml
```

6. Once Jenkins is ready, start the pipeline defined previously:

```
$ oc start-build mavenapp-pipeline
```

7. When the pipeline has finished building, deploy the new application using `new-app` and expose its route:

```
$ oc new-app mavenapp
$ oc expose svc/mavenapp
```

8. Using your browser, navigate to the route for the application:

```
$ oc get route mavenapp
```

CHAPTER 8. BUILDS

8.1. HOW BUILDS WORK

8.1.1. What Is a Build?

A *build* in OpenShift Online is the process of transforming input parameters into a resulting object. Most often, builds are used to transform source code into a runnable container image.

A *build configuration*, or **BuildConfig**, is characterized by a *build strategy* and one or more sources. The strategy determines the aforementioned process, while the sources provide its input.

The supported build strategies are:

- Source-to-Image (S2I) ([description](#), [options](#))
- Pipeline ([description](#), [options](#))

And there are six types of sources that can be given as *build input*:

- [Git](#)
- [Binary](#)
- [Image](#)
- [Input secrets](#)
- [External artifacts](#)

It is up to each build strategy to consider or ignore a certain type of source, as well as to determine how it is to be used. Binary and Git are mutually exclusive source types. Image can be used by itself or together with either Git or Binary. The Binary source type is unique from the other options in [how it is specified to the system](#).

8.1.2. What Is a BuildConfig?

A build configuration describes a single build definition and a set of [triggers](#) for when a new build should be created. Build configurations are defined by a **BuildConfig**, which is a REST object that can be used in a POST to the API server to create a new instance.

Depending on how you choose to create your application using OpenShift Online, a **BuildConfig** is typically generated automatically for you if you use the web console or CLI, and it can be edited at any time. Understanding the parts that make up a **BuildConfig** and their available options can help if you choose to manually tweak your configuration later.

The following example **BuildConfig** results in a new build every time a container image tag or the source code changes:

BuildConfig Object Definition

```
kind: "BuildConfig"
apiVersion: "v1"
metadata:
  name: "ruby-sample-build" 1
```

```

spec:
  runPolicy: "Serial" 2
  triggers: 3
  -
    type: "GitHub"
    github:
      secret: "secret101"
  - type: "Generic"
    generic:
      secret: "secret101"
  -
    type: "ImageChange"
  source: 4
  git:
    uri: "https://github.com/openshift/ruby-hello-world"
  strategy: 5
  sourceStrategy:
    from:
      kind: "ImageStreamTag"
      name: "ruby-20-centos7:latest"
  output: 6
  to:
    kind: "ImageStreamTag"
    name: "origin-ruby-sample:latest"
  postCommit: 7
  script: "bundle exec rake test"

```

- 1 This specification will create a new **BuildConfig** named **ruby-sample-build**.
- 2 The **runPolicy** field controls whether builds created from this build configuration can be run simultaneously. The default value is **Serial**, which means new builds will run sequentially, not simultaneously.
- 3 You can specify a list of [triggers](#), which cause a new build to be created.
- 4 The **source** section defines the source of the build. The source type determines the primary source of input, and can be either **Git**, to point to a code repository location, or **Binary**, to accept binary payloads. It is possible to have multiple sources at once, refer to the documentation for each source type for details.
- 5 The **strategy** section describes the build strategy used to execute the build. You can specify a **Source** strategy here. This above example uses the **ruby-20-centos7** container image that Source-To-Image will use for the application build.
- 6 After the container image is successfully built, it will be pushed into the repository described in the **output** section.
- 7 The **postCommit** section defines an optional [build hook](#).

8.2. BASIC BUILD OPERATIONS

8.2.1. Starting a Build

Manually start a new build from an existing build configuration in your current project using the following command:

```
$ oc start-build <buildconfig_name>
```

Re-run a build using the **--from-build** flag:

```
$ oc start-build --from-build=<build_name>
```

Specify the **--follow** flag to stream the build's logs in stdout:

```
$ oc start-build <buildconfig_name> --follow
```

Specify the **--env** flag to set any desired environment variable for the build:

```
$ oc start-build <buildconfig_name> --env=<key>=<value>
```

Rather than relying on a Git source pull for a build, you can also start a build by directly pushing your source, which could be the contents of a Git or SVN working directory, a set of prebuilt binary artifacts you want to deploy, or a single file. This can be done by specifying one of the following options for the **start-build** command:

Option	Description
--from-dir=<directory>	Specifies a directory that will be archived and used as a binary input for the build.
--from-file=<file>	Specifies a single file that will be the only file in the build source. The file is placed in the root of an empty directory with the same file name as the original file provided.
--from-repo=<local_source_repo>	Specifies a path to a local repository to use as the binary input for a build. Add the --commit option to control which branch, tag, or commit is used for the build.

When passing any of these options directly to the build, the contents are streamed to the build and override the current build source settings.



NOTE

Builds triggered from binary input will not preserve the source on the server, so rebuilds triggered by base image changes will use the source specified in the build configuration.

For example, the following command sends the contents of a local Git repository as an archive from the tag **v2** and starts a build:

```
$ oc start-build hello-world --from-repo=./hello-world --commit=v2
```

8.2.2. Canceling a Build

Manually cancel a build using the web console, or with the following CLI command:

```
$ oc cancel-build <build_name>
```

Cancel multiple builds at the same time:

```
$ oc cancel-build <build1_name> <build2_name> <build3_name>
```

Cancel all builds created from the build configuration:

```
$ oc cancel-build bc/<buildconfig_name>
```

Cancel all builds in a given state (for example, **new** or **pending**), ignoring the builds in other states:

```
$ oc cancel-build bc/<buildconfig_name> --state=<state>
```

8.2.3. Deleting a BuildConfig

Delete a **BuildConfig** using the following command:

```
$ oc delete bc <BuildConfigName>
```

This will also delete all builds that were instantiated from this **BuildConfig**. Specify the **--cascade=false** flag if you do not want to delete the builds:

```
$ oc delete --cascade=false bc <BuildConfigName>
```

8.2.4. Viewing Build Details

You can view build details with the web console or by using the **oc describe** CLI command:

```
$ oc describe build <build_name>
```

This displays information such as:

- The build source
- The build strategy
- The output destination
- Digest of the image in the destination registry
- How the build was created

If the build uses the **Source** strategy, the **oc describe** output also includes information about the source revision used for the build, including the commit ID, author, committer, and message.

8.2.5. Accessing Build Logs

You can access build logs using the web console or the CLI.

To stream the logs using the build directly:

```
$ oc logs -f build/<build_name>
```

To stream the logs of the latest build for a build configuration:

```
$ oc logs -f bc/<buildconfig_name>
```

To return the logs of a given version build for a build configuration:

```
$ oc logs --version=<number> bc/<buildconfig_name>
```

Log Verbosity

To enable more verbose output, pass the **BUILD_LOGLEVEL** environment variable as part of the **sourceStrategy** in a **BuildConfig**:

```
sourceStrategy:
...
env:
- name: "BUILD_LOGLEVEL"
  value: "2" 1
```

1 Adjust this value to the desired log level.



NOTE

A platform administrator can set the default build verbosity for the entire OpenShift Online instance by configuring **env/BUILD_LOGLEVEL** for the **BuildDefaults** admission controller. This default can be overridden by specifying **BUILD_LOGLEVEL** in a given **BuildConfig**. You can specify a higher priority override on the command line for non-binary builds by passing **--build-loglevel** to **oc start-build**.

Available log levels for Source builds are as follows:

Level 0	Produces output from containers running the <i>assemble</i> script and all encountered errors. This is the default.
Level 1	Produces basic information about the executed process.
Level 2	Produces very detailed information about the executed process.
Level 3	Produces very detailed information about the executed process, and a listing of the archive contents.
Level 4	Currently produces the same information as level 3.
Level 5	Produces everything mentioned on previous levels and additionally provides docker push messages.

8.3. BUILD INPUTS

8.3.1. How Build Inputs Work

A *build input* provides source content for builds to operate on. There are several ways to provide source in OpenShift Online. In order of precedence:

- [Content extracted from existing images](#)
- [Git repositories](#)
- [Binary \(Local\) inputs](#)
- [Input secrets](#)
- [External artifacts](#)



IMPORTANT

The Docker build strategy is not supported in OpenShift Online. Therefore, inline Dockerfile definitions are not accepted.

Different inputs can be combined into a single build. Binary (local) input and Git repositories are mutually exclusive inputs.

Input secrets are useful for when you do not want certain resources or credentials used during a build to be available in the final application image produced by the build, or want to consume a value that is defined in a **Secret** resource. External artifacts can be used to pull in additional files that are not available as one of the other build input types.

Whenever a build is run:

1. A working directory is constructed and all input content is placed in the working directory. For example, the input Git repository is cloned into the working directory, and files specified from input images are copied into the working directory using the target path.
2. The build process changes directories into the **contextDir**, if one is defined.
3. The content from the current directory is provided to the build process for reference by the **assemble** script. This means any input content that resides outside the **contextDir** will be ignored by the build.

The following example of a source definition includes multiple input types and an explanation of how they are combined. For more details on how each input type is defined, see the specific sections for each input type.

```
source:
  git:
    uri: https://github.com/openshift/ruby-hello-world.git 1
  images:
  - from:
    kind: ImageStreamTag
    name: myinputimage:latest
    namespace: mynamespace
  paths:
```

```
- destinationDir: app/dir/injected/dir ❷
  sourcePath: /usr/lib/somefile.jar
contextDir: "app/dir" ❸
```

- ❶ The repository to be cloned into the working directory for the build.
- ❷ `/usr/lib/somefile.jar` from `myinputimage` will be stored in `<workingdir>/app/dir/injected/dir`.
- ❸ The working directory for the build will become `<original_workingdir>/app/dir`.

8.3.2. Image Source

Additional files can be provided to the build process via images. Input images are referenced in the same way the **From** and **To** image targets are defined. This means both container images and [image stream tags](#) can be referenced. In conjunction with the image, you must provide one or more path pairs to indicate the path of the files or directories to copy the image and the destination to place them in the build context.

The source path can be any absolute path within the image specified. The destination must be a relative directory path. At build time, the image will be loaded and the indicated files and directories will be copied into the context directory of the build process. This is the same directory into which the source repository content (if any) is cloned. If the source path ends in `/`, then the content of the directory will be copied, but the directory itself will not be created at the destination.

Image inputs are specified in the **source** definition of the **BuildConfig**:

```
source:
  git:
    uri: https://github.com/openshift/ruby-hello-world.git
  images: ❶
  - from: ❷
    kind: ImageStreamTag
    name: myinputimage:latest
    namespace: mynamespace
  paths: ❸
  - destinationDir: injected/dir ❹
    sourcePath: /usr/lib/somefile.jar ❺
  - from:
    kind: ImageStreamTag
    name: myotherinputimage:latest
    namespace: myothernamespace
  pullSecret: mysecret ❻
  paths:
  - destinationDir: injected/dir
    sourcePath: /usr/lib/somefile.jar
```

- ❶ An array of one or more input images and files.
- ❷ A reference to the image containing the files to be copied.
- ❸ An array of source/destination paths.
- ❹ The directory relative to the build root where the build process can access the file.

- 5 The location of the file to be copied out of the referenced image.
- 6 An optional secret provided if credentials are needed to access the input image.

8.3.3. Git Source

When specified, source code will be fetched from the location supplied.

The source definition is part of the **spec** section in the **BuildConfig**:

```
source:
  git: 1
    uri: "https://github.com/openshift/ruby-hello-world"
    ref: "master"
  contextDir: "app/dir" 2
```

- 1 The **git** field contains the URI to the remote Git repository of the source code. Optionally, specify the **ref** field to check out a specific Git reference. A valid **ref** can be a SHA1 tag or a branch name.
- 2 The **contextDir** field allows you to override the default location inside the source code repository where the build looks for the application source code. If your application exists inside a sub-directory, you can override the default location (the root folder) using this field.

If the **ref** field denotes a pull request, the system will use a **git fetch** operation and then checkout **FETCH_HEAD**.

When no **ref** value is provided, OpenShift Online performs a shallow clone (**--depth=1**). In this case, only the files associated with the most recent commit on the default branch (typically **master**) are downloaded. This results in repositories downloading faster, but without the full commit history. To perform a full **git clone** of the default branch of a specified repository, set **ref** to the name of the default branch (for example **master**).

8.3.3.1. Using a Proxy

If your Git repository can only be accessed using a proxy, you can define the proxy to use in the **source** section of the **BuildConfig**. You can configure both a HTTP and HTTPS proxy to use. Both fields are optional. Domains for which no proxying should be performed can also be specified via the **NoProxy** field.



NOTE

Your source URI must use the HTTP or HTTPS protocol for this to work.

```
source:
  git:
    uri: "https://github.com/openshift/ruby-hello-world"
    httpProxy: http://proxy.example.com
    httpsProxy: https://proxy.example.com
    noProxy: somedomain.com, otherdomain.com
```

**NOTE**

For Pipeline strategy builds, given the current restrictions with the Git plug-in for Jenkins, any Git operations through the Git plug-in will not leverage the HTTP or HTTPS proxy defined in the **BuildConfig**. The Git plug-in only will use the proxy configured in the Jenkins UI at the Plugin Manager panel. This proxy will then be used for all git interactions within Jenkins, across all jobs. You can find instructions on how to configure proxies through the Jenkins UI at [JenkinsBehindProxy](#).

8.3.3.2. Source Clone Secrets

Builder pods require access to any Git repositories defined as source for a build. Source clone secrets are used to provide the builder pod with access it would not normally have access to, such as private repositories or repositories with self-signed or untrusted SSL certificates.

The following source clone secret configurations are supported.

- [.gitconfig File](#)
- [Basic Authentication](#)
- [SSH Key Authentication](#)
- [Trusted Certificate Authorities](#)

**NOTE**

You can also use [combinations](#) of these configurations to meet your specific needs.

Builds are run with the **builder** service account, which must have access to any source clone secrets used. Access is granted with the following command:

```
$ oc secrets link builder mysecret
```

**NOTE**

Limiting secrets to only the service accounts that reference them is disabled by default. This means that if **serviceAccountConfig.limitSecretReferences** is set to **false** (the default setting) in the master configuration file, linking secrets to a service is not required.

8.3.3.2.1. Automatically Adding a Source Clone Secret to a Build Configuration

When a **BuildConfig** is created, OpenShift Online can automatically populate its source clone secret reference. This behaviour allows the resulting **Builds** to automatically use the credentials stored in the referenced **Secret** to authenticate to a remote Git repository, without requiring further configuration.

To use this functionality, a **Secret** containing the Git repository credentials must exist in the namespace in which the **BuildConfig** will later be created. This **Secret** must additionally include one or more annotations prefixed with **build.openshift.io/source-secret-match-uri-**. The value of each of these annotations is a URI pattern, defined as follows. When a **BuildConfig** is created without a source clone secret reference and its Git source URI matches a URI pattern in a **Secret** annotation, OpenShift Online will automatically insert a reference to that **Secret** in the **BuildConfig**.

A URI pattern must consist of:

- a valid scheme (`*://`, `git://`, `http://`, `https://` or `ssh://`).
- a host (`*` or a valid hostname or IP address optionally preceded by `*`).
- a path (`/*` or `/` followed by any characters optionally including `*` characters).

In all of the above, a `*` character is interpreted as a wildcard.

IMPORTANT

URI patterns must match Git source URIs which are conformant to [RFC3986](#). Do not include a username (or password) component in a URI pattern.

For example, if you use `ssh://git@bitbucket.atlassian.com:7999/ATLASSIAN/jira.git` for a git repository URL, the source secret must be specified as `ssh://bitbucket.atlassian.com:7999/*` (and not `ssh://git@bitbucket.atlassian.com:7999/*`).

```
$ oc annotate secret mysecret \
    'build.openshift.io/source-secret-match-uri-1=ssh://bitbucket.atlassian.com:7999/*'
```

If multiple **Secrets** match the Git URI of a particular **BuildConfig**, OpenShift Online will select the secret with the longest match. This allows for basic overriding, as in the following example.

The following fragment shows two partial source clone secrets, the first matching any server in the domain **mycorp.com** accessed by HTTPS, and the second overriding access to servers **mydev1.mycorp.com** and **mydev2.mycorp.com**:

```
kind: Secret
apiVersion: v1
metadata:
  name: matches-all-corporate-servers-https-only
  annotations:
    build.openshift.io/source-secret-match-uri-1: https://*.mycorp.com/*
data:
  ...

kind: Secret
apiVersion: v1
metadata:
  name: override-for-my-dev-servers-https-only
  annotations:
    build.openshift.io/source-secret-match-uri-1: https://mydev1.mycorp.com/*
    build.openshift.io/source-secret-match-uri-2: https://mydev2.mycorp.com/*
data:
  ...
```

Add a **build.openshift.io/source-secret-match-uri-** annotation to a pre-existing secret using:

```
$ oc annotate secret mysecret \
    'build.openshift.io/source-secret-match-uri-1=https://*.mycorp.com/*'
```

8.3.3.2.2. Manually Adding Source Clone Secrets

Source clone secrets can be added manually to a build configuration by adding a **sourceSecret** field to the **source** section inside the **BuildConfig** and setting it to the name of the **secret** that you created (**basicsecret**, in this example).

```
apiVersion: "v1"
kind: "BuildConfig"
metadata:
  name: "sample-build"
spec:
  output:
    to:
      kind: "ImageStreamTag"
      name: "sample-image:latest"
  source:
    git:
      uri: "https://github.com/user/app.git"
      sourceSecret:
        name: "basicsecret"
  strategy:
    sourceStrategy:
      from:
        kind: "ImageStreamTag"
        name: "python-33-centos7:latest"
```



NOTE

You can also use the **oc set build-secret** command to set the source clone secret on an existing build configuration:

```
$ oc set build-secret --source bc/sample-build basicsecret
```

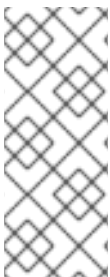
[Defining Secrets in the BuildConfig](#) provides more information on this topic.

8.3.3.2.3. .gitconfig File

If the cloning of your application is dependent on a **.gitconfig** file, then you can create a secret that contains it, and then add it to the builder service account, and then your **BuildConfig**.

To create a secret from a **.gitconfig** file:

```
$ oc create secret generic <secret_name> --from-file=<path/to/.gitconfig>
```



NOTE

SSL verification can be turned off if **sslVerify=false** is set for the **http** section in your **.gitconfig** file:

```
[http]
  sslVerify=false
```

8.3.3.2.4. .gitconfig File for Secured Git

If your Git server is secured with 2-way SSL and user name with password you must add the certificate files to your source build and add references to the certificate files in the `.gitconfig` file:

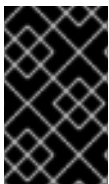
1. Add the `client.crt`, `cacert.crt`, and `client.key` files to the `/var/run/secrets/openshift.io/source/` folder in the [application source code](#).
2. In the `.gitconfig` file for the server, add the **[http]** section shown in the following example:

```
# cat .gitconfig
[user]
  name = <name>
  email = <email>
[http]
  sslVerify = false
  sslCert = /var/run/secrets/openshift.io/source/client.crt
  sslKey = /var/run/secrets/openshift.io/source/client.key
  sslCaInfo = /var/run/secrets/openshift.io/source/cacert.crt
```

3. Create the secret:

```
$ oc create secret generic <secret_name> \
  --from-literal=username=<user_name> \ 1
  --from-literal=password=<password> \ 2
  --from-file=.gitconfig=.gitconfig \
  --from-file=client.crt=/var/run/secrets/openshift.io/source/client.crt \
  --from-file=cacert.crt=/var/run/secrets/openshift.io/source/cacert.crt \
  --from-file=client.key=/var/run/secrets/openshift.io/source/client.key
```

- 1** The user's Git user name.
- 2** The password for this user.



IMPORTANT

To avoid having to enter your password again, be sure to specify the S2I image in your builds. However, if you cannot clone the repository, you still need to specify your user name and password to promote the build.

8.3.3.2.5. Basic Authentication

Basic authentication requires either a combination of `--username` and `--password`, or a **token** to authenticate against the SCM server.

Create the **secret** first before using the user name and password to access the private repository:

```
$ oc create secret generic <secret_name> \
  --from-literal=username=<user_name> \
  --from-literal=password=<password> \
  --type=kubernetes.io/basic-auth
```

To create a basic authentication secret with a token:


```
$ oc create secret generic <secret_name> \
  --from-literal=password=<token> \
  --type=kubernetes.io/basic-auth
```

8.3.3.2.6. SSH Key Authentication

SSH key based authentication requires a private SSH key.

The repository keys are usually located in the `$HOME/.ssh/` directory, and are named **id_dsa.pub**, **id_ecdsa.pub**, **id_ed25519.pub**, or **id_rsa.pub** by default. Generate SSH key credentials with the following command:

```
$ ssh-keygen -t rsa -C "your_email@example.com"
```



NOTE

Creating a passphrase for the SSH key prevents OpenShift Online from building. When prompted for a passphrase, leave it blank.

Two files are created: the public key and a corresponding private key (one of **id_dsa**, **id_ecdsa**, **id_ed25519**, or **id_rsa**). With both of these in place, consult your source control management (SCM) system's manual on how to upload the public key. The private key is used to access your private repository.

Before using the SSH key to access the private repository, create the secret first:

```
$ oc create secret generic <secret_name> \
  --from-file=ssh-privatekey=<path/to/ssh/private/key> \
  --type=kubernetes.io/ssh-auth
```

8.3.3.2.7. Trusted Certificate Authorities

The set of TLS certificate authorities that are trusted during a **git clone** operation are built into the OpenShift Online infrastructure images. If your Git server uses a self-signed certificate or one signed by an authority not trusted by the image, you can create a secret that contains the certificate or disable TLS verification.

If you create a secret for the **CA certificate**, OpenShift Online uses it to access your Git server during the **git clone** operation. Using this method is significantly more secure than disabling Git's SSL verification, which accepts any TLS certificate that is presented.

Complete one of the following processes:

- Create a secret with a CA certificate file (recommended).
 - a. If your CA uses Intermediate Certificate Authorities, combine the certificates for all CAs in a **ca.crt** file. Run the following command:

```
$ cat intermediateCA.crt intermediateCA.crt rootCA.crt > ca.crt
```

- b. Create the secret:

```
$ oc create secret generic mycert --from-file=ca.crt=</path/to/file> 1
```

1 You must use the key name **ca.crt**.

- Disable Git TLS verification.
Set the **GIT_SSL_NO_VERIFY** environment variable to **true** in the appropriate strategy section of your build configuration. You can use the **oc set env** command to manage **BuildConfig** environment variables.

8.3.3.2.8. Combinations

Below are several examples of how you can combine the above methods for creating source clone secrets for your specific needs.

- a. To create an SSH-based authentication secret with a **.gitconfig** file:

```
$ oc create secret generic <secret_name> \
  --from-file=ssh-privatekey=<path/to/ssh/private/key> \
  --from-file=<path/to/.gitconfig> \
  --type=kubernetes.io/ssh-auth
```

- b. To create a secret that combines a **.gitconfig** file and CA certificate:

```
$ oc create secret generic <secret_name> \
  --from-file=ca.crt=<path/to/certificate> \
  --from-file=<path/to/.gitconfig>
```

- c. To create a basic authentication secret with a CA certificate file:

```
$ oc create secret generic <secret_name> \
  --from-literal=username=<user_name> \
  --from-literal=password=<password> \
  --from-file=ca.crt=</path/to/file> \
  --type=kubernetes.io/basic-auth
```

- d. To create a basic authentication secret with a **.gitconfig** file:

```
$ oc create secret generic <secret_name> \
  --from-literal=username=<user_name> \
  --from-literal=password=<password> \
  --from-file=</path/to/.gitconfig> \
  --type=kubernetes.io/basic-auth
```

- e. To create a basic authentication secret with a **.gitconfig** file and CA certificate file:

```
$ oc create secret generic <secret_name> \
  --from-literal=username=<user_name> \
  --from-literal=password=<password> \
  --from-file=</path/to/.gitconfig> \
  --from-file=ca.crt=</path/to/file> \
  --type=kubernetes.io/basic-auth
```

8.3.4. Binary (Local) Source

Streaming content from a local file system to the builder is called a **Binary** type build. The corresponding value of **BuildConfig.spec.source.type** is **Binary** for such builds.

This source type is unique in that it is leveraged solely based on your use of the **oc start-build**.



NOTE

Binary type builds require content to be streamed from the local file system, so automatically triggering a binary type build (e.g. via an image change trigger) is not possible, because the binary files cannot be provided. Similarly, you cannot launch binary type builds from the web console.

To utilize binary builds, invoke **oc start-build** with one of these options:

- **--from-file**: The contents of the file you specify are sent as a binary stream to the builder. You can also specify a URL to a file. Then, the builder stores the data in a file with the same name at the top of the build context.
- **--from-dir** and **--from-repo**: The contents are archived and sent as a binary stream to the builder. Then, the builder extracts the contents of the archive within the build context directory. With **--from-dir**, you can also specify a URL to an archive, which will be extracted.
- **--from-archive**: The archive you specify is sent to the builder, where it is extracted within the build context directory. This option behaves the same as **--from-dir**; an archive is created on your host first, whenever the argument to these options is a directory.

In each of the above cases:

- If your **BuildConfig** already has a **Binary** source type defined, it will effectively be ignored and replaced by what the client sends.
- If your **BuildConfig** has a **Git** source type defined, it is dynamically disabled, since **Binary** and **Git** are mutually exclusive, and the data in the binary stream provided to the builder takes precedence.

Instead of a file name, you can pass a URL with HTTP or HTTPS schema to **--from-file** and **--from-archive**. When using **--from-file** with a URL, the name of the file in the builder image is determined by the **Content-Disposition** header sent by the web server, or the last component of the URL path if the header is not present. No form of authentication is supported and it is not possible to use custom TLS certificate or disable certificate validation.

When using **oc new-build --binary=true**, the command ensures that the restrictions associated with binary builds are enforced. The resulting **BuildConfig** will have a source type of **Binary**, meaning that the only valid way to run a build for this **BuildConfig** is to use **oc start-build** with one of the **--from** options to provide the requisite binary data.

In the case of the binary stream encapsulating extracted archive content, the value of the **contextDir** field is interpreted as a subdirectory within the archive, and, if valid, the builder changes into that subdirectory before executing the build.

8.3.5. Input Secrets

In some scenarios, build operations require credentials to access dependent resources, but it is undesirable for those credentials to be available in the final application image produced by the build. You can define *input secrets* for this purpose.

For example, when building a Node.js application, you can set up your private mirror for Node.js modules. In order to download modules from that private mirror, you have to supply a custom `.npmrc` file for the build that contains a URL, user name, and password. For security reasons, you do not want to expose your credentials in the application image.

This example describes Node.js, but you can use the same approach for adding SSL certificates into the `/etc/ssl/certs` directory, API keys or tokens, license files, and more.

8.3.5.1. Adding Input Secrets

To add an input secret to an existing **BuildConfig**:

1. Create the secret, if it does not exist:

```
$ oc create secret generic secret-npmrc \
  --from-file=.npmrc=<path/to/.npmrc>
```

This creates a new secret named `secret-npmrc`, which contains the base64 encoded content of the `~/npmrc` file.

2. Add the secret to the **source** section in the existing **BuildConfig**:

```
source:
  git:
    uri: https://github.com/openshift/nodejs-ex.git
  secrets:
    - secret:
      name: secret-npmrc
```

To include the secret in a new **BuildConfig**, run the following command:

```
$ oc new-build \
  openshift/nodejs-010-centos7~https://github.com/openshift/nodejs-ex.git \
  --build-secret secret-npmrc
```

During the build, the `.npmrc` file is copied into the directory where the source code is located. In OpenShift Online S2I builder images, this is the image working directory, which is set using the **WORKDIR** instruction in the `Dockerfile`. If you want to specify another directory, add a **destinationDir** to the secret definition:

```
source:
  git:
    uri: https://github.com/openshift/nodejs-ex.git
  secrets:
    - secret:
      name: secret-npmrc
      destinationDir: /etc
```

You can also specify the destination directory when creating a new **BuildConfig**:

```
$ oc new-build \
  openshift/nodejs-010-centos7~https://github.com/openshift/nodejs-ex.git \
  --build-secret "secret-npmrc:/etc"
```

In both cases, the `.npmrc` file is added to the `/etc` directory of the build environment.

8.3.5.2. Source-to-Image Strategy

When using a **Source** strategy, all defined input secrets are copied to their respective **destinationDir**. If you left **destinationDir** empty, then the secrets are placed in the working directory of the builder image.

The same rule is used when a **destinationDir** is a relative path; the secrets are placed in the paths that are relative to the image's working directory. The **destinationDir** must exist or an error will occur. No directory paths are created during the copy process.



NOTE

Currently, any files with these secrets are world-writable (have **0666** permissions) and will be truncated to size zero after executing the **assemble** script. This means that the secret files will exist in the resulting image, but they will be empty for security reasons.

8.3.6. Using External Artifacts

It is not recommended to store binary files in a source repository. Therefore, you may find it necessary to define a build which pulls additional files (such as Java **.jar** dependencies) during the build process. How this is done depends on the build strategy you are using.

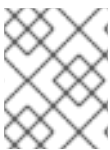
For a **Source** build strategy, you must put appropriate shell commands into the **assemble** script:

`.s2i/bin/assemble` File

```
#!/bin/sh
APP_VERSION=1.0
wget http://repository.example.com/app/app-$APP_VERSION.jar -O app.jar
```

`.s2i/bin/run` File

```
#!/bin/sh
exec java -jar app.jar
```



NOTE

For more information on how to control which **assemble** and **run** script is used by a Source build, see [Overriding Builder Image Scripts](#).

In practice, you may want to use an environment variable for the file location so that the specific file to be downloaded can be customized using an environment variable defined on the **BuildConfig**, rather than updating the **assemble** script.

You can choose between different methods of defining environment variables:

- [Using the `.s2i/environment` file](#) (only for a Source build strategy)
- [Setting in **BuildConfig**](#)
- [Providing explicitly using `oc start-build --env`](#) (only for builds that are triggered manually)

8.3.7. Using Docker Credentials for Private Registries

You can supply builds with a `.docker/config.json` file with valid credentials for private Docker registries. This allows you to push the output image into a private Docker registry or pull a builder image from the private Docker registry that requires authentication.



NOTE

For the OpenShift Online Docker registry, this is not required because secrets are generated automatically for you by OpenShift Online.

The `.docker/config.json` file is found in your home directory by default and has the following format:

```
auths:
  https://index.docker.io/v1/: 1
    auth: "YWRfbGZhcGU6R2labnRib21ifTE=" 2
    email: "user@example.com" 3
```

- 1 URL of the registry.
- 2 Encrypted password.
- 3 Email address for the login.

You can define multiple Docker registry entries in this file. Alternatively, you can also add authentication entries to this file by running the `docker login` command. The file will be created if it does not exist.

Kubernetes provides [Secret](#) objects, which can be used to store configuration and passwords.

1. Create the secret from your local `.docker/config.json` file:

```
$ oc create secret generic dockerhub \
  --from-file=.dockerconfigjson=<path/to/.docker/config.json> \
  --type=kubernetes.io/dockerconfigjson
```

This generates a JSON specification of the secret named `dockerhub` and creates the object.

2. Once the secret is created, add it to the builder service account. Each build is run with the `builder` role, so you must give it access your secret with the following command:

```
$ oc secrets link builder dockerhub
```

3. Add a `pushSecret` field into the `output` section of the `BuildConfig` and set it to the name of the `secret` that you created, which in the above example is `dockerhub`:

```
spec:
  output:
    to:
      kind: "DockerImage"
      name: "private.registry.com/org/private-image:latest"
    pushSecret:
      name: "dockerhub"
```

You can also use the **oc set build-secret** command to set the push secret on the build configuration:

```
$ oc set build-secret --push bc/sample-build dockerhub
```

4. Pull the builder container image from a private Docker registry by specifying the **pullSecret** field, which is part of the build strategy definition:

```
strategy:
  sourceStrategy:
    from:
      kind: "DockerImage"
      name: "docker.io/user/private_repository"
    pullSecret:
      name: "dockerhub"
```

You can also use the **oc set build-secret** command to set the pull secret on the build configuration:

```
$ oc set build-secret --pull bc/sample-build dockerhub
```

8.4. BUILD OUTPUT

8.4.1. Build Output Overview

Builds that use the **Source** strategy result in the creation of a new container image. The image is then pushed to the container image registry specified in the **output** section of the **Build** specification.

If the output kind is **ImageStreamTag**, then the image will be pushed to the integrated OpenShift Online registry and tagged in the specified image stream. If the output is of type **DockerImage**, then the name of the output reference will be used as a Docker push specification. The specification may contain a registry or will default to DockerHub if no registry is specified. If the output section of the build specification is empty, then the image will not be pushed at the end of the build.

Output to an ImageStreamTag

```
spec:
  output:
    to:
      kind: "ImageStreamTag"
      name: "sample-image:latest"
```

Output to a Docker Push Specification

```
spec:
  output:
    to:
      kind: "DockerImage"
      name: "my-registry.mycompany.com:5000/myimages/myimage:tag"
```

8.4.2. Output Image Environment Variables

Source strategy builds set the following environment variables on output images:

Variable	Description
OPENSIFT_BUILD_NAME	Name of the build
OPENSIFT_BUILD_NAMESPACE	Namespace of the build
OPENSIFT_BUILD_SOURCE	The source URL of the build
OPENSIFT_BUILD_REFERENCE	The Git reference used in the build
OPENSIFT_BUILD_COMMIT	Source commit used in the build

Additionally, any user-defined environment variable, for example those configured via **Source** strategy options, will also be part of the output image environment variable list.

8.4.3. Output Image Labels

Source builds set the following labels on output images:

Label	Description
io.openshift.build.commit.author	Author of the source commit used in the build
io.openshift.build.commit.date	Date of the source commit used in the build
io.openshift.build.commit.id	Hash of the source commit used in the build
io.openshift.build.commit.message	Message of the source commit used in the build
io.openshift.build.commit.ref	Branch or reference specified in the source
io.openshift.build.source-location	Source URL for the build

You can also use the **BuildConfig.spec.output.imageLabels** field to specify a list of custom labels that will be applied to each image built from the **BuildConfig**.

Custom Labels to be Applied to Built Images

```
spec:
  output:
    to:
      kind: "ImageStreamTag"
      name: "my-image:latest"
    imageLabels:
      - name: "vendor"
```



```
value: "MyCompany"
- name: "authoritative-source-url"
  value: "registry.mycompany.com"
```

8.4.4. Output Image Digest

Built images can be uniquely identified by their [digest](#), which can later be used to [pull the image by digest](#) regardless of its current tag.

Source builds store the digest in **Build.status.output.to.imageDigest** after the image is pushed to a registry. The digest is computed by the registry. Therefore, it may not always be present, for example when the registry did not return a digest, or when the builder image did not understand its format.

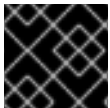
Built Image Digest After a Successful Push to the Registry

```
status:
  output:
    to:
      imageDigest:
        sha256:29f5d56d12684887bdfa50dcd29fc31eea4aaf4ad3bec43daf19026a7ce69912
```

8.4.5. Using Docker Credentials for Private Registries

To push an image to a private Docker registry, credentials can be supplied using a secret. See [Build Inputs](#) for instructions.

8.5. BUILD STRATEGY OPTIONS



IMPORTANT

The Docker build strategy is not supported in OpenShift Online.

8.5.1. Source-to-Image Strategy Options

The following options are specific to the [S2I build strategy](#).

8.5.1.1. Force Pull

By default, if the builder image specified in the build configuration is available locally on the node, that image will be used. However, to override the local image and refresh it from the registry to which the image stream points, create a **BuildConfig** with the **forcePull** flag set to **true**:

```
strategy:
  sourceStrategy:
    from:
      kind: "ImageStreamTag"
      name: "builder-image:latest" 1
    forcePull: true 2
```

1 The builder image being used, where the local version on the node may not be up to date with the version in the registry to which the image stream points.

- 2 This flag causes the local builder image to be ignored and a fresh version to be pulled from the registry to which the image stream points. Setting **forcePull** to **false** results in the default behavior

8.5.1.2. Incremental Builds

S2I can perform incremental builds, which means it reuses artifacts from previously-built images. To create an incremental build, create a **BuildConfig** with the following modification to the strategy definition:

```
strategy:
  sourceStrategy:
    from:
      kind: "ImageStreamTag"
      name: "incremental-image:latest" 1
    incremental: true 2
```

- 1 Specify an image that supports incremental builds. Consult the documentation of the builder image to determine if it supports this behavior.
- 2 This flag controls whether an incremental build is attempted. If the builder image does not support incremental builds, the build will still succeed, but you will get a log message stating the incremental build was not successful because of a missing **save-artifacts** script.



NOTE

See the [S2I Requirements](#) topic for information on how to create a builder image supporting incremental builds.

8.5.1.3. Overriding Builder Image Scripts

You can override the **assemble**, **run**, and **save-artifacts** S2I scripts provided by the builder image in one of two ways. Either:

1. Provide an **assemble**, **run**, and/or **save-artifacts** script in the **.s2i/bin** directory of your application source repository, or
2. Provide a URL of a directory containing the scripts as part of the strategy definition. For example:

```
strategy:
  sourceStrategy:
    from:
      kind: "ImageStreamTag"
      name: "builder-image:latest"
    scripts: "http://somehost.com/scripts_directory" 1
```

- 1 This path will have **run**, **assemble**, and **save-artifacts** appended to it. If any or all scripts are found they will be used in place of the same named script(s) provided in the image.



NOTE

Files located at the **scripts** URL take precedence over files located in `.s2i/bin` of the source repository. See the [S2I Requirements](#) topic and the [S2I documentation](#) for information on how S2I scripts are used.

8.5.1.4. Environment Variables

There are two ways to make environment variables available to the [source build](#) process and resulting image. [Environment files](#) and [BuildConfig environment](#) values. Variables provided will be present during the build process and in the output image.

8.5.1.4.1. Environment Files

Source build enables you to set environment values (one per line) inside your application, by specifying them in a `.s2i/environment` file in the source repository. The environment variables specified in this file are present during the build process and in the output image. The complete list of supported environment variables is available in the [documentation](#) for each image.

If you provide a `.s2i/environment` file in your source repository, S2I reads this file during the build. This allows customization of the build behavior as the `assemble` script may use these variables.

For example, if you want to disable assets compilation for your Rails application, you can add **DISABLE_ASSET_COMPILATION=true** in the `.s2i/environment` file to cause assets compilation to be skipped during the build.

In addition to builds, the specified environment variables are also available in the running application itself. For example, you can add **RAILS_ENV=development** to the `.s2i/environment` file to cause the Rails application to start in **development** mode instead of **production**.

8.5.1.4.2. BuildConfig Environment

You can add environment variables to the **sourceStrategy** definition of the **BuildConfig**. The environment variables defined there are visible during the `assemble` script execution and will be defined in the output image, making them also available to the `run` script and application code.

For example disabling assets compilation for your Rails application:

```
sourceStrategy:
...
  env:
    - name: "DISABLE_ASSET_COMPILATION"
      value: "true"
```

The [Build Environment](#) section provides more advanced instructions.

You can also manage environment variables defined in the **BuildConfig** with the `oc set env` command.

8.5.1.5. Adding Secrets via Web Console

To add a secret to your build configuration so that it can access a private repository:

1. Create a new OpenShift Online project.
2. [Create a secret](#) that contains credentials for accessing a private source code repository.

3. Create a [Source-to-Image \(S2I\) build configuration](#).
4. On the build configuration editor page or in the **create app from builder image** page of the [web console](#), set the **Source Secret**.
5. Click the **Save** button.

8.5.1.5.1. Enabling Pulling and Pushing

Enable pulling to a private registry by setting the **Pull Secret** in the build configuration and enable pushing by setting the **Push Secret**.

8.5.1.6. Ignoring Source Files

Source to image supports a **.s2iignore** file, which contains a list of file patterns that should be ignored. Files in the build working directory, as provided by the various [input sources](#), that match a pattern found in the **.s2iignore** file will not be made available to the **assemble** script.

For more details on the format of the **.s2iignore** file, see the [source-to-image documentation](#).

8.5.2. Pipeline Strategy Options

The following options are specific to the [Pipeline build strategy](#).

8.5.2.1. Providing the Jenkinsfile

You can provide the Jenkinsfile in one of two ways:

1. Embed the Jenkinsfile in the build configuration.
2. Include in the build configuration a reference to the Git repository that contains the Jenkinsfile.

Embedded Definition

```
kind: "BuildConfig"
apiVersion: "v1"
metadata:
  name: "sample-pipeline"
spec:
  strategy:
    jenkinsPipelineStrategy:
      jenkinsfile: |-
        node('agent') {
          stage 'build'
          openshiftBuild(buildConfig: 'ruby-sample-build', showBuildLogs: 'true')
          stage 'deploy'
          openshiftDeploy(deploymentConfig: 'frontend')
        }
```

Reference to Git Repository

```
kind: "BuildConfig"
apiVersion: "v1"
metadata:
```

```

name: "sample-pipeline"
spec:
  source:
    git:
      uri: "https://github.com/openshift/ruby-hello-world"
  strategy:
    jenkinsPipelineStrategy:
      jenkinsfilePath: some/repo/dir/filename 1

```

- 1** The optional **jenkinsfilePath** field specifies the name of the file to use, relative to the source **contextDir**. If **contextDir** is omitted, it defaults to the root of the repository. If **jenkinsfilePath** is omitted, it defaults to *Jenkinsfile*.

8.5.2.2. Environment Variables

To make environment variables available to the [Pipeline build](#) process, you can add environment variables to the **jenkinsPipelineStrategy** definition of the **BuildConfig**.

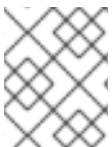
Once defined, the environment variables will be set as parameters for any Jenkins job associated with the **BuildConfig**.

For example:

```

jenkinsPipelineStrategy:
  ...
  env:
    - name: "FOO"
      value: "BAR"

```



NOTE

You can also manage environment variables defined in the **BuildConfig** with the **oc set env** command.

8.5.2.2.1. Mapping Between BuildConfig Environment Variables and Jenkins Job Parameters

When a Jenkins job is created or updated based on changes to a Pipeline strategy **BuildConfig**, any environment variables in the **BuildConfig** are mapped to Jenkins job parameters definitions, where the default values for the Jenkins job parameters definitions are the current values of the associated environment variables.

After the Jenkins job's initial creation, you can still add additional parameters to the job from the Jenkins console. The parameter names differ from the names of the environment variables in the **BuildConfig**. The parameters are honored when builds are started for those Jenkins jobs.

How you start builds for the Jenkins job dictates how the parameters are set. If you start with **oc start-build**, the values of the environment variables in the **BuildConfig** are the parameters set for the corresponding job instance. Any changes you make to the parameters' default values from the Jenkins console are ignored. The **BuildConfig** values take precedence.

If you start with **oc start-build -e**, the values for the environment variables specified in the **-e** option take precedence. And if you specify an environment variable not listed in the **BuildConfig**, they will be added as a Jenkins job parameter definitions. Also any changes you make from the Jenkins console to

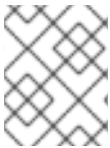
the parameters corresponding to the environment variables are ignored. The **BuildConfig** and what you specify with **oc start-build -e** takes precedence.

If you start the Jenkins job via the Jenkins console, then you can control the setting of the parameters via the Jenkins console as part of starting a build for the job.

8.6. BUILD ENVIRONMENT

8.6.1. Overview

As with pod environment variables, build environment variables can be defined in terms of references to other resources/variables using the Downward API. However, there are some exceptions as noted below.



NOTE

You can also manage environment variables defined in the **BuildConfig** with the **oc set env** command.

8.6.2. Using Build Fields as Environment Variables

You can inject information about the build object by setting the **fieldPath** environment variable source to the **JsonPath** of the field from which you are interested in obtaining the value.

```
env:
  - name: FIELDREF_ENV
    valueFrom:
      fieldRef:
        fieldPath: metadata.name
```



NOTE

Jenkins Pipeline strategy does not support **valueFrom** syntax for environment variables.

8.6.3. Using Container Resources as Environment Variables

Referencing container resources using **valueFrom** in build environment variables is not supported as the references are resolved before the container is created.

8.6.4. Using Secrets as Environment Variables

You can make key values from Secrets available as environment variables using the **valueFrom** syntax.

```
apiVersion: v1
kind: BuildConfig
metadata:
  name: secret-example-bc
spec:
  strategy:
    sourceStrategy:
      env:
        - name: MYVAL
          valueFrom:
```

```
secretKeyRef:
  key: myval
  name: mysecret
```

8.7. TRIGGERING BUILDS

8.7.1. Build Triggers Overview

When defining a **BuildConfig**, you can define triggers to control the circumstances in which the **BuildConfig** should be run. The following build triggers are available:

- [Webhook](#)
- [Image change](#)
- [Configuration change](#)

8.7.2. Webhook Triggers

Webhook triggers allow you to trigger a new build by sending a request to the OpenShift Online API endpoint. You can define these triggers using [GitHub](#), [GitLab](#), [Bitbucket](#), or Generic webhooks.

OpenShift Online webhooks currently only support their analogous versions of the push event for each of the Git based source code management systems (SCMs). All other event types are ignored.

When the push events are processed, a confirmation is made as to whether the branch reference inside the event matches the branch reference in the corresponding **BuildConfig**. If they match, then the exact commit reference noted in the webhook event is checked out for the OpenShift Online build. If they do not match, no build is triggered.



NOTE

oc new-app and **oc new-build** will create GitHub and Generic webhook triggers automatically, but any other needed webhook triggers must be added manually (see [Setting Triggers](#)).

For all webhooks, you must define a **Secret** with a key named **WebHookSecretKey** and the value being the value to be supplied when invoking the webhook. The webhook definition must then reference the secret. The secret ensures the uniqueness of the URL, preventing others from triggering the build. The value of the key will be compared to the secret provided during the webhook invocation.

For example here is a GitHub webhook with a reference to a secret named **mysecret**:

```
type: "GitHub"
github:
  secretReference:
    name: "mysecret"
```

The secret is then defined as follows. Note that the value of the secret is base64 encoded as is required for any **data** field of a **Secret** object.

```
- kind: Secret
  apiVersion: v1
```

```

metadata:
  name: mysecret
  creationTimestamp:
data:
  WebHookSecretKey: c2VjcmV0dmFsdWUx

```

8.7.2.1. GitHub Webhooks

[GitHub webhooks](#) handle the call made by GitHub when a repository is updated. When defining the trigger, you must specify a **secret**, which will be part of the URL you supply to GitHub when configuring the webhook.

Example GitHub webhook definition:

```

type: "GitHub"
github:
  secretReference:
    name: "mysecret"

```



NOTE

The secret used in the webhook trigger configuration is not the same as **secret** field you encounter when configuring webhook in GitHub UI. The former is to make the webhook URL unique and hard to predict, the latter is an optional string field used to create HMAC hex digest of the body, which is sent as an **X-Hub-Signature** header.

The payload URL is returned as the GitHub Webhook URL by the **oc describe** command (see [Displaying Webhook URLs](#)), and is structured as follows:

```

http://<openshift_api_host:port>/oapi/v1/namespaces/<namespace>/buildconfigs/<name>/webhooks/<secret>/github

```

To configure a GitHub Webhook:

1. After creating a **BuildConfig** from a GitHub repository, run:

```
$ oc describe bc/<name-of-your-BuildConfig>
```

This generates a webhook GitHub URL that looks like:

```

<https://api.starter-us-east-1.openshift.com:443/oapi/v1/namespaces/nsname/buildconfigs/bcname/webhooks/<secret>/github>.

```

2. Cut and paste this URL into GitHub, from the GitHub web console.
3. In your GitHub repository, select **Add Webhook** from **Settings → Webhooks & Services**
4. Paste the URL output (similar to above) into the **Payload URL** field.
5. Change the **Content Type** from GitHub's default **application/x-www-form-urlencoded** to **application/json**.

6. Click **Add webhook**.

You should see a message from GitHub stating that your webhook was successfully configured.

Now, whenever you push a change to your GitHub repository, a new build will automatically start, and upon a successful build a new deployment will start.



NOTE

[Gogs](#) supports the same webhook payload format as GitHub. Therefore, if you are using a Gogs server, you can define a GitHub webhook trigger on your **BuildConfig** and trigger it via your Gogs server also.

Given a file containing a valid JSON payload, such as **payload.json**, you can manually trigger the webhook via **curl**:

```
$ curl -H "X-GitHub-Event: push" -H "Content-Type: application/json" -k -X POST --data-binary
@payload.json
https://<openshift_api_host:port>/oapi/v1/namespaces/<namespace>/buildconfigs/<name>/webhooks/<secret>/github
```

The **-k** argument is only necessary if your API server does not have a properly signed certificate.

8.7.2.2. GitLab Webhooks

[GitLab webhooks](#) handle the call made by GitLab when a repository is updated. As with the GitHub triggers, you must specify a **secret**. The following example is a trigger definition YAML within the **BuildConfig**:

```
type: "GitLab"
gitlab:
  secretReference:
    name: "mysecret"
```

The payload URL is returned as the GitLab Webhook URL by the **oc describe** command (see [Displaying Webhook URLs](#)), and is structured as follows:

```
http://<openshift_api_host:port>/oapi/v1/namespaces/<namespace>/buildconfigs/<name>/webhooks/<secret>/gitlab
```

To configure a GitLab Webhook:

1. Describe the build configuration to get the webhook URL:

```
$ oc describe bc <name>
```

2. Copy the webhook URL, replacing **<secret>** with your secret value.
3. Follow the [GitLab setup instructions](#) to paste the webhook URL into your GitLab repository settings.

Given a file containing a valid JSON payload, such as **payload.json**, you can manually trigger the webhook via **curl**:

■

```
$ curl -H "X-GitLab-Event: Push Hook" -H "Content-Type: application/json" -k -X POST --data-binary
@payload.json
https://<openshift_api_host:port>/oapi/v1/namespaces/<namespace>/buildconfigs/<name>/webhooks/<secret>/gitlab
```

The **-k** argument is only necessary if your API server does not have a properly signed certificate.

8.7.2.3. Bitbucket Webhooks

[Bitbucket webhooks](#) handle the call made by Bitbucket when a repository is updated. Similar to the previous triggers, you must specify a **secret**. The following example is a trigger definition YAML within the **BuildConfig**:

```
type: "Bitbucket"
bitbucket:
  secretReference:
    name: "mysecret"
```

The payload URL is returned as the Bitbucket Webhook URL by the **oc describe** command (see [Displaying Webhook URLs](#)), and is structured as follows:

```
http://<openshift_api_host:port>/oapi/v1/namespaces/<namespace>/buildconfigs/<name>/webhooks/<secret>/bitbucket
```

To configure a Bitbucket Webhook:

1. Describe the build configuration to get the webhook URL:

```
$ oc describe bc <name>
```

2. Copy the webhook URL, replacing **<secret>** with your secret value.
3. Follow the [Bitbucket setup instructions](#) to paste the webhook URL into your Bitbucket repository settings.

Given a file containing a valid JSON payload, such as **payload.json**, you can manually trigger the webhook via **curl**:

```
$ curl -H "X-Event-Key: repo:push" -H "Content-Type: application/json" -k -X POST --data-binary
@payload.json
https://<openshift_api_host:port>/oapi/v1/namespaces/<namespace>/buildconfigs/<name>/webhooks/<secret>/bitbucket
```

The **-k** argument is only necessary if your API server does not have a properly signed certificate.

8.7.2.4. Generic Webhooks

Generic webhooks are invoked from any system capable of making a web request. As with the other webhooks, you must specify a secret, which will be part of the URL that the caller must use to trigger the build. The secret ensures the uniqueness of the URL, preventing others from triggering the build. The following is an example trigger definition YAML within the **BuildConfig**:

```
type: "Generic"
generic:
```

```
secretReference:
  name: "mysecret"
  allowEnv: true 1
```

- 1** Set to **true** to allow a generic webhook to pass in environment variables.

To set up the caller, supply the calling system with the URL of the generic webhook endpoint for your build:

```
http://<openshift_api_host:port>/oapi/v1/namespaces/<namespace>/buildconfigs/<name>/webhooks/<secret>/generic
```

The caller must invoke the webhook as a **POST** operation.

To invoke the webhook manually you can use **curl**:

```
$ curl -X POST -k
https://<openshift_api_host:port>/oapi/v1/namespaces/<namespace>/buildconfigs/<name>/webhooks/<secret>/generic
```

The HTTP verb must be set to **POST**. The insecure **-k** flag is specified to ignore certificate validation. This second flag is not necessary if your cluster has properly signed certificates.

The endpoint can accept an optional payload with the following format:

```
git:
  uri: "<url to git repository>"
  ref: "<optional git reference>"
  commit: "<commit hash identifying a specific git commit>"
  author:
    name: "<author name>"
    email: "<author e-mail>"
  committer:
    name: "<committer name>"
    email: "<committer e-mail>"
  message: "<commit message>"
env: 1
  - name: "<variable name>"
    value: "<variable value>"
```

- 1** Similar to the **BuildConfig environment** variables, the environment variables defined here are made available to your build. If these variables collide with the **BuildConfig** environment variables, these variables take precedence. By default, environment variables passed via webhook are ignored. Set the **allowEnv** field to **true** on the webhook definition to enable this behavior.

To pass this payload using **curl**, define it in a file named **payload_file.yaml** and run:

```
$ curl -H "Content-Type: application/yaml" --data-binary @payload_file.yaml -X POST -k
https://<openshift_api_host:port>/oapi/v1/namespaces/<namespace>/buildconfigs/<name>/webhooks/<secret>/generic
```

The arguments are the same as the previous example with the addition of a header and a payload. The **-H** argument sets the **Content-Type** header to **application/yaml** or **application/json** depending on your

payload format. The **--data-binary** argument is used to send a binary payload with newlines intact with the **POST** request.



NOTE

OpenShift Online permits builds to be triggered via the generic webhook even if an invalid request payload is presented (for example, invalid content type, unparsable or invalid content, and so on). This behavior is maintained for backwards compatibility. If an invalid request payload is presented, OpenShift Online returns a warning in JSON format as part of its **HTTP 200 OK** response.

8.7.2.5. Displaying Webhook URLs

Use the following command to display any webhook URLs associated with a build configuration:

```
$ oc describe bc <name>
```

If the above command does not display any webhook URLs, then no webhook trigger is defined for that build configuration. See [Setting Triggers](#) to manually add triggers.

8.7.3. Image Change Triggers

Image change triggers allow your build to be automatically invoked when a new version of an upstream image is available. For example, if a build is based on top of a RHEL image, then you can trigger that build to run any time the RHEL image changes. As a result, the application image is always running on the latest RHEL base image.

Configuring an image change trigger requires the following actions:

1. Define an **ImageStream** that points to the upstream image you want to trigger on:

```
kind: "ImageStream"
apiVersion: "v1"
metadata:
  name: "ruby-20-centos7"
```

This defines the image stream that is tied to a container image repository located at **<system-registry>/<namespace>/ruby-20-centos7**. The **<system-registry>** is defined as a service with the name **docker-registry** running in OpenShift Online.

2. If an image stream is the base image for the build, set the **from** field in the build strategy to point to the image stream:

```
strategy:
  sourceStrategy:
    from:
      kind: "ImageStreamTag"
      name: "ruby-20-centos7:latest"
```

In this case, the **sourceStrategy** definition is consuming the **latest** tag of the image stream named **ruby-20-centos7** located within this namespace.

3. Define a build with one or more triggers that point to image streams:

```

type: "imageChange" 1
imageChange: {}
type: "imageChange" 2
imageChange:
  from:
    kind: "ImageStreamTag"
    name: "custom-image:latest"

```

- 1 An image change trigger that monitors the **ImageStream** and **Tag** as defined by the build strategy's **from** field. The **imageChange** object here must be empty.
- 2 An image change trigger that monitors an arbitrary image stream. The **imageChange** part in this case must include a **from** field that references the **ImageStreamTag** to monitor.

When using an image change trigger for the strategy image stream, the generated build is supplied with an immutable Docker tag that points to the latest image corresponding to that tag. This new image reference will be used by the strategy when it executes for the build.

For other image change triggers that do not reference the strategy image stream, a new build will be started, but the build strategy will not be updated with a unique image reference.

In the example above that has an image change trigger for the strategy, the resulting build will be:

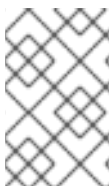
```

strategy:
  sourceStrategy:
    from:
      kind: "DockerImage"
      name: "172.30.17.3:5001/mynamespace/ruby-20-centos7:<immutableid>"

```

This ensures that the triggered build uses the new image that was just pushed to the repository, and the build can be re-run any time with the same inputs.

If a build is triggered due to a webhook trigger or manual request, the build that is created uses the **<immutableid>** resolved from the **ImageStream** referenced by the **Strategy**. This ensures that builds are performed using consistent image tags for ease of reproduction.



NOTE

Image streams that point to container images in [v1 Docker registries](#) only trigger a build once when the [image stream tag](#) becomes available and not on subsequent image updates. This is due to the lack of uniquely identifiable images in v1 Docker registries.

8.7.4. Configuration Change Triggers

A configuration change trigger allows a build to be automatically invoked as soon as a new **BuildConfig** is created. The following is an example trigger definition YAML within the **BuildConfig**:

```

type: "ConfigChange"

```

**NOTE**

Configuration change triggers currently only work when creating a new **BuildConfig**. In a future release, configuration change triggers will also be able to launch a build whenever a **BuildConfig** is updated.

8.7.4.1. Setting Triggers Manually

Triggers can be added to and removed from build configurations with **oc set triggers**. For example, to set a GitHub webhook trigger on a build configuration, use:

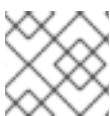
```
$ oc set triggers bc <name> --from-github
```

To set an imagechange trigger, use

```
$ oc set triggers bc <name> --from-image='<image>'
```

To remove a trigger, add **--remove**:

```
$ oc set triggers bc <name> --from-bitbucket --remove
```

**NOTE**

When a webhook trigger already exists, adding it again regenerates the webhook secret.

For more information, consult the help documentation with **oc set triggers --help**

8.8. BUILD HOOKS

8.8.1. Build Hooks Overview

Build hooks allow behavior to be injected into the build process.

The **postCommit** field of a **BuildConfig** object executes commands inside a temporary container that is running the build output image. The hook is executed immediately after the last layer of the image has been committed and before the image is pushed to a registry.

The current working directory is set to the image's **WORKDIR**, which is the default working directory of the container image. For most images, this is where the source code is located.

The hook fails if the script or command returns a non-zero exit code or if starting the temporary container fails. When the hook fails it marks the build as failed and the image is not pushed to a registry. The reason for failing can be inspected by looking at the build logs.

Build hooks can be used to run unit tests to verify the image before the build is marked complete and the image is made available in a registry. If all tests pass and the test runner returns with exit code 0, the build is marked successful. In case of any test failure, the build is marked as failed. In all cases, the build log will contain the output of the test runner, which can be used to identify failed tests.

The **postCommit** hook is not only limited to running tests, but can be used for other commands as well. Since it runs in a temporary container, changes made by the hook do not persist, meaning that the hook execution cannot affect the final image. This behavior allows for, among other uses, the installation and usage of test dependencies that are automatically discarded and will be not present in the final image.

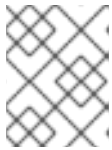
8.8.2. Configuring Post Commit Build Hooks

There are different ways to configure the post build hook. All forms in the following examples are equivalent and execute **bundle exec rake test --verbose**:

- Shell script:

```
postCommit:
  script: "bundle exec rake test --verbose"
```

The **script** value is a shell script to be run with `/bin/sh -ic`. Use this when a shell script is appropriate to execute the build hook. For example, for running unit tests as above. To control the image entry point, or if the image does not have `/bin/sh`, use **command** and/or **args**.



NOTE

The additional `-i` flag was introduced to improve the experience working with CentOS and RHEL images, and may be removed in a future release.

- Command as the image entry point:

```
postCommit:
  command: ["/bin/bash", "-c", "bundle exec rake test --verbose"]
```

In this form, **command** is the command to run, which overrides the image entry point in the exec form, as documented in the [Dockerfile reference](#). This is needed if the image does not have `/bin/sh`, or if you do not want to use a shell. In all other cases, using **script** might be more convenient.

- Pass arguments to the default entry point:

```
postCommit:
  args: ["bundle", "exec", "rake", "test", "--verbose"]
```

In this form, **args** is a list of arguments that are provided to the default entry point of the image. The image entry point must be able to handle arguments.

- Shell script with arguments:

```
postCommit:
  script: "bundle exec rake test $1"
  args: ["--verbose"]
```

Use this form if you need to pass arguments that would otherwise be hard to quote properly in the shell script. In the **script**, `$0` will be `/bin/sh` and `$1`, `$2`, etc, are the positional arguments from **args**.

- Command with arguments:

```
postCommit:
  command: ["bundle", "exec", "rake", "test"]
  args: ["--verbose"]
```

This form is equivalent to appending the arguments to **command**.

**NOTE**

Providing both **script** and **command** simultaneously creates an invalid build hook.

8.8.2.1. Using the CLI

The **oc set build-hook** command can be used to set the build hook for a build configuration.

To set a command as the post-commit build hook:

```
$ oc set build-hook bc/mybc \
  --post-commit \
  --command \
  -- bundle exec rake test --verbose
```

To set a script as the post-commit build hook:

```
$ oc set build-hook bc/mybc --post-commit --script="bundle exec rake test --verbose"
```

8.9. BUILD RUN POLICY**8.9.1. Build Run Policy Overview**

The build run policy describes the order in which the builds created from the build configuration should run. This can be done by changing the value of the **runPolicy** field in the **spec** section of the **Build** specification.

It is also possible to change the **runPolicy** value for existing build configurations.

- Changing **Parallel** to **Serial** or **SerialLatestOnly** and triggering a new build from this configuration will cause the new build to wait until all parallel builds complete as the serial build can only run alone.
- Changing **Serial** to **SerialLatestOnly** and triggering a new build will cause cancellation of all existing builds in queue, except the currently running build and the most recently created build. The newest build will execute next.

8.9.2. Serial Run Policy

Setting the **runPolicy** field to **Serial** will cause all new builds created from the **Build** configuration to be run sequentially. That means there will be only one build running at a time and every new build will wait until the previous build completes. Using this policy will result in consistent and predictable build output. This is the default **runPolicy**.

Triggering three builds from the **sample-build** configuration, using the **Serial** policy will result in:

NAME	TYPE	FROM	STATUS	STARTED	DURATION
sample-build-1	Source	Git@e79d887	Running	13 seconds ago	13s
sample-build-2	Source	Git	New		
sample-build-3	Source	Git	New		

When the **sample-build-1** build completes, the **sample-build-2** build will run:

NAME	TYPE	FROM	STATUS	STARTED	DURATION
sample-build-1	Source	Git@e79d887	Completed	43 seconds ago	34s
sample-build-2	Source	Git@1aa381b	Running	2 seconds ago	2s
sample-build-3	Source	Git	New		

8.9.3. SerialLatestOnly Run Policy

Setting the **runPolicy** field to **SerialLatestOnly** will cause all new builds created from the **Build** configuration to be run sequentially, same as using the **Serial** run policy. The difference is that when a currently running build completes, the next build that will run is the latest build created. In other words, you do not wait for the queued builds to run, as they are skipped. Skipped builds are marked as **Cancelled**. This policy can be used for fast, iterative development.

Triggering three builds from the **sample-build** configuration, using the **SerialLatestOnly** policy will result in:

NAME	TYPE	FROM	STATUS	STARTED	DURATION
sample-build-1	Source	Git@e79d887	Running	13 seconds ago	13s
sample-build-2	Source	Git	Cancelled		
sample-build-3	Source	Git	New		

The **sample-build-2** build will be canceled (skipped) and the next build run after **sample-build-1** completes will be the **sample-build-3** build:

NAME	TYPE	FROM	STATUS	STARTED	DURATION
sample-build-1	Source	Git@e79d887	Completed	43 seconds ago	34s
sample-build-2	Source	Git	Cancelled		
sample-build-3	Source	Git@1aa381b	Running	2 seconds ago	2s

8.9.4. Parallel Run Policy

Setting the **runPolicy** field to **Parallel** causes all new builds created from the **Build** configuration to be run in parallel. This can produce unpredictable results, as the first created build can complete last, which will replace the pushed container image produced by the last build which completed earlier.

Use the parallel run policy in cases where you do not care about the order in which the builds will complete.

Triggering three builds from the **sample-build** configuration, using the **Parallel** policy will result in three simultaneous builds:

NAME	TYPE	FROM	STATUS	STARTED	DURATION
sample-build-1	Source	Git@e79d887	Running	13 seconds ago	13s
sample-build-2	Source	Git@a76d881	Running	15 seconds ago	3s
sample-build-3	Source	Git@689d111	Running	17 seconds ago	3s

The completion order is not guaranteed:

NAME	TYPE	FROM	STATUS	STARTED	DURATION
sample-build-1	Source	Git@e79d887	Running	13 seconds ago	13s
sample-build-2	Source	Git@a76d881	Running	15 seconds ago	3s
sample-build-3	Source	Git@689d111	Completed	17 seconds ago	5s

8.10. ADVANCED BUILD OPERATIONS

8.10.1. Setting Build Resources

By default, builds are completed by pods using unbound resources, such as memory and CPU. These resources can be limited by specifying resource limits in a project's default container limits.

You can also limit resource use by specifying resource limits as part of the build configuration. In the following example, each of the **resources**, **cpu**, and **memory** parameters are optional:

```
apiVersion: "v1"
kind: "BuildConfig"
metadata:
  name: "sample-build"
spec:
  resources:
    limits:
      cpu: "100m" 1
      memory: "256Mi" 2
```

1 **cpu** is in CPU units: **100m** represents 0.1 CPU units ($100 * 1e-3$).

2 **memory** is in bytes: **256Mi** represents 268435456 bytes ($256 * 2^{20}$).

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**:

```
resources:
  requests: 1
    cpu: "100m"
    memory: "256Mi"
```

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 build process.

Otherwise, build pod creation will fail, citing a failure to satisfy quota.

8.10.2. Setting Maximum Duration

When defining a **BuildConfig**, you can define its maximum duration by setting the **completionDeadlineSeconds** field. It is specified in seconds and is not set by default. When not set, there is no maximum duration enforced.

The maximum duration is counted from the time when a build pod gets scheduled in the system, and defines how long it can be active, including the time needed to pull the builder image. After reaching the specified timeout, the build is terminated by OpenShift Online.

The following example shows the part of a **BuildConfig** specifying **completionDeadlineSeconds** field for 30 minutes:

```
spec:
  completionDeadlineSeconds: 1800
```



NOTE

This setting is not supported with the Pipeline Strategy option.

8.10.3. Assigning Builds to Specific Nodes

Builds can be targeted to run on specific nodes by specifying labels in the **nodeSelector** field of a build configuration. The **nodeSelector** value is a set of key/value pairs that are matched to **node** labels when scheduling the build pod.

```
apiVersion: "v1"
kind: "BuildConfig"
metadata:
  name: "sample-build"
spec:
  nodeSelector: ❶
    key1: value1
    key2: value2
```

- ❶ Builds associated with this build configuration will run only on nodes with the **key1=value1** and **key2=value2** labels.

The **nodeSelector** value can also be controlled by cluster-wide default and override values. Defaults will only be applied if the build configuration does not define any key/value pairs for the **nodeSelector** and also does not define an explicitly empty map value of **nodeSelector: {}**. Override values will replace values in the build configuration on a key by key basis.



NOTE

If the specified **NodeSelector** cannot be matched to a node with those labels, the build still stay in the **Pending** state indefinitely.

8.10.4. Chaining Builds

For compiled languages (Go, C, C++, Java, etc.), including the dependencies necessary for compilation in the application image might increase the size of the image or introduce vulnerabilities that can be exploited.

To avoid these problems, two builds can be chained together: one that produces the compiled artifact, and a second build that places that artifact in a separate image that runs the artifact.

8.10.5. Build Pruning

By default, builds that have completed their lifecycle are persisted indefinitely. You can limit the number of previous builds that are retained by supplying a positive integer value for **successfulBuildsHistoryLimit** or **failedBuildsHistoryLimit** as shown in the following sample build configuration.

```
apiVersion: "v1"
```

```
kind: "BuildConfig"
metadata:
  name: "sample-build"
spec:
  successfulBuildsHistoryLimit: 2 1
  failedBuildsHistoryLimit: 2 2
```

- 1** **successfulBuildsHistoryLimit** will retain up to two builds with a status of **completed**.
- 2** **failedBuildsHistoryLimit** will retain up to two builds with a status of **failed**, **cancelled**, or **error**.

Build pruning is triggered by the following actions:

- Updating a build configuration.
- A build completes its lifecycle.

Builds are sorted by their creation timestamp with the oldest builds being pruned first.

8.11. BUILD TROUBLESHOOTING

8.11.1. Requested Access to Resources Denied

Issue

A build fails with:

```
requested access to the resource is denied
```

Resolution

You have exceeded one of the [image quotas](#) set on your project. Check your current quota and verify the limits applied and storage in use:

```
$ oc describe quota
```

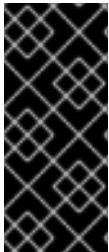
CHAPTER 9. DEPLOYMENTS

9.1. HOW DEPLOYMENTS WORK

9.1.1. What Is a Deployment?

OpenShift Online deployments provide fine-grained management over common user applications. They are described using three separate API objects:

- A deployment configuration, which describes the desired state of a particular component of the application as a pod template.
- One or more replication controllers, which contain a point-in-time record of the state of a deployment configuration as a pod template.
- One or more pods, which represent an instance of a particular version of an application.



IMPORTANT

Users do not need to manipulate replication controllers or pods owned by deployment configurations. The deployment system ensures changes to deployment configurations are propagated appropriately. If the existing deployment strategies are not suited for your use case and you have the need to run manual steps during the lifecycle of your deployment, then you should consider creating a [custom strategy](#).

When you create a deployment configuration, a replication controller is created representing the deployment configuration's pod template. If the deployment configuration 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 replication controller.

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.

Features provided by the deployment system:

- A [deployment configuration](#), which is a template for running applications.
- [Triggers](#) that drive automated deployments in response to events.
- User-customizable [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](#) for executing custom behavior in different points during the lifecycle of a deployment.
- Versioning of your application in order to support [rollbacks](#) either manually or automatically in case of deployment failure.
- Manual replication [scaling](#) and [autoscaling](#).

9.1.2. Creating a Deployment Configuration

Deployment configurations are **deploymentConfig** OpenShift Online API resources which can be managed with the **oc** command like any other resource. The following is an example of a **deploymentConfig** resource:

```
kind: "DeploymentConfig"
apiVersion: "v1"
metadata:
  name: "frontend"
spec:
  template: 1
  metadata:
    labels:
      name: "frontend"
  spec:
    containers:
      - name: "helloworld"
        image: "openshift/origin-ruby-sample"
        ports:
          - containerPort: 8080
            protocol: "TCP"
  replicas: 5 2
  triggers:
    - type: "ConfigChange" 3
    - type: "ImageChange" 4
    imageChangeParams:
      automatic: true
      containerNames:
        - "helloworld"
      from:
        kind: "ImageStreamTag"
        name: "origin-ruby-sample:latest"
  strategy: 5
  type: "Rolling"
  paused: false 6
  revisionHistoryLimit: 2 7
  minReadySeconds: 0 8
```

- 1 The pod template of the **frontend** deployment configuration describes a simple Ruby application.
- 2 There will be 5 replicas of **frontend**.
- 3 A [configuration change trigger](#) causes a new replication controller to be created any time the pod template changes.
- 4 An [image change trigger](#) trigger causes a new replication controller to be created each time a new version of the **origin-ruby-sample:latest** image stream tag is available.
- 5 The [Rolling strategy](#) is the default way of deploying your pods. May be omitted.
- 6 Pause a deployment configuration. This disables the functionality of all triggers and allows for multiple changes on the pod template before actually rolling it out.
- 7 Revision history limit is the limit of old replication controllers you want to keep around for rolling back. May be omitted. If omitted, old replication controllers will not be cleaned up.

- 8 Minimum seconds to wait (after the readiness checks succeed) for a pod to be considered available. The default value is 0.

9.2. BASIC DEPLOYMENT OPERATIONS

9.2.1. Starting a Deployment

You can start a new deployment process manually using the web console, or from the CLI:

```
$ oc rollout latest dc/<name>
```



NOTE

If a deployment process is already in progress, the command will display a message and a new replication controller will not be deployed.

9.2.2. Viewing a Deployment

To get basic information about all the available revisions of your application:

```
$ oc rollout history dc/<name>
```

This will show details about all recently created replication controllers for the provided deployment configuration, including any currently running deployment process.

You can view details specific to a revision by using the **--revision** flag:

```
$ oc rollout history dc/<name> --revision=1
```

For more detailed information about a deployment configuration and its latest revision:

```
$ oc describe dc <name>
```



NOTE

The [web console](#) shows deployments in the **Browse** tab.

9.2.3. 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.

To rollback to the last successful deployed revision of your configuration:

```
$ oc rollout undo dc/<name>
```

The deployment configuration's template will be reverted to match the deployment revision specified in the undo command, and a new replication controller will be started. If no revision is specified with **--to-revision**, then the last successfully deployed revision will be used.

Image change triggers on the deployment configuration 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 configurations 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.

9.2.4. 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.

Add the **command** parameters to the **spec** field of the deployment configuration. 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'
  ...
```

9.2.5. Viewing Deployment Logs

To stream the logs of the latest revision for a given deployment configuration:

```
$ oc logs -f dc/<name>
```

If the latest revision is running or failed, **oc logs** will return the logs of the process that is responsible for deploying your pods. If it is successful, **oc logs** will return the logs from a pod of your application.

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>
```

For more options on retrieving logs see:

```
$ oc logs --help
```

9.2.6. Setting Deployment Triggers

A deployment configuration 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 deployment configuration, a **ConfigChange** trigger is added by default. If triggers are defined as an empty field, deployments must be [started manually](#).

9.2.6.1. Configuration Change Trigger

The **ConfigChange** trigger results in a new replication controller whenever changes are detected in the pod template of the deployment configuration.



NOTE

If a **ConfigChange** trigger is defined on a deployment configuration, the first replication controller will be automatically created soon after the deployment configuration itself is created and it is not paused.

Example 9.1. A ConfigChange Trigger

```
triggers:
- type: "ConfigChange"
```

9.2.6.2. ImageChange Trigger

The **ImageChange** 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).

Example 9.2. An ImageChange 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 deployment configuration's **helloworld** container, a new replication controller is created using the new image for the **helloworld** container.



NOTE

If an **ImageChange** trigger is defined on a deployment configuration (with a **ConfigChange** trigger and **automatic=false**, or with **automatic=true**) and the **ImageStreamTag** pointed by the **ImageChange** trigger does not exist yet, then the initial deployment process will automatically start as soon as an image is imported or pushed by a build to the **ImageStreamTag**.

9.2.6.2.1. Using the Command Line

The **oc set triggers** command can be used to set a deployment trigger for a deployment configuration. For the example above, you can set the **ImageChangeTrigger** by using the following command:

```
$ oc set triggers dc/frontend --from-image=myproject/origin-ruby-sample:latest -c helloworld
```

For more information, see:

```
$ oc set triggers --help
```

9.2.7. Setting Deployment Resources

A deployment is completed by a pod that consumes resources (memory and CPU) 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.

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.

In the following example, each of **resources**, **cpu**, and **memory** is optional:

```

type: "Recreate"
resources:
  limits:
    cpu: "100m" 1
    memory: "256Mi" 2

```

- 1** **cpu** is in CPU units: **100m** represents 0.1 CPU units ($100 * 1e-3$).
- 2** **memory** is in bytes: **256Mi** represents 268435456 bytes ($256 * 2^{20}$).

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"

```

- 1** The **requests** object contains the list of resources that correspond to the list of resources in the quota.

See [Quotas and Limit Ranges](#) to learn more about compute resources and the differences between requests and limits.

- A limit range defined in your project, where the defaults from the **LimitRange** object apply to pods created during the deployment process.

Otherwise, deploy pod creation will fail, citing a failure to satisfy quota.

9.2.8. Manual Scaling

In addition to rollbacks, you can exercise fine-grained control over the number of replicas from the web console, or by using the **oc scale** command. For example, the following command sets the replicas in the deployment configuration **frontend** 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 deployment configuration **frontend**.



NOTE

Pods can also be autoscaled using the **oc autoscale** command. See [Pod Autoscaling](#) for more details.

9.3. DEPLOYMENT STRATEGIES

9.3.1. What Are 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.

The most common strategy is to use a [blue-green deployment](#). The new version (the blue version) is brought up for testing and evaluation, while the users still use the stable version (the green version). When ready, the users are switched to the blue version. If a problem arises, you can switch back to the green 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 may need to be scaled.

There are things to consider when choosing a deployment strategy.

- Long running connections need to be handled gracefully.
- Database conversions can get tricky and will need to be done and rolled back along with the application.
- If the application is a hybrid of microservices and traditional components downtime may be needed to complete the transition.
- You need the infrastructure to do this.
- If you have a non-isolated test environment, you can break both new and old versions.

Since the end user usually accesses the application through a route handled by a router, the deployment strategy can focus on deployment configuration features or routing features.

Strategies that focus on the deployment configuration impact all routes that use the application. Strategies that use router features target individual routes.

Many deployment strategies are supported through the deployment configuration and some additional strategies are supported through router features. The deployment configuration-based strategies are discussed in this section.

- [Rolling Strategy](#) and Canary Deployments
- [Recreate Strategy](#)
- [Custom Strategy](#)
- [Blue-Green Deployment](#) using routes
- [A/B Deployment](#) and canary deployments using routes
- [One Service, Multiple Deployment Configurations](#)

The [Rolling strategy](#) is the default strategy used if no strategy is specified on a deployment configuration.

A deployment strategy uses [readiness checks](#) to determine if a new pod is ready for use. If a readiness check fails, the deployment configuration will retry to run the pod until it times out. The default timeout is **10m**, a value set in **TimeoutSeconds** in **dc.spec.strategy.*params**.

9.3.2. Rolling Strategy

A rolling deployment slowly replaces instances of the previous version of an application with instances of the new version of the application. 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.

9.3.2.1. Canary Deployments

All rolling deployments in OpenShift Online 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 deployment configuration will be automatically rolled back. The readiness check is part of the application code, and may be as sophisticated as necessary to ensure the new instance is ready to be used. If you need to 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.

9.3.2.2. 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](#).

The following is an example of the Rolling strategy:

```
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 will:

1. Execute any **pre** lifecycle hook.
2. Scale up the new replication controller based on the surge count.
3. Scale down the old replication controller based on the max unavailable count.
4. Repeat this scaling until the new replication controller has reached the desired replica count and the old replication controller has been scaled to zero.
5. Execute 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 need to take into account resource quota and can accept partial unavailability, use **maxUnavailable**.

9.3.2.3. Rolling Example

Rolling deployments are the default in OpenShift Online. To see a rolling update, follow these steps:

1. Create an application based on the example deployment images found in [DockerHub](#):

```
$ oc new-app openshift/deployment-example
```

If you have the router installed, make the application available via a route (or use the service IP directly)

```
$ oc expose svc/deployment-example
```

- Browse to the application at **deployment-example.<project>.<router_domain>** to verify you see the **v1** image.
- 2. Scale the deployment configuration up to three replicas:


```
$ oc scale dc/deployment-example --replicas=3
```
- 3. 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
```
- 4. In your browser, refresh the page until you see the **v2** image.
- 5. If you are using the CLI, the following command will show you how many pods are on version 1 and how many are on version 2. In the web console, you should see the pods slowly being added to v2 and removed from v1.

```
$ oc describe dc deployment-example
```

During the deployment process, the new replication controller is incrementally scaled up. Once the new pods are marked as **ready** (by passing their readiness check), the deployment process will continue. If the pods do not become ready, the process will abort, and the deployment configuration will be rolled back to its previous version.

9.3.3. Recreate Strategy

The Recreate strategy has basic rollout behavior and supports [lifecycle hooks](#) for injecting code into the deployment process.

The following is an example of the Recreate strategy:

```
strategy:
  type: Recreate
  recreateParams: ①
  pre: {} ②
  mid: {}
  post: {}
```

① **recreateParams** are optional.

② **pre**, **mid**, and **post** are [lifecycle hooks](#).

The Recreate strategy will:

1. Execute any **pre** lifecycle hook.
2. Scale down the previous deployment to zero.
3. Execute any **mid** lifecycle hook.
4. Scale up the new deployment.

- Execute 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.

9.3.3.1. 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.

9.3.4. Custom Strategy

The Custom strategy allows you to provide your own deployment behavior.

The following is an example of the Custom strategy:

```
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 Online provides the following environment variables to the deployment process:

Environment Variable	Description
OPENSIFT_DEPLOYMENT_NAME	The name of the new deployment (a replication controller).
OPENSIFT_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.

Learn more about [advanced deployment strategies](#).

Alternatively, use **customParams** 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, but the default OpenShift Online deployer image will be used instead:

```
strategy:
  type: Rolling
  customParams:
    command:
      - /bin/sh
      - -c
      - |
        set -e
        openshift-deploy --until=50%
        echo Halfway there
        openshift-deploy
        echo Complete
```

This will result 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 Online API or the Kubernetes API the container that executes the strategy can use the service account token available inside the container for authentication.

9.3.5. Lifecycle Hooks

The [Recreate](#) and [Rolling](#) strategies support lifecycle hooks, which allow behavior to be injected into the deployment process at predefined points within the strategy:

The following is an example of a **pre** lifecycle hook:

```
pre:
  failurePolicy: Abort
  execNewPod: {} 1
```

1 **execNewPod** is a [pod-based lifecycle hook](#).

Every hook has a **failurePolicy**, 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.

9.3.5.1. Pod-based Lifecycle Hook

Pod-based lifecycle hooks execute hook code in a new pod derived from the template in a deployment configuration.

The following simplified example deployment configuration 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 will have the following properties:

- The hook command will be **/usr/bin/command arg1 arg2**.
- The hook container will have the **CUSTOM_VAR1=custom_value1** environment variable.
- The hook failure policy is **Abort**, meaning the deployment process will fail if the hook fails.
- The hook pod will inherit the **data** volume from the deployment configuration pod.

9.3.5.2. Using the Command Line

The **oc set deployment-hook** command can be used to set the deployment hook for a deployment configuration. For the example above, you can set the pre-deployment hook with the following command:

```
$ oc set deployment-hook dc/frontend --pre -c helloworld -e CUSTOM_VAR1=custom_value1 \
-v data --failure-policy=abort -- /usr/bin/command arg1 arg2
```

9.4. ADVANCED DEPLOYMENT STRATEGIES

9.4.1. Advanced Deployment Strategies

[Deployment strategies](#) provide a way for the application to evolve. Some strategies use the [deployment configuration](#) to make changes that are seen by users of all routes that resolve to the application. Other strategies, such as the ones described here, use router features to impact specific routes.

9.4.2. Blue-Green Deployment

Blue-green deployments involve running two versions of an application at the same time and moving traffic from the in-production version (the green version) to the newer version (the blue version). You can use a [rolling strategy](#) or switch services in a route.



NOTE

Since many applications depend on persistent data, you will need to have an application that supports [N-1 compatibility](#), which means you share data and implement live migration between your database, store, or disk by creating two copies of your 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.

9.4.2.1. Using a Blue-Green Deployment

Blue-Green deployments use two deployment configurations. Both are running, and the one in production depends on the service the route specifies, with each deployment configuration exposed to a

different service. 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, blue, version is live.

If necessary, you can roll back to the older, green, version by switching service back to the previous version.

Using a Route and Two Services

This example sets up two deployment configurations; one for the stable version (the green version) and the other for the newer version (the blue version).

A route points to a service, and can be changed to point to a different service at any time. As a developer, you can test the new version of your code by connecting to the new service before your production traffic is routed to it.

Routes are intended for web (HTTP and HTTPS) traffic, so this technique is best suited for web applications.

1. Create two copies of the example application:

```
$ oc new-app openshift/deployment-example:v1 --name=example-green
$ oc new-app openshift/deployment-example:v2 --name=example-blue
```

This creates two independent application components: one running the **v1** image under the **example-green** service, and one using the **v2** image under the **example-blue** service.

2. Create a route that points to the old service:

```
$ oc expose svc/example-green --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-blue**:

```
$ oc patch route/bluegreen-example -p '{"spec":{"to":{"name":"example-blue"}}}'
```

5. To verify that the route has changed, refresh the browser until you see the **v2** image.

9.4.3. A/B Deployment

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. Since 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 may need 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 need to 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 need [N-1 compatibility](#) to properly work together.

OpenShift Online supports N-1 compatibility through the web console as well as the command line interface.

9.4.3.1. 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**, no new requests go to the service, however existing connections remain active. 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 desired. In this case, reduce the number of pods to get the desired load balance **weight**. See the [Alternate Backends and Weights](#) section for more information.

The web console allows users to set the weighting and show balance between them:

The screenshot displays the OpenShift web console interface. At the top, the 'OPENSIFT' logo is visible on the left, and a user profile 'developer' is on the right. The main header shows 'Load balancing A/B testing' with a dropdown arrow and 'Add to Project' on the right. A sidebar on the left contains navigation icons for various system components.

The main content area shows a 'REPLICATION CONTROLLER' for 'frontend'. Below this, it indicates the 'CONTAINER: RUBY-HELLOWORLD' with 'Image: openshift/ruby-hello-world' and 'Ports: 8080/TCP'. A large circular gauge displays '3 pods'.

The 'Networking' section is divided into two columns: 'SERVICE Internal Traffic' and 'ROUTES External Traffic'.
 - The first service, 'ab-service-1', has internal traffic on '5432/TCP → 8080'. The corresponding route is 'http://ab.example.com', which is a 'Route ab-route' using a 'Traffic Split'. The split shows 'ab-service-1' at 70% (represented by a blue bar) and 'ab-service-2' at 30% (represented by a grey bar).
 - The second service, 'ab-service-2', also has internal traffic on '5432/TCP → 8080'. The corresponding route is 'http://ab.example.com', which is a 'Route ab-route' using a 'Traffic Split'. The split shows 'ab-service-2' at 30% (represented by a blue bar) and 'ab-service-1' at 70% (represented by a grey bar).

To set up the A/B environment:

1. Create the two applications and give them different names. Each creates a deployment configuration. The applications are versions of the same program; one is usually the current production version and the other the proposed new version:

```
$ oc new-app openshift/deployment-example1 --name=ab-example-a
$ oc new-app openshift/deployment-example2 --name=ab-example-b
```

2. Expose the deployment configuration to create a service:

```
$ oc expose dc/ab-example-a --name=ab-example-A
$ oc expose dc/ab-example-b --name=ab-example-B
```

At this point both applications are deployed and are running and have services.

3. Make the application available externally via a route. You can expose either service at this point, it may be convenient to expose the current production version and latter modify the route to add the new version.

```
$ oc expose svc/ab-example-A
```

Browse to the application at **ab-example.<project>.<router_domain>** to verify that you see the desired version.

4. When you deploy the route, the router will [balance 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** will bring the A/B setup to life. This can be done by the **oc set route-backends** command or by editing the route.



NOTE

Changes to the route just change the portion of traffic to the various services. You may need to scale the deployment configurations to adjust the number of pods to handle the anticipated loads.

To edit the route, run:

```
$ oc edit route <route-name>
...
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
```

```
...
```

9.4.3.1.1. Managing Weights Using the Web Console

1. Navigate to the Route details page (Applications/Routes).
2. Select **Edit** from the Actions menu.
3. Check **Split traffic across multiple services**
4. The **Service Weights** slider sets the percentage of traffic sent to each service.

Edit Route nodejs-ex

Hostname

Public hostname for the route. If not specified, a hostname is generated.

The hostname can't be changed after the route is created.

Path

Path that the router watches to route traffic to the service.

*** Service**

Service to route to.

Target Port

Target port for traffic.

Alternate Services

Split traffic across multiple services

Routes can direct traffic to multiple services for A/B testing. Each service has a weight controlling how much traffic it gets.

*** Service**

Alternate service for route traffic.

[Remove Service](#)

Service Weights

nodejs-ex 25% 75% mongodb

Percentage of traffic sent to each service. Drag the slider to adjust the values or [edit weights as integers](#).

For traffic split between more than two services, the relative weights are specified by integers between 0 and 256 for each service.

Edit Route nodejs-ex

Hostname

Public hostname for the route. If not specified, a hostname is generated.

The hostname can't be changed after the route is created.

Path

Path that the router watches to route traffic to the service.

*** Service**

Service to route to.

*** Weight**

Weight is a number between 0 and 256 that specifies the relative weight against other route services.

Target Port

Target port for traffic.

Alternate Services

Split traffic across multiple services

Routes can direct traffic to multiple services for A/B testing. Each service has a weight controlling how much traffic it gets.

*** Service**

Alternate service for route traffic.

*** Weight**

Weight is a number between 0 and 256 that specifies the relative weight against other route services.

[Remove Service](#)

*** Service**

Alternate service for route traffic.

*** Weight**

Weight is a number between 0 and 256 that specifies the relative weight against other route services.

Traffic weightings are shown on the **Overview** in the expanded rows of the applications between which traffic is split.

9.4.3.1.2. Managing Weights Using the CLI

This command manages the services and corresponding weights [load balanced](#) by the route.

```
$ 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 web ab-example-A=198 ab-example-B=2
```

This means 99% of traffic will be sent to service **ab-example-A** and 1% to service **ab-example-B**.

This command does not scale the deployment configurations. You may need to do that to have enough pods to handle the request load.

The command with no flags displays the current configuration.

```
$ oc set route-backends web
NAME          KIND    TO          WEIGHT
routes/web    Service ab-example-A 198 (99%)
routes/web    Service ab-example-B 2 (1%)
```

The **--adjust** flag allows you to alter the weight of an individual service relative to itself or to the primary service. Specifying a percentage will adjust the service relative to either the primary or the first alternate (if you specify the primary). If there are other backends their weights will be kept proportional to the changed.

```
$ oc set route-backends web --adjust ab-example-A=200 ab-example-B=10
$ oc set route-backends web --adjust ab-example-B=5%
$ oc set route-backends web --adjust ab-example-B=+15%
```

The **--equal** flag sets the **weight** of all services to 100

```
$ oc set route-backends web --equal
```

The **--zero** flag sets the **weight** of all services to 0. All requests will return with a 503 error.



NOTE

Not all routers may support multiple or weighted backends.

9.4.3.1.3. One Service, Multiple Deployment Configurations

If you have the router installed, make the application available via a route (or use the service IP directly):

```
$ oc expose svc/ab-example
```

Browse to the application at **ab-example.<project>.<router_domain>** to verify you see the **v1** image.

1. Create a second shard based on the same source image as the first shard but different tagged version, and set a unique value:

```
$ oc new-app openshift/deployment-example:v2 --name=ab-example-b --labels=ab-example=true SUBTITLE="shard B" COLOR="red"
```

2. Edit the newly created shard to set a label **ab-example=true** that will be common to all shards:

```
$ oc edit dc/ab-example-b
```

In the editor, add the line **ab-example: "true"** underneath **spec.selector** and **spec.template.metadata.labels** alongside the existing **deploymentconfig=ab-example-b** label. Save and exit the editor.

3. Trigger a re-deployment of the second shard to pick up the new labels:

```
$ oc rollout latest dc/ab-example-b
```

- At this point, both sets of pods are being served under the route. However, since both browsers (by leaving a connection open) and the router (by default, through a cookie) will attempt to preserve your connection to a back-end server, you may not see both shards being returned to you. To force your browser to one or the other shard, use the scale command:

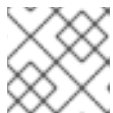
```
$ oc scale dc/ab-example-a --replicas=0
```

Refreshing your browser should show **v2** and **shard B** (in red).

```
$ oc scale dc/ab-example-a --replicas=1; oc scale dc/ab-example-b --replicas=0
```

Refreshing your browser should show **v1** and **shard A** (in blue).

If you trigger a deployment on either shard, only the pods in that shard will be affected. You can easily trigger a deployment by changing the **SUBTITLE** environment variable in either deployment config **oc edit dc/ab-example-a** or **oc edit dc/ab-example-b**. You can add additional shards by repeating steps 5-7.



NOTE

These steps will be simplified in future versions of OpenShift Online.

9.4.4. Proxy Shard / Traffic Splitter

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 would forward 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.

While an implementation is beyond the scope of this example, 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 Online router with proportional balancing capabilities.

9.4.5. 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.

9.4.6. Graceful Termination

OpenShift Online 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 Online will send a **TERM** signal to the processes in the container. Application code, on receiving **SIGTERM**, should stop accepting new connections. This will ensure that load balancers route traffic to other active instances. The application code should then wait 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 will be 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 may be customized per application as necessary.

CHAPTER 10. TEMPLATES

10.1. OVERVIEW

A template describes a set of [objects](#) that can be parameterized and processed to produce a list of objects for creation by OpenShift Online. A template can be processed to create anything you have permission to create within a project, for example [services](#), [build configurations](#), and [deployment configurations](#). A template may also define a set of [labels](#) to apply to every object defined in the template.

You can create a list of objects from a template [using the CLI](#) or, if a [template has been uploaded](#) to your project or the global template library, [using the web console](#). For a curated set of templates, see the [OpenShift Image Streams and Templates library](#).

10.2. UPLOADING A TEMPLATE

If you have a JSON or YAML file that defines a template, for example as seen in [this example](#), you can upload the template to projects using the CLI. This saves the template to the project for repeated use by any user with appropriate access to that project. Instructions on [writing your own templates](#) are provided later in this topic.

To upload a template to your current project's template library, pass the JSON or YAML file with the following command:

```
$ oc create -f <filename>
```

You can upload a template to a different project using the **-n** option with the name of the project:

```
$ oc create -f <filename> -n <project>
```

The template is now available for selection using the web console or the CLI.

10.3. CREATING FROM TEMPLATES USING THE WEB CONSOLE

See [Creating an Application Using the Web Console](#).

10.4. CREATING FROM TEMPLATES USING THE CLI

You can use the CLI to process templates and use the configuration that is generated to create objects.

10.4.1. Labels

[Labels](#) are used to manage and organize generated objects, such as pods. The labels specified in the template are applied to every object that is generated from the template.

There is also the ability to add labels in the template from the command line.

```
$ oc process -f <filename> -l name=otherLabel
```

10.4.2. Parameters

The list of parameters that you can override are listed in the [parameters section of the template](#). You can list them with the CLI by using the following command and specifying the file to be used:

```
$ oc process --parameters -f <filename>
```

Alternatively, if the template is already uploaded:

```
$ oc process --parameters -n <project> <template_name>
```

For example, the following shows the output when listing the parameters for one of the Quickstart templates in the default **openshift** project:

```
$ oc process --parameters -n openshift rails-postgresql-example
NAME          DESCRIPTION
GENERATOR     VALUE
SOURCE_REPOSITORY_URL    The URL of the repository with your application source code
https://github.com/sclorg/rails-ex.git
SOURCE_REPOSITORY_REF    Set this to a branch name, tag or other ref of your repository if
you are not using the default branch
CONTEXT_DIR           Set this to the relative path to your project if it is not in the root of your
repository
APPLICATION_DOMAIN    The exposed hostname that will route to the Rails service
rails-postgresql-example.openshiftapps.com
GITHUB_WEBHOOK_SECRET A secret string used to configure the GitHub webhook
expression [a-zA-Z0-9]{40}
SECRET_KEY_BASE       Your secret key for verifying the integrity of signed cookies
expression [a-z0-9]{127}
APPLICATION_USER       The application user that is used within the sample application to
authorize access on pages openshift
APPLICATION_PASSWORD   The application password that is used within the sample
application to authorize access on pages secret
DATABASE_SERVICE_NAME Database service name
postgresql
POSTGRESQL_USER        database username
expression user[A-Z0-9]{3}
POSTGRESQL_PASSWORD    database password
expression [a-zA-Z0-9]{8}
POSTGRESQL_DATABASE    database name
root
POSTGRESQL_MAX_CONNECTIONS database max connections
10
POSTGRESQL_SHARED_BUFFERS database shared buffers
12MB
```

The output identifies several parameters that are generated with a regular expression-like generator when the template is processed.

10.4.3. Generating a List of Objects

Using the CLI, you can process a file defining a template to return the list of objects to standard output:

```
$ oc process -f <filename>
```

Alternatively, if the template has already been uploaded to the current project:

```
$ oc process <template_name>
```

You can create objects from a template by processing the template and piping the output to **oc create**:

```
$ oc process -f <filename> | oc create -f -
```

Alternatively, if the template has already been uploaded to the current project:

```
$ oc process <template> | oc create -f -
```

You can override any [parameter](#) values defined in the file by adding the **-p** option for each **<name>=<value>** pair you want to override. A parameter reference may appear in any text field inside the template items.

For example, in the following the **POSTGRESQL_USER** and **POSTGRESQL_DATABASE** parameters of a template are overridden to output a configuration with customized environment variables:

Example 10.1. Creating a List of Objects from a Template

```
$ oc process -f my-rails-postgresql \  
-p POSTGRESQL_USER=bob \  
-p POSTGRESQL_DATABASE=mydatabase
```

The JSON file can either be redirected to a file or applied directly without uploading the template by piping the processed output to the **oc create** command:

```
$ oc process -f my-rails-postgresql \  
-p POSTGRESQL_USER=bob \  
-p POSTGRESQL_DATABASE=mydatabase \  
| oc create -f -
```

If you have large number of parameters, you can store them in a file and then pass this file to **oc process**:

```
$ cat postgres.env  
POSTGRESQL_USER=bob  
POSTGRESQL_DATABASE=mydatabase  
$ oc process -f my-rails-postgresql --param-file=postgres.env
```

You can also read the environment from standard input by using **"-"** as the argument to **--param-file**:

```
$ sed s/bob/alice/ postgres.env | oc process -f my-rails-postgresql --param-file=-
```

10.5. MODIFYING AN UPLOADED TEMPLATE

You can edit a template that has already been uploaded to your project by using the following command:

```
$ oc edit template <template>
```

10.6. USING THE INSTANT APP AND QUICKSTART TEMPLATES

OpenShift Online provides a number of default Instant App and Quickstart templates to make it easy to quickly get started creating a new application for different languages. Templates are provided for Rails (Ruby), Django (Python), Node.js, CakePHP (PHP), and Dancer (Perl). Your cluster administrator should have created these templates in the default, global **openshift** project so you have access to them. You can list the available default Instant App and Quickstart templates with:

```
$ oc get templates -n openshift
```

By default, the templates build using a public source repository on [GitHub](#) that contains the necessary application code. In order to be able to modify the source and build your own version of the application, you must:

1. Fork the repository referenced by the template's default **SOURCE_REPOSITORY_URL** parameter.
2. Override the value of the **SOURCE_REPOSITORY_URL** parameter when creating from the template, specifying your fork instead of the default value.

By doing this, the build configuration created by the template will now point to your fork of the application code, and you can modify the code and rebuild the application at will.



NOTE

Some of the Instant App and Quickstart templates define a database [deployment configuration](#). The configuration they define uses ephemeral storage for the database content. These templates should be used for demonstration purposes only as all database data will be lost if the database pod restarts for any reason.

10.7. WRITING TEMPLATES

You can define new templates to make it easy to recreate all the objects of your application. The template will define the objects it creates along with some metadata to guide the creation of those objects.

Example 10.2. A Simple Template Object Definition (YAML)

```
apiVersion: v1
kind: Template
metadata:
  name: redis-template
annotations:
  description: "Description"
  iconClass: "icon-redis"
  tags: "database,nosql"
objects:
- apiVersion: v1
  kind: Pod
  metadata:
    name: redis-master
  spec:
    containers:
    - env:
```

```

- name: REDIS_PASSWORD
  value: ${REDIS_PASSWORD}
  image: dockerfile/redis
  name: master
  ports:
  - containerPort: 6379
    protocol: TCP
parameters:
- description: Password used for Redis authentication
  from: '[A-Z0-9]{8}'
  generate: expression
  name: REDIS_PASSWORD
labels:
  redis: master

```

10.7.1. Description

The template description informs users what the template does and helps them find it when searching in the web console. Additional metadata beyond the template name is optional, but useful to have. In addition to general descriptive information, the metadata also includes a set of tags. Useful tags include the name of the language the template is related to (for example, **java**, **php**, **ruby**, and so on).

Example 10.3. Template Description Metadata

```

kind: Template
apiVersion: v1
metadata:
  name: cakephp-mysql-example 1
  annotations:
    openshift.io/display-name: "CakePHP MySQL Example (Ephemeral)" 2
  description: >-
    An example CakePHP application with a MySQL database. For more information
    about using this template, including OpenShift considerations, see
    https://github.com/sclorg/cakephp-ex/blob/master/README.md.

    WARNING: Any data stored will be lost upon pod destruction. Only use this
    template for testing." 3
  openshift.io/long-description: >-
    This template defines resources needed to develop a CakePHP application,
    including a build configuration, application deployment configuration, and
    database deployment configuration. The database is stored in
    non-persistent storage, so this configuration should be used for
    experimental purposes only. 4
  tags: "quickstart,php,cakephp" 5
  iconClass: icon-php 6
  openshift.io/provider-display-name: "Red Hat, Inc." 7
  openshift.io/documentation-url: "https://github.com/sclorg/cakephp-ex" 8
  openshift.io/support-url: "https://access.redhat.com" 9
  message: "Your admin credentials are ${ADMIN_USERNAME}:${ADMIN_PASSWORD}" 10

```

1 The unique name of the template.

- 2 A brief, user-friendly name, which can be employed by user interfaces.
- 3 A description of the template. Include enough detail that the user will understand what is being deployed and any caveats they need to know before deploying. It should also provide links to additional information, such as a *README* file. Newlines can be included to create paragraphs.
- 4 Additional template description. This may be displayed by the service catalog, for example.
- 5 Tags to be associated with the template for searching and grouping. Add tags that will include it into one of the provided catalog categories. Refer to the **id** and **categoryAliases** in **CATALOG_CATEGORIES** in the console's [constants file](#).
- 6 An icon to be displayed with your template in the web console. Choose from our existing [logo icons](#) when possible. You can also use icons from [FontAwesome](#) and [PatternFly](#).
- 7 The name of the person or organization providing the template.
- 8 A URL referencing further documentation for the template.
- 9 A URL where support can be obtained for the template.
- 10 An instructional message that is displayed when this template is instantiated. This field should inform the user how to use the newly created resources. Parameter substitution is performed on the message before being displayed so that generated credentials and other parameters can be included in the output. Include links to any next-steps documentation that users should follow.

10.7.2. Labels

Templates can include a set of [labels](#). These labels will be added to each object created when the template is instantiated. Defining a label in this way makes it easy for users to find and manage all the objects created from a particular template.

Example 10.4. Template Object Labels

```
kind: "Template"
apiVersion: "v1"
...
labels:
  template: "cakephp-mysql-example" 1
  app: "${NAME}" 2
```

- 1 A label that will be applied to all objects created from this template.
- 2 A parameterized label that will also be applied to all objects created from this template. Parameter expansion is carried out on both label keys and values.

10.7.3. Parameters

Parameters allow a value to be supplied by the user or generated when the template is instantiated. Then, that value is substituted wherever the parameter is referenced. References can be defined in any

field in the objects list field. This is useful for generating random passwords or allowing the user to supply a host name or other user-specific value that is required to customize the template. Parameters can be referenced in two ways:

- As a string value by placing values in the form `${PARAMETER_NAME}` in any string field in the template.
- As a json/yaml value by placing values in the form `${{PARAMETER_NAME}}` in place of any field in the template.

When using the `${PARAMETER_NAME}` syntax, multiple parameter references can be combined in a single field and the reference can be embedded within fixed data, such as `"http://${PARAMETER_1}${PARAMETER_2}"`. Both parameter values will be substituted and the resulting value will be a quoted string.

When using the `${{PARAMETER_NAME}}` syntax only a single parameter reference is allowed and leading/trailing characters are not permitted. The resulting value will be unquoted unless, after substitution is performed, the result is not a valid json object. If the result is not a valid json value, the resulting value will be quoted and treated as a standard string.

A single parameter can be referenced multiple times within a template and it can be referenced using both substitution syntaxes within a single template.

A default value can be provided, which is used if the user does not supply a different value:

Example 10.5. Setting an Explicit Value as the Default Value

```
parameters:
- name: USERNAME
  description: "The user name for Joe"
  value: joe
```

Parameter values can also be generated based on rules specified in the parameter definition:

Example 10.6. Generating a Parameter Value

```
parameters:
- name: PASSWORD
  description: "The random user password"
  generate: expression
  from: "[a-zA-Z0-9]{12}"
```

In the example above, processing will generate a random password 12 characters long consisting of all upper and lowercase alphabet letters and numbers.

The syntax available is not a full regular expression syntax. However, you can use `\w`, `\d`, and `\a` modifiers:

- `[w]{10}` produces 10 alphabet characters, numbers, and underscores. This follows the PCRE standard and is equal to `[a-zA-Z0-9_]{10}`.
- `[d]{10}` produces 10 numbers. This is equal to `[0-9]{10}`.
- `[a]{10}` produces 10 alphabetical characters. This is equal to `[a-zA-Z]{10}`.

Here is an example of a full template with parameter definitions and references:

Example 10.7. A full template with parameter definitions and references

```

kind: Template
apiVersion: v1
metadata:
  name: my-template
objects:
- kind: BuildConfig
  apiVersion: v1
  metadata:
    name: cakephp-mysql-example
    annotations:
      description: Defines how to build the application
  spec:
    source:
      type: Git
      git:
        uri: "${SOURCE_REPOSITORY_URL}" 1
        ref: "${SOURCE_REPOSITORY_REF}"
        contextDir: "${CONTEXT_DIR}"
- kind: DeploymentConfig
  apiVersion: v1
  metadata:
    name: frontend
  spec:
    replicas: "${REPLICA_COUNT}" 2
parameters:
- name: SOURCE_REPOSITORY_URL 3
  displayName: Source Repository URL 4
  description: The URL of the repository with your application source code 5
  value: https://github.com/sclorg/cakephp-ex.git 6
  required: true 7
- name: GITHUB_WEBHOOK_SECRET
  description: A secret string used to configure the GitHub webhook
  generate: expression 8
  from: "[a-zA-Z0-9]{40}" 9
- name: REPLICAS_COUNT
  description: Number of replicas to run
  value: "2"
  required: true
message: "... The GitHub webhook secret is ${GITHUB_WEBHOOK_SECRET} ..." 10

```

- 1 This value will be replaced with the value of the **SOURCE_REPOSITORY_URL** parameter when the template is instantiated.
- 2 This value will be replaced with the unquoted value of the **REPLICA_COUNT** parameter when the template is instantiated.
- 3 The name of the parameter. This value is used to reference the parameter within the template.
- 4 The user-friendly name for the parameter. This will be displayed to users.

- 5 A description of the parameter. Provide more detailed information for the purpose of the parameter, including any constraints on the expected value. Descriptions should use complete
- 6 A default value for the parameter which will be used if the user does not override the value when instantiating the template. Avoid using default values for things like passwords, instead use generated parameters in combination with Secrets.
- 7 Indicates this parameter is required, meaning the user cannot override it with an empty value. If the parameter does not provide a default or generated value, the user must supply a value.
- 8 A parameter which has its value generated.
- 9 The input to the generator. In this case, the generator will produce a 40 character alphanumeric value including upper and lowercase characters.
- 10 Parameters can be included in the template message. This informs the user about generated values.

10.7.4. Object List

The main portion of the template is the list of objects which will be created when the template is instantiated. This can be any [valid API object](#), such as a **BuildConfig**, **DeploymentConfig**, **Service**, etc. The object will be created exactly as defined here, with any parameter values substituted in prior to creation. The definition of these objects can reference parameters defined earlier.

```
kind: "Template"
apiVersion: "v1"
metadata:
  name: my-template
objects:
- kind: "Service" 1
  apiVersion: "v1"
  metadata:
    name: "cakephp-mysql-example"
    annotations:
      description: "Exposes and load balances the application pods"
  spec:
    ports:
      - name: "web"
        port: 8080
        targetPort: 8080
    selector:
      name: "cakephp-mysql-example"
```

- 1 The definition of a **Service** which will be created by this template.

**NOTE**

If an object definition's metadata includes a fixed **namespace** field value, the field will be stripped out of the definition during template instantiation. If the **namespace** field contains a parameter reference, normal parameter substitution will be performed and the object will be created in whatever namespace the parameter substitution resolved the value to, assuming the user has permission to create objects in that namespace.

10.7.5. Marking Templates as Bindable

The template service broker advertises one service in its catalog for each Template object that it is aware of. By default, each of these services is advertised as being "bindable", meaning an end user is permitted to bind against the provisioned service.

Template authors can prevent end users from binding against services provisioned from a given Template by adding the annotation **template.openshift.io/bindable: "false"** to the Template.

10.7.6. Exposing Object Fields

Template authors can indicate that fields of particular objects in a template should be exposed. The template service broker recognizes exposed fields on ConfigMap, Secret, Service and Route objects, and returns the values of the exposed fields when a user binds a service backed by the broker.

To expose one or more fields of an object, add annotations prefixed by **template.openshift.io/expose-** or **template.openshift.io/base64-expose-** to the object in the template.

Each annotation key, with its prefix removed, is passed through to become a key in a **bind** response.

Each annotation value is a [Kubernetes JSONPath expression](#), which is resolved at bind time to indicate the object field whose value should be returned in the **bind** response.

**NOTE**

Bind response key/value pairs can be used in other parts of the system as environment variables. Therefore, it is recommended that every annotation key with its prefix removed should be a valid environment variable name – beginning with a character **A-Z, a-z**, or underscore, and being followed by zero or more characters **A-Z, a-z, 0-9**, or underscore.

Use the **template.openshift.io/expose-** annotation to return the field value as a string. This is convenient, although it does not handle arbitrary binary data. If you want to return binary data, use the **template.openshift.io/base64-expose-** annotation instead to base64 encode the data before it is returned.

**NOTE**

Unless escaped with a backslash, Kubernetes' JSONPath implementation interprets characters such as **.**, **@**, and others as metacharacters, regardless of their position in the expression. Therefore, for example, to refer to a **ConfigMap** datum named **my.key**, the required JSONPath expression would be **{.data['my.key']}**. Depending on how the JSONPath expression is then written in YAML, an additional backslash might be required, for example **"{.data['my\\.key']}**".

The following is an example of different objects' fields being exposed:

```

kind: Template
apiVersion: v1
metadata:
  name: my-template
objects:
- kind: ConfigMap
  apiVersion: v1
  metadata:
    name: my-template-config
    annotations:
      template.openshift.io/expose-username: "{.data['my\\.username']}"
  data:
    my.username: foo
- kind: Secret
  apiVersion: v1
  metadata:
    name: my-template-config-secret
    annotations:
      template.openshift.io/base64-expose-password: "{.data['password']}"
  stringData:
    password: bar
- kind: Service
  apiVersion: v1
  metadata:
    name: my-template-service
    annotations:
      template.openshift.io/expose-service_ip_port: "{.spec.clusterIP};{.spec.ports[?
(.name==\"web\").port]}"
  spec:
    ports:
      - name: "web"
        port: 8080
- kind: Route
  apiVersion: v1
  metadata:
    name: my-template-route
    annotations:
      template.openshift.io/expose-uri: "http://{.spec.host}{.spec.path}"
  spec:
    path: mypath

```

An example response to a **bind** operation given the above partial template follows:

```

{
  "credentials": {
    "username": "foo",
    "password": "YmFy",
    "service_ip_port": "172.30.12.34:8080",
    "uri": "http://route-test.router.default.svc.cluster.local/mypath"
  }
}

```

10.7.7. Waiting for Template Readiness

Template authors can indicate that certain objects within a template should be waited for before a template instantiation by the service catalog, Template Service Broker, or TemplateInstance API is considered complete.

To use this feature, mark one or more objects of kind **Build**, **BuildConfig**, **Deployment**, **DeploymentConfig**, **Job**, or **StatefulSet** in a template with the following annotation:

```
"template.alpha.openshift.io/wait-for-ready": "true"
```

Template instantiation will not complete until all objects marked with the annotation report ready. Similarly, if any of the annotated objects report failed, or if the template fails to become ready within a fixed timeout of one hour, the template instantiation will fail.

For the purposes of instantiation, readiness and failure of each object kind are defined as follows:

Kind	Readiness	Failure
Build	Object reports phase Complete	Object reports phase Canceled, Error, or Failed
BuildConfig	Latest associated Build object reports phase Complete	Latest associated Build object reports phase Canceled, Error, or Failed
Deployment	Object reports new ReplicaSet and deployment available (this honors readiness probes defined on the object)	Object reports Progressing condition as false
DeploymentConfig	Object reports new ReplicationController and deployment available (this honors readiness probes defined on the object)	Object reports Progressing condition as false
Job	Object reports completion	Object reports that one or more failures have occurred
StatefulSet	Object reports all replicas ready (this honors readiness probes defined on the object)	Not applicable

The following is an example template extract, which uses the **wait-for-ready** annotation. Further examples can be found in the OpenShift quickstart templates.

```
kind: Template
apiVersion: v1
metadata:
  name: my-template
objects:
- kind: BuildConfig
  apiVersion: v1
  metadata:
    name: ...
  annotations:
    # wait-for-ready used on BuildConfig ensures that template instantiation
```

```

    # will fail immediately if build fails
    template.alpha.openshift.io/wait-for-ready: "true"
spec:
  ...
- kind: DeploymentConfig
  apiVersion: v1
  metadata:
    name: ...
    annotations:
      template.alpha.openshift.io/wait-for-ready: "true"
  spec:
    ...
- kind: Service
  apiVersion: v1
  metadata:
    name: ...
  spec:
    ...

```

10.7.8. Other Recommendations

- Set [memory](#), [CPU](#), and [storage](#) default sizes to make sure your application is given enough resources to run smoothly.
- Avoid referencing the **latest** tag from images if that tag is used across major versions. This may cause running applications to break when new images are pushed to that tag.
- A good template builds and deploys cleanly without requiring modifications after the template is deployed.

10.7.9. Creating a Template from Existing Objects

If you are upgrading from OpenShift Online Starter to OpenShift Online Pro, use **oc export all** to export all of your existing objects. OpenShift Online Pro does not support per-object resource migration.

Rather than writing an entire template from scratch, you can export existing objects from your project in template form, and then modify the template from there by adding parameters and other customizations. To export objects in a project in template form, run:

```
$ oc export all --as-template=<template_name> > <template_filename>
```

You can also substitute a particular resource type or multiple resources instead of **all**. Run **oc export -h** for more examples.

The object types included in **oc export all** are:

- BuildConfig
- Build
- DeploymentConfig
- ImageStream
- Pod

- ReplicationController
- Route
- Service

CHAPTER 11. OPENING A REMOTE SHELL TO CONTAINERS

11.1. OVERVIEW

The **oc rsh** command allows you to locally access and manage tools that are on the system. The secure shell (SSH) is the underlying technology and industry standard that provides a secure connection to the application. Access to applications with the shell environment is protected and restricted with Security-Enhanced Linux (SELinux) policies.

11.2. START A SECURE SHELL SESSION

Open a remote shell session to a container:

```
$ oc rsh <pod>
```

While in the remote shell, you can issue commands as if you are inside the container and perform local operations like monitoring, debugging, and using CLI commands specific to what is running in the container.

For example, in a MySQL container, you can count the number of records in the database by invoking the **mysql** command, then using the prompt to type in the **SELECT** command. You can also use commands like **ps(1)** and **ls(1)** for validation.

BuildConfigs and **DeployConfigs** map out how you want things to look and pods (with containers inside) are created and dismantled as needed. Your changes are not persistent. If you make changes directly within the container and that container is destroyed and rebuilt, your changes will no longer exist.



NOTE

oc exec can be used to execute a command remotely. However, the **oc rsh** command provides an easier way to keep a remote shell open persistently.

11.3. SECURE SHELL SESSION HELP

For help with usage, options, and to see examples:

```
$ oc rsh -h
```

CHAPTER 12. SERVICE ACCOUNTS

12.1. OVERVIEW

When a person uses the OpenShift Online CLI or web console, their API token authenticates them to the OpenShift API. However, when a regular user's credentials are not available, it is common for components to make API calls independently. For example:

- Replication controllers make API calls to create or delete pods.
- Applications inside containers could make API calls for discovery purposes.
- External applications could make API calls for monitoring or integration purposes.

Service accounts provide a flexible way to control API access without sharing a regular user's credentials.

12.2. USER NAMES AND GROUPS

Every service account has an associated user name that can be granted roles, just like a regular user. The user name is derived from its project and name:

```
system:serviceaccount:<project>:<name>
```

For example, to add the **view** role to the **robot** service account in the **top-secret** project:

```
$ oc policy add-role-to-user view system:serviceaccount:top-secret:robot
```

IMPORTANT

If you want to grant access to a specific service account in a project, you can use the **-z** flag. From the project to which the service account belongs, use the **-z** flag and specify the **<serviceaccount_name>**. This is highly recommended, as it helps prevent typos and ensures that access is granted only to the specified service account. For example:

```
$ oc policy add-role-to-user <role_name> -z <serviceaccount_name>
```

If not in the project, use the **-n** option to indicate the project namespace it applies to, as shown in the examples below.

Every service account is also a member of two groups:

system:serviceaccount

Includes all service accounts in the system.

system:serviceaccount:<project>

Includes all service accounts in the specified project.

For example, to allow all service accounts in all projects to view resources in the **top-secret** project:

```
$ oc policy add-role-to-group view system:serviceaccount -n top-secret
```

To allow all service accounts in the **managers** project to edit resources in the **top-secret** project:

```
$ oc policy add-role-to-group edit system:serviceaccount:managers -n top-secret
```

12.3. DEFAULT SERVICE ACCOUNTS AND ROLES

Three service accounts are automatically created in every project:

Service Account	Usage
builder	Used by build pods. It is given the system:image-builder role, which allows pushing images to any image stream in the project using the internal Docker registry.
deployer	Used by deployment pods and is given the system:deployer role, which allows viewing and modifying replication controllers and pods in the project.
default	Used to run all other pods unless they specify a different service account.

All service accounts in a project are given the **system:image-puller** role, which allows pulling images from any image stream in the project using the internal Docker registry.

12.4. MANAGING SERVICE ACCOUNTS

Service accounts are API objects that exist within each project. To manage service accounts, you can use the **oc** command with the **sa** or **serviceaccount** object type or use the web console.

To get a list of existing service accounts in the current project:

```
$ oc get sa
NAME      SECRETS  AGE
builder   2        2d
default   2        2d
deployer  2        2d
```

To create a new service account:

```
$ oc create sa robot
serviceaccount "robot" created
```

As soon as a service account is created, two secrets are automatically added to it:

- an API token
- credentials for the OpenShift Container Registry

These can be seen by describing the service account:

```
$ oc describe sa robot
Name: robot
Namespace: project1
Labels: <none>
Annotations: <none>
```

```
Image pull secrets: robot-dockercfg-qzbhb
```

```
Mountable secrets: robot-token-f4khf
                   robot-dockercfg-qzbhb
```

```
Tokens:           robot-token-f4khf
                   robot-token-z8h44
```

The system ensures that service accounts always have an API token and registry credentials.

The generated API token and registry credentials do not expire, but they can be revoked by deleting the secret. When the secret is deleted, a new one is automatically generated to take its place.

12.5. ENABLING SERVICE ACCOUNT AUTHENTICATION

Service accounts authenticate to the API using tokens signed by a private RSA key. The authentication layer verifies the signature using a matching public RSA key.

To enable service account token generation, update the **serviceAccountConfig** stanza in the */etc/origin/master/master-config.yml* file on the master to specify a **privateKeyFile** (for signing), and a matching public key file in the **publicKeyFiles** list:

```
serviceAccountConfig:
  ...
  masterCA: ca.crt 1
  privateKeyFile: serviceaccount.private.key 2
  publicKeyFiles:
  - serviceaccount.public.key 3
  - ...
```

- 1 CA file used to validate the API server's serving certificate.
- 2 Private RSA key file (for token signing).
- 3 Public RSA key files (for token verification). If private key files are provided, then the public key component is used. Multiple public key files can be specified, and a token will be accepted if it can be validated by one of the public keys. This allows rotation of the signing key, while still accepting tokens generated by the previous signer.

12.6. MANAGING ALLOWED SECRETS

In addition to providing API credentials, a pod's service account determines which secrets the pod is allowed to use.

Pods use secrets in two ways:

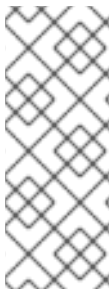
- image pull secrets, providing credentials used to pull images for the pod's containers
- mountable secrets, injecting the contents of secrets into containers as files

To allow a secret to be used as an image pull secret by a service account's pods, run:

```
$ oc secrets link --for=pull <serviceaccount-name> <secret-name>
```

To allow a secret to be mounted by a service account's pods, run:

```
$ oc secrets link --for=mount <serviceaccount-name> <secret-name>
```



NOTE

Limiting secrets to only the service accounts that reference them is disabled by default. This means that if **serviceAccountConfig.limitSecretReferences** is set to **false** (the default setting) in the master configuration file, mounting secrets to a service account's pods with the **--for=mount** option is not required. However, using the **--for=pull** option to enable using an image pull secret is required, regardless of the **serviceAccountConfig.limitSecretReferences** value.

This example creates and adds secrets to a service account:

```
$ oc create secret generic secret-plans \
  --from-file=plan1.txt \
  --from-file=plan2.txt
secret/secret-plans

$ oc create secret docker-registry my-pull-secret \
  --docker-username=mastermind \
  --docker-password=12345 \
  --docker-email=mastermind@example.com
secret/my-pull-secret

$ oc secrets link robot secret-plans --for=mount

$ oc secrets link robot my-pull-secret --for=pull

$ oc describe serviceaccount robot
Name:          robot
Labels:        <none>
Image pull secrets: robot-dockercfg-624cx
                 my-pull-secret

Mountable secrets: robot-token-uzkbh
                 robot-dockercfg-624cx
                 secret-plans

Tokens:        robot-token-8bhpp
                 robot-token-uzkbh
```

12.7. USING A SERVICE ACCOUNT'S CREDENTIALS INSIDE A CONTAINER

When a pod is created, it specifies a service account (or uses the default service account), and is allowed to use that service account's API credentials and referenced secrets.

A file containing an API token for a pod's service account is automatically mounted at */var/run/secrets/kubernetes.io/serviceaccount/token*.

That token can be used to make API calls as the pod's service account. This example calls the *users/~* API to get information about the user identified by the token:

```
$ TOKEN="$(cat /var/run/secrets/kubernetes.io/serviceaccount/token)"

$ curl --cacert /var/run/secrets/kubernetes.io/serviceaccount/ca.crt \
  "https://openshift.default.svc.cluster.local/oapi/v1/users/~" \
  -H "Authorization: Bearer $TOKEN"

kind: "User"
apiVersion: "user.openshift.io/v1"
metadata:
  name: "system:serviceaccount:top-secret:robot"
  selflink: "/oapi/v1/users/system:serviceaccount:top-secret:robot"
  creationTimestamp: null
identities: null
groups:
  - "system:serviceaccount"
  - "system:serviceaccount:top-secret"
```

12.8. USING A SERVICE ACCOUNT'S CREDENTIALS EXTERNALLY

The same token can be distributed to external applications that need to authenticate to the API.

Use the following syntax to view a service account's API token:

```
$ oc describe secret <secret-name>
```

For example:

```
$ oc describe secret robot-token-uzkbh -n top-secret
Name: robot-token-uzkbh
Labels: <none>
Annotations: kubernetes.io/service-account.name=robot,kubernetes.io/service-
account.uid=49f19e2e-16c6-11e5-afdc-3c970e4b7ffe

Type: kubernetes.io/service-account-token

Data

token: eyJhbGciOiJSUzI1NiIsInR5cGU6IjY4LWVudC99...

$ oc login --token=eyJhbGciOiJSUzI1NiIsInR5cGU6IjY4LWVudC99...
Logged into "https://server:8443" as "system:serviceaccount:top-secret:robot" using the token
provided.

You don't have any projects. You can try to create a new project, by running

  $ oc new-project <projectname>

$ oc whoami
system:serviceaccount:top-secret:robot
```

CHAPTER 13. MANAGING IMAGES

13.1. OVERVIEW

An [image stream](#) comprises any number of [container images](#) identified by tags. It presents a single virtual view of related images, similar to a Docker image repository.

By watching an image stream, builds and deployments can receive notifications when new images are added or modified and react by performing a build or deployment, respectively.

There are many ways you can interact with images and set up image streams, depending on where the images' registries are located, any authentication requirements around those registries, and how you want your builds and deployments to behave. The following sections cover a range of these topics.

13.2. TAGGING IMAGES

Before working with OpenShift Online image streams and their tags, it helps to first understand image tags in the context of container images generally.

Container images can have names added to them that make it more intuitive to determine what they contain, called a *tag*. Using a tag to specify the version of what is contained in the image is a common use case. If you have an image named **ruby**, you could have a tag named **2.0** for 2.0 version of Ruby, and another named **latest** to indicate literally the latest built image in that repository overall.

When interacting directly with images using the **docker** CLI, the **docker tag** command can add tags, which essentially adds an alias to an image that can consist of several parts. Those parts can include:

```
<registry_server>/<user_name>/<image_name>:<tag>
```

The **<user_name>** part in the above could also refer to a [project](#) or [namespace](#) if the image is being stored in an OpenShift Online environment with an internal registry (the OpenShift Container Registry).

OpenShift Online provides the **oc tag** command, which is similar to the **docker tag** command, but operates on image streams instead of directly on images.



NOTE

See Red Hat Enterprise Linux 7's [Getting Started with Containers](#) documentation for more about tagging images directly using the **docker** CLI.

13.2.1. Adding Tags to Image Streams

Keeping in mind that an image stream in OpenShift Online comprises zero or more container images identified by tags, you can add tags to an image stream using the **oc tag** command:

```
$ oc tag <source> <destination>
```

For example, to configure the **ruby** image streams **static-2.0** tag to always refer to the current image for the **ruby** image streams **2.0** tag:

```
$ oc tag ruby:2.0 ruby:static-2.0
```


This creates a new image stream tag named **static-2.0** in the **ruby** image stream. The new tag directly references the image id that the **ruby:2.0** image stream tag pointed to at the time **oc tag** was run, and the image it points to never changes.

There are different types of tags available. The default behavior uses a *permanent* tag, which points to a specific image in time; even when the source changes, the new (destination) tag does not change.

A *tracking* tag means the destination tag's metadata is updated during the import of the source tag. To ensure the destination tag is updated whenever the source tag changes, use the **--alias=true** flag:

```
$ oc tag --alias=true <source> <destination>
```



NOTE

Use a *tracking* tag for creating permanent aliases (for example, **latest** or **stable**). The tag works correctly *only* within a single image stream. Trying to create a cross-image-stream alias produces an error.

You can also add the **--scheduled=true** flag to have the destination tag be refreshed (i.e., re-imported) periodically. The period is configured globally at the system level. See [Importing Tag and Image Metadata](#) for more details.

The **--reference** flag creates an image stream tag that is not imported. The tag points to the source location, permanently.

If you want to instruct Docker to always fetch the tagged image from the integrated registry, use **--reference-policy=local**. The registry uses the pull-through feature to serve the image to the client. By default, the image blobs are mirrored locally by the registry. As a result, they can be pulled more quickly the next time they are needed. The flag also allows for pulling from insecure registries without a need to supply **--insecure-registry** to the Docker daemon as long as the image stream has an [insecure annotation](#) or the tag has an [insecure import policy](#).

13.2.2. Recommended Tagging Conventions

Images evolve over time and their tags reflect this. An image tag always points to the latest image built.

If there is too much information embedded in a tag name (for example, **v2.0.1-may-2016**), the tag points to just one revision of an image and is never updated. Using default image pruning options, such an image is never removed.

Instead, if the tag is named **v2.0**, more image revisions are more likely. This results in longer [tag history](#) and, therefore, the image pruner is more likely to remove old and unused images.

Although tag naming convention is up to you, here are a few examples in the format **<image_name>**: **<image_tag>**:

Table 13.1. Image Tag Naming Conventions

Description	Example
Revision	myimage:v2.0.1
Architecture	myimage:v2.0-x86_64

Description	Example
Base image	myimage:v1.2-centos7
Latest (potentially unstable)	myimage:latest
Latest stable	myimage:stable

If you require dates in tag names, periodically inspect old and unsupported images and **istags** and remove them. Otherwise, you might experience increasing resource usage caused by old images.

13.2.3. Removing Tags from Image Streams

To remove a tag completely from an image stream run:

```
$ oc delete istag/ruby:latest
```

or:

```
$ oc tag -d ruby:latest
```

13.2.4. Referencing Images in Image Streams

Images can be referenced in image streams using the following reference types:

- An **ImageStreamTag** is used to reference or retrieve an image for a given image stream and tag. It uses the following convention for its name:

```
<image_stream_name>:<tag>
```

- An **ImageStreamImage** is used to reference or retrieve an image for a given image stream and image name. It uses the following convention for its name:

```
<image_stream_name>@<id>
```

The **<id>** is an immutable identifier for a specific image, also called a digest.

- A **DockerImage** is used to reference or retrieve an image for a given external registry. It uses standard Docker *pull specification* for its name, e.g.:

```
openshift/ruby-20-centos7:2.0
```



NOTE

When no tag is specified, it is assumed the **latest** tag is used.

You can also reference a third-party registry:

```
registry.access.redhat.com/rhel7:latest
```

Or an image with a digest:

```
centos/ruby-22-
centos7@sha256:3a335d7d8a452970c5b4054ad7118ff134b3a6b50a2bb6d0c07c746e8986b2
8e
```

When viewing example image stream definitions, such as the [example CentOS image streams](#), you may notice they contain definitions of **ImageStreamTag** and references to **DockerImage**, but nothing related to **ImageStreamImage**.

This is because the **ImageStreamImage** objects are automatically created in OpenShift Online whenever you import or tag an image into the image stream. You should never have to explicitly define an **ImageStreamImage** object in any image stream definition that you use to create image streams.

You can view an image's object definition by retrieving an **ImageStreamImage** definition using the image stream name and ID:

```
$ oc export isimage <image_stream_name>@<id>
```



NOTE

You can find valid **<id>** values for a given image stream by running:

```
$ oc describe is <image_stream_name>
```

For example, from the **ruby** image stream asking for the **ImageStreamImage** with the name and ID of **ruby@3a335d7**:

Definition of an Image Object Retrieved via **ImageStreamImage**

```
$ oc export isimage ruby@3a335d7

apiVersion: v1
image:
  dockerImageLayers:
  - name: sha256:a3ed95caeb02ffe68cdd9fd84406680ae93d633cb16422d00e8a7c22955b46d4
    size: 0
  - name: sha256:ee1dd2cb6df21971f4af6de0f1d7782b81fb63156801cfde2bb47b4247c23c29
    size: 196634330
  - name: sha256:a3ed95caeb02ffe68cdd9fd84406680ae93d633cb16422d00e8a7c22955b46d4
    size: 0
  - name: sha256:a3ed95caeb02ffe68cdd9fd84406680ae93d633cb16422d00e8a7c22955b46d4
    size: 0
  - name: sha256:ca062656bff07f18bff46be00f40cfbb069687ec124ac0aa038fd676cfaea092
    size: 177723024
  - name: sha256:63d529c59c92843c395befd065de516ee9ed4995549f8218eac6ff088bfa6b6e
    size: 55679776
  dockerImageMetadata:
    Architecture: amd64
    Author: SoftwareCollections.org <sclorg@redhat.com>
    Config:
      Cmd:
      - /bin/sh
```

```

- -c
- $STI_SCRIPTS_PATH/usage
Entrypoint:
- container-entrypoint
Env:
- PATH=/opt/app-root/src/bin:/opt/app-
root/bin:/usr/local/sbin:/usr/local/bin:/usr/sbin:/usr/bin:/sbin:/bin
- STI_SCRIPTS_URL=image:///usr/libexec/s2i
- STI_SCRIPTS_PATH=/usr/libexec/s2i
- HOME=/opt/app-root/src
- BASH_ENV=/opt/app-root/etc/scl_enable
- ENV=/opt/app-root/etc/scl_enable
- PROMPT_COMMAND=. /opt/app-root/etc/scl_enable
- RUBY_VERSION=2.2
ExposedPorts:
  8080/tcp: {}
Image: d9c3abc5456a9461954ff0de8ae25e0e016aad35700594714d42b687564b1f51
Labels:
  build-date: 2015-12-23
  io.k8s.description: Platform for building and running Ruby 2.2 applications
  io.k8s.display-name: Ruby 2.2
  io.openshift.builder-base-version: 8d95148
  io.openshift.builder-version: 8847438ba06307f86ac877465eadc835201241df
  io.openshift.s2i.scripts-url: image:///usr/libexec/s2i
  io.openshift.tags: builder,ruby,ruby22
  io.s2i.scripts-url: image:///usr/libexec/s2i
  license: GPLv2
  name: CentOS Base Image
  vendor: CentOS
  User: "1001"
  WorkingDir: /opt/app-root/src
ContainerConfig: {}
Created: 2016-01-26T21:07:27Z
DockerVersion: 1.8.2-el7
Id: 57b08d979c86f4500dc8cad639c9518744c8dd39447c055a3517dc9c18d6fccd
Parent: d9c3abc5456a9461954ff0de8ae25e0e016aad35700594714d42b687564b1f51
Size: 430037130
apiVersion: "1.0"
kind: DockerImage
dockerImageMetadataVersion: "1.0"
dockerImageReference: centos/ruby-22-
centos7@sha256:3a335d7d8a452970c5b4054ad7118ff134b3a6b50a2bb6d0c07c746e8986b28e
metadata:
  creationTimestamp: 2016-01-29T13:17:45Z
  name: sha256:3a335d7d8a452970c5b4054ad7118ff134b3a6b50a2bb6d0c07c746e8986b28e
  resourceVersion: "352"
  uid: af2e7a0c-c68a-11e5-8a99-525400f25e34
kind: ImageStreamImage
metadata:
  creationTimestamp: null
  name: ruby@3a335d7
  namespace: openshift
  selflink: /oapi/v1/namespaces/openshift/imagestreamimages/ruby@3a335d7

```

13.3. IMAGE PULL POLICY

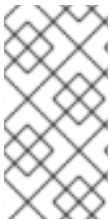
Each container in a pod has a container image. Once you have created an image and pushed it to a registry, you can then refer to it in the pod.

When OpenShift Online creates containers, it uses the container's **imagePullPolicy** to determine if the image should be pulled prior to starting the container. There are three possible values for **imagePullPolicy**:

- **Always** - always pull the image.
- **IfNotPresent** - only pull the image if it does not already exist on the node.
- **Never** - never pull the image.

If a container's **imagePullPolicy** parameter is not specified, OpenShift Online sets it based on the image's tag:

1. If the tag is **latest**, OpenShift Online defaults **imagePullPolicy** to **Always**.
2. Otherwise, OpenShift Online defaults **imagePullPolicy** to **IfNotPresent**.



NOTE

When using the **Never** Image Pull Policy, you can ensure that private images can only be used by pods with credentials to pull those images using the **AlwaysPullImages admission controller**. If this admission controller is not enabled, any pod from any user on a node can use the image without any authorization check against the image.

13.4. ACCESSING THE INTERNAL REGISTRY

You can access OpenShift Online's internal registry directly to push or pull images. For example, this could be helpful if you wanted to [create an image stream by manually pushing an image](#), or just to **docker pull** an image directly.

OpenShift Online gives developers a hands-on preview of the OpenShift platform in a hosted environment that includes access to an internal registry.

The internal registry authenticates using the same [tokens](#) as the OpenShift Online API. To perform a **docker login** against the internal registry, you can choose any user name and email, but the password must be a valid OpenShift Online token.

To log into the internal registry:

1. Log in to OpenShift Online:

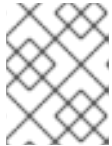
```
$ oc login
```

2. Get your access token:

```
$ oc whoami -t
```

3. Log in to the internal registry using the token. You must have **docker** installed on your system:

```
$ docker login -u <user_name> -e <email_address> \
-p <token_value> https://registry.<clusterID>.openshift.com
```

**NOTE**

Contact your cluster administrator if you do not know the registry IP or host name and port to use.

In order to pull an image, the authenticated user must have **get** rights on the requested **imagestreams/layers**. In order to push an image, the authenticated user must have **update** rights on the requested **imagestreams/layers**.

By default, all service accounts in a project have rights to pull any image in the same project, and the **builder** service account has rights to push any image in the same project.

13.5. USING IMAGE PULL SECRETS

[Docker registries](#) can be secured to prevent unauthorized parties from accessing certain images. If you are [using OpenShift Online's internal registry](#) and are pulling from image streams located in the same project, then your pod's service account should already have the correct permissions and no additional action should be required.

However, for other scenarios, such as referencing images across OpenShift Online projects or from secured registries, then additional configuration steps are required. The following sections detail these scenarios and their required steps.

13.5.1. Allowing Pods to Reference Images Across Projects

When using the internal registry, to allow pods in **project-a** to reference images in **project-b**, a service account in **project-a** must be bound to the **system:image-puller** role in **project-b**:

```
$ oc policy add-role-to-user \
  system:image-puller system:serviceaccount:project-a:default \
  --namespace=project-b
```

After adding that role, the pods in **project-a** that reference the default service account is able to pull images from **project-b**.

To allow access for any service account in **project-a**, use the group:

```
$ oc policy add-role-to-group \
  system:image-puller system:serviceaccounts:project-a \
  --namespace=project-b
```

13.5.2. Allowing Pods to Reference Images from Other Secured Registries

The **.dockercfg** file (or **\$HOME/.docker/config.json** for newer Docker clients) is a Docker credentials file that stores your information if you have previously logged into a secured or insecure registry.

To pull a secured container image that is not from OpenShift Online's internal registry, you must create a *pull secret* from your Docker credentials and add it to your service account.

If you already have a **.dockercfg** file for the secured registry, you can create a secret from that file by running:

```
$ oc create secret generic <pull_secret_name> \
  --from-file=.dockercfg=<path/to/.dockercfg> \
  --type=kubernetes.io/dockercfg
```

Or if you have a *\$HOME/.docker/config.json* file:

```
$ oc create secret generic <pull_secret_name> \
  --from-file=.dockerconfigjson=<path/to/.docker/config.json> \
  --type=kubernetes.io/dockerconfigjson
```

If you do not already have a Docker credentials file for the secured registry, you can create a secret by running:

```
$ oc create secret docker-registry <pull_secret_name> \
  --docker-server=<registry_server> \
  --docker-username=<user_name> \
  --docker-password=<password> \
  --docker-email=<email>
```

To use a secret for pulling images for pods, you must add the secret to your service account. The name of the service account in this example should match the name of the service account the pod uses; **default** is the default service account:

```
$ oc secrets link default <pull_secret_name> --for=pull
```

To use a secret for pushing and pulling build images, the secret must be mountable inside of a pod. You can do this by running:

```
$ oc secrets link builder <pull_secret_name>
```

13.5.2.1. Pulling from Private Registries with Delegated Authentication

A private registry can delegate authentication to a separate service. In these cases, image pull secrets must be defined for both the authentication and registry endpoints.



NOTE

Third-party images in the Red Hat Container Catalog are served from the Red Hat Connect Partner Registry (**registry.connect.redhat.com**). This registry delegates authentication to **sso.redhat.com**, so the following procedure applies.

1. Create a secret for the delegated authentication server:

```
$ oc create secret docker-registry \
  --docker-server=sso.redhat.com \
  --docker-username=developer@example.com \
  --docker-password=***** \
  --docker-email=unused \
  redhat-connect-sso

secret/redhat-connect-sso
```

2. Create a secret for the private registry:

```
$ oc create secret docker-registry \
  --docker-server=privateregistry.example.com \
  --docker-username=developer@example.com \
  --docker-password=***** \
  --docker-email=unused \
  private-registry
```

```
secret/private-registry
```

NOTE

The Red Hat Connect Partner Registry (registry.connect.redhat.com) does not accept the auto-generated **dockercfg** secret type ([BZ#1476330](#)). A generic file-based secret must be created using the generated file from a **docker login** command:

```
$ docker login registry.connect.redhat.com --username developer@example.com
```

```
Password: *****
```

```
Login Succeeded
```

```
$ oc create secret generic redhat-connect --from-
file=.dockerconfigjson=.docker/config.json
```

```
$ oc secrets link default redhat-connect --for=pull
```

13.6. IMPORTING TAG AND IMAGE METADATA

An image stream can be configured to import tag and image metadata from an image repository in an external Docker image registry. You can do this using a few different methods.

- You can manually import tag and image information with the **oc import-image** command using the **--from** option:

```
$ oc import-image <image_stream_name>[:<tag>] --from=<docker_image_repo> --confirm
```

For example:

```
$ oc import-image my-ruby --from=docker.io/openshift/ruby-20-centos7 --confirm
The import completed successfully.
```

```
Name: my-ruby
```

```
Created: Less than a second ago
```

```
Labels: <none>
```

```
Annotations: openshift.io/image.dockerRepositoryCheck=2016-05-06T20:59:30Z
```

```
Docker Pull Spec: 172.30.94.234:5000/demo-project/my-ruby
```

```
Tag Spec   Created   PullSpec   Image
```

```
latest docker.io/openshift/ruby-20-centos7 Less than a second ago docker.io/openshift/ruby-
20-centos7@sha256:772c5bf9b2d1e8... <same>
```

You can also add the **--all** flag to import all tags for the image instead of just **latest**.

- Like most objects in OpenShift Online, you can also write and save a JSON or YAML definition to a file then create the object using the CLI. Set the **spec.dockerImageRepository** field to the Docker pull spec for the image:

```
apiVersion: "v1"
kind: "ImageStream"
metadata:
  name: "my-ruby"
spec:
  dockerImageRepository: "docker.io/openshift/ruby-20-centos7"
```

Then create the object:

```
$ oc create -f <file>
```

When you create an image stream that references an image in an external Docker registry, OpenShift Online communicates with the external registry within a short amount of time to get up to date information about the image.

After the tag and image metadata is synchronized, the image stream object would look similar to the following:

```
apiVersion: v1
kind: ImageStream
metadata:
  name: my-ruby
  namespace: demo-project
  selflink: /oapi/v1/namespaces/demo-project/imagestreams/my-ruby
  uid: 5b9bd745-13d2-11e6-9a86-0ada84b8265d
  resourceVersion: '4699413'
  generation: 2
  creationTimestamp: '2016-05-06T21:34:48Z'
  annotations:
    openshift.io/image.dockerRepositoryCheck: '2016-05-06T21:34:48Z'
spec:
  dockerImageRepository: docker.io/openshift/ruby-20-centos7
  tags:
  -
    name: latest
    annotations: null
    from:
      kind: DockerImage
      name: 'docker.io/openshift/ruby-20-centos7:latest'
      generation: 2
      importPolicy: { }
status:
  dockerImageRepository: '172.30.94.234:5000/demo-project/my-ruby'
  tags:
  -
    tag: latest
    items:
    -
      created: '2016-05-06T21:34:48Z'
      dockerImageReference: 'docker.io/openshift/ruby-20-
```

```
centos7@sha256:772c5bf9b2d1e8e80742ed75aab05820419dc4532fa6d7ad8a1efddda5493dc3'
  image: 'sha256:772c5bf9b2d1e8e80742ed75aab05820419dc4532fa6d7ad8a1efddda5493dc3'
  generation: 2
```

You can set a tag to query external registries at a scheduled interval to synchronize tag and image metadata by setting the **--scheduled=true** flag with the **oc tag** command as mentioned in [Adding Tags to Image Streams](#).

Alternatively, you can set **importPolicy.scheduled** to **true** in the tag's definition:

```
apiVersion: v1
kind: ImageStream
metadata:
  name: ruby
spec:
  tags:
  - from:
    kind: DockerImage
    name: openshift/ruby-20-centos7
  name: latest
  importPolicy:
    scheduled: true
```

13.6.1. Importing Images from Insecure Registries

An image stream can be configured to import tag and image metadata from insecure image registries, such as those signed with a self-signed certificate or using plain HTTP instead of HTTPS.

To configure this, add the **openshift.io/image.insecureRepository** annotation and set it to **true**. This setting bypasses certificate validation when connecting to the registry:

```
kind: ImageStream
apiVersion: v1
metadata:
  name: ruby
  annotations:
    openshift.io/image.insecureRepository: "true" 1
spec:
  dockerImageRepository: my.repo.com:5000/myimage
```

1 Set the **openshift.io/image.insecureRepository** annotation to **true**



IMPORTANT

This option instructs integrated registry to fall back to an insecure transport for any external image tagged in the image stream when serving it, which is dangerous. If possible, avoid this risk by [marking just an istag as insecure](#).

13.6.1.1. Image Stream Tag Policies

13.6.1.1.1. Insecure Tag Import Policy

The above annotation applies to all images and tags of a particular **ImageStream**. For a finer-grained control, policies may be set on **istags**. Set **importPolicy.insecure** in the tag's definition to **true** to allow a fall-back to insecure transport just for images under this tag.



NOTE

The fall-back to insecure transport for an image under particular **istag** is enabled either when the image stream is annotated as insecure or the **istag** has insecure import policy. The **importPolicy.insecure** set to **false** can not override the image stream annotation.

13.6.1.1.2. Reference Policy

The Reference Policy allows you to specify from where resources that reference this image stream tag pulls the image. It is only applicable to remote images (those imported from external registries). There are two options to choose from, **Local** and **Source**.

The **Source** policy instructs clients to pull directly from the source registry of the image. The integrated registry is not involved unless the image is managed by the cluster. (It is not an external image.) This is the default policy.

The **Local** policy instructs clients to always pull from the integrated registry. This is useful if you want to pull from external insecure registries without modifying Docker daemon settings.

This policy only affects the use of the image stream tag. Components or operations that directly reference or pull the image using its external registry location is not redirected to the internal registry.

The pull-through feature

of the registry serves the remote image to the client. This feature, which is on by default, must be enabled for the local reference policy to be used. Additionally, by default, all the blobs are mirrored for faster access later.

You can set the policy in a specification of image stream tag as **referencePolicy.type**.

Example of Insecure Tag with a Local Reference Policy

```
kind: ImageStream
apiVersion: v1
metadata:
  name: ruby
  tags:
  - from:
    kind: DockerImage
    name: my.repo.com:5000/myimage
    name: mytag
    importPolicy:
      insecure: true ①
    referencePolicy:
      type: Local ②
```

① Set tag **mytag** to use an insecure connection to that registry.

② Set tag **mytag** to use integrated registry for pulling external images. If the reference policy type is set to **Source**, clients fetch the image directly from **my.repo.com:5000/myimage**.

13.6.2. Importing Images from Private Registries

An image stream can be configured to import tag and image metadata from private image registries, requiring authentication.

To configure this, you need to create a [secret](#), which is used to store your credentials. See [Allowing Pods to Reference Images from Other Secured Registries](#) for instructions on creating a secret using **oc create secret** command.

After the secret is configured, proceed with creating the new image stream or using the **oc import-image** command. During the import process, OpenShift Online picks up the secrets and provide them to the remote party.



NOTE

When importing from an insecure registry, the registry URL defined in the secret must include the **:80** port suffix or the secret is not used when attempting to import from the registry.

13.6.3. Adding Trusted Certificates for External Registries

If the registry you are importing from is using a certificate that is not signed by a standard certificate authority, you need to explicitly configure the system to trust the registry's certificate or signing authority. This can be done by adding the CA certificate or registry certificate to the host system running the registry import controller (typically the master node).

You must add the certificate or CA certificate to **/etc/pki/tls/certs** or **/etc/pki/ca-trust**, respectively, on the host system. You also need to run the **update-ca-trust** command on Red Hat distributions followed by a restart of the master services to pick up the certificate changes.

13.6.4. Importing Images Across Projects

An image stream can be configured to import tag and image metadata from the internal registry, but from a different project. The recommended method for this is to use the **oc tag** command as shown in [Adding Tags to Image Streams](#) :

```
$ oc tag <source_project>/<image_stream>:<tag> <new_image_stream>:<new_tag>
```

Another method is to import the image from the other project manually using the pull spec:



WARNING

The following method is strongly discouraged and should be used only if the former using **oc tag** is insufficient.

1. First, add the necessary [policy](#) to access the other project:

```
$ oc policy add-role-to-group \
  system:image-puller \
```

```
system:serviceaccounts:<destination_project> \
-n <source_project>
```

This allows **<destination_project>** to pull images from **<source_project>**.

2. With the policy in place, you can import the image manually:

```
$ oc import-image <new_image_stream> --confirm \
--from=<docker_registry>/<source_project>/<image_stream>
```

13.6.5. Creating an Image Stream by Manually Pushing an Image

An image stream can also be automatically created by manually pushing an image to the internal registry. This is only possible when using an OpenShift Online internal registry.

Before performing this procedure, the following must be satisfied:

- The destination project you push to must already exist.
- The user must be authorized to **{get, update} "imagestream/layers"** in that project. In addition, since the image stream does not already exist, the user must be authorized to **{create} "imagestream"** in that project. If you are a project administrator, then you would have these permissions.



NOTE

The **system:image-pusher** role does not grant permission to create new image streams, only to push images to existing image streams, so it cannot be used to push images to image streams that do not yet exist unless additional permissions are also granted to the user.

To create an image stream by manually pushing an image:

1. First, [log in to the internal registry](#) .
2. Then, tag your image using the appropriate internal registry location. For example, if you had already pulled the **docker.io/centos:centos7** image locally:

```
$ docker tag docker.io/centos:centos7 https://registry.<clusterID>.openshift.com
```

3. Finally, push the image to your internal registry. For example:

```
$ docker push https://registry.<clusterID>.openshift.com
The push refers to a repository [https://registry.<clusterID>.openshift.com] (len: 1)
c8a648134623: Pushed
2bf4902415e3: Pushed
latest: digest:
sha256:be8bc4068b2f60cf274fc216e4caba6aa845fff5fa29139e6e7497bb57e48d67 size:
6273
```

4. Verify that the image stream was created:

```
$ oc get is
NAME          DOCKER REPO          TAGS    UPDATED
my-image     172.30.48.125:5000/test/my-image  latest  3 seconds ago
```

13.7. TRIGGERING UPDATES ON IMAGE STREAM CHANGES

When an image stream tag is updated to point to a new image, OpenShift Online can automatically take action to roll the new image out to resources that were using the old image. This is configured in different ways depending on the type of resource that is referencing the image stream tag.

13.7.1. OpenShift Resources

OpenShift DeploymentConfigs and BuildConfigs can be automatically triggered by changes to ImageStreamTags. The triggered action can be run using the new value of the image referenced by the updated ImageStreamTag. For more details on using this capability see the documentation on [BuildConfig triggers](#) and [DeploymentConfig triggers](#).

13.7.2. Kubernetes Resources

Unlike DeploymentConfigs and BuildConfigs, which include as part of their API definition a set of fields for controlling triggers, Kubernetes resources do not have fields for triggering. Instead, OpenShift Online uses annotations to allow users to request triggering. The annotation is defined as follows:

```
Key: image.openshift.io/triggers
Value: array of triggers, where each item has the schema:
[
  {
    "from" :{
      "kind": "ImageStreamTag", // required, the resource to trigger from, must be ImageStreamTag
      "name": "example:latest", // required, the name of an ImageStreamTag
      "namespace": "myapp",    // optional, defaults to the namespace of the object
    },
    // required, JSON path to change
    // Note that this field is limited today, and only accepts a very specific set
    // of inputs (a JSON path expression that precisely matches a container by ID or index).
    // For pods this would be "spec.containers[?(@.name='web')].image".
    "fieldPath": "spec.template.spec.containers[?(@.name='web')].image",
    // optional, set to true to temporarily disable this trigger.
    "paused": "false"
  },
  ...
]
```

When OpenShift Online sees one of the core Kubernetes resources that contains both a pod template (i.e, only CronJobs, Deployments, StatefulSets, DaemonSets, Jobs, ReplicaSets, ReplicationControllers, and Pods) and this annotation, it attempts to update the object using the image currently associated with the ImageStreamTag referenced by trigger. The update is performed against the **fieldPath** specified.

In the following example the trigger fires when the **example:latest** imagestream tag is updated. Upon firing, the object's pod template image reference for the **web** container is updated with a new image value. If the pod template is part of a Deployment definition, the change to the pod template automatically triggers a deployment, effectively rolling out the new image.

```
image.openshift.io/triggers=[{"from":
{"kind":"ImageStreamTag","name":"example:latest"},"fieldPath":"spec.template.spec.containers[?
(@.name='web')].image"}]
```

When adding an Image Trigger to Deployments, you can also use the **oc set triggers** command. For example the following command adds an image change trigger to the Deployment named **example** such that when the **example:latest** image stream tag is updated, the **web** container inside the deployment updates with the new image value:

```
$ oc set triggers deploy/example --from-image=example:latest -c web
```

Unless the Deployment is paused, this pod template update automatically causes a deployment to occur with the new image value.

13.8. WRITING IMAGE STREAM DEFINITIONS

You can define image streams by writing the image stream definition for the entire image stream. This allows you to distribute the definition to different clusters without running **oc** commands.

An image stream definition specifies information about the image stream and the specific tags to be imported.

Definition of an Image Stream Object

```
apiVersion: v1
kind: ImageStream
metadata:
  name: ruby
  annotations:
    openshift.io/display-name: Ruby 1
spec:
  tags:
    - name: '2.0' 2
      annotations:
        openshift.io/display-name: Ruby 2.0 3
      description: >- 4
        Build and run Ruby 2.0 applications on CentOS 7. For more information
        about using this builder image, including OpenShift considerations,
        see
        https://github.com/sclorg/s2i-ruby-container/tree/master/2.0/README.md.
      iconClass: icon-ruby 5
      sampleRepo: 'https://github.com/sclorg/ruby-ex.git' 6
      tags: 'builder,ruby' 7
      supports: 'ruby' 8
      version: '2.0' 9
  from:
    kind: DockerImage 10
    name: 'docker.io/openshift/ruby-20-centos7:latest' 11
```

1 A brief, user-friendly name for the whole image stream.

2 The tag is referred to as the version. Tags appear in a drop-down menu.

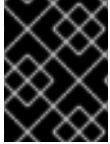
- 3 A user-friendly name for this tag within the image stream. This should be brief and include version information when appropriate.
- 4 A description of the tag, which includes enough detail for users to understand what the image is providing. It can include links to additional instructions. Limit the description to a few sentences.
- 5 The icon to show for this tag. Pick from our existing [logo icons](#) when possible. Icons from [FontAwesome](#) and [Patternfly](#) can also be used. Alternatively, provide icons through CSS customizations that can be added to an OpenShift Online cluster that uses your image stream. You must specify an icon class that exists, or it prevents falling back to the generic icon.
- 6 A URL to a source repository that works with this builder image tag and results in a sample running application.
- 7 Categories that the image stream tag is associated with. The builder tag is required for it to show up in the catalog. Add tags that associates it with one of the provided catalog categories. Refer to the **id** and **categoryAliases** in **CATALOG_CATEGORIES** in the console's [constants file](#). The categories can also be customized for the whole cluster.
- 8 Languages this image supports. This value is used during **oc new-app** invocations to try to match potential builder images to the provided source repository.
- 9 Version information for this tag.
- 10 The type of object this image stream tag is referencing. Valid values are: **DockerImage**, **ImageStreamTag**, and **ImageStreamImage**.
- 11 The object this image stream tag imports.

For more information on the fields that can be defined in an **ImageStream**, see the [Imagestream API](#) and the [ImagestreamTag API](#).

CHAPTER 14. QUOTAS AND LIMIT RANGES

14.1. OVERVIEW

Using [quotas](#) and [limit ranges](#), cluster administrators can set constraints to limit the number of objects or amount of compute resources that are used in your project. This helps cluster administrators better manage and allocate resources across all projects, and ensure that no projects are using more than is appropriate for the cluster size.



IMPORTANT

OpenShift Online Pro project owners can change quotas for their project, but not limit ranges. OpenShift Online Starter users cannot modify quotas or limit ranges.

The following sections help you understand how to check on your quota and limit range settings, what sorts of things they can constrain, and how you can request or limit compute resources in your own pods and containers.

14.2. QUOTAS

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 may be consumed by resources in that project.



NOTE

Quotas are set by cluster administrators and are scoped to a given project.

14.2.1. Viewing Quotas

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:

1. First, get the list of quotas defined in the project. For example, for a project called **demoproject**:

```
$ oc get quota -n demoproject
NAME          AGE
besteffort    11m
compute-resources  2m
core-object-counts  29m
```

2. Then, describe the quota you are interested in, for example the **core-object-counts** quota:

```
$ oc describe quota core-object-counts -n demoproject
Name: core-object-counts
Namespace: demoproject
Resource Used Hard
-----
```

```

configmaps 3 10
persistentvolumeclaims 0 4
replicationcontrollers 3 20
secrets 9 10
services 2 10

```

Full quota definitions can be viewed by running **oc export** on the object. The following show some sample 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

```

- 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.

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
  limits.cpu: "2" 4
  limits.memory: 2Gi 5

```

- 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 CPU limits cannot exceed 2 cores.
- 5 Across all pods in a non-terminal state, the sum of memory limits cannot exceed 2Gi.

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
  scopes:
    - NotTerminating 4

```

- 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 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
  scopes:
    - Terminating 4

```

- 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 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 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 is set to **0**, it means bronze storage class cannot create claims.

14.2.2. Resources Managed by Quota

The following describes the set of compute resources and object types that may be managed by a quota.



NOTE

A pod is in a terminal state if **status.phase in (Failed, Succeeded)** is true.

Table 14.1. 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.
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.
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.

Table 14.2. 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 14.3. 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 replication controllers 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.
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 image streams that can exist in the project.

14.2.3. Quota Scopes

Each quota can have an associated set of scopes. A quota will only measure 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**

14.2.4. 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. If project modifications exceed a quota usage limit, the server denies the action. An appropriate error message is returned explaining the quota constraint violated, and what your currently observed usage stats are in the system.

14.2.5. Requests Versus Limits

When allocating [compute resources](#), each container may specify a request and a limit value each for CPU and memory. 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.

See [Compute Resources](#) for more on setting requests and limits in pods and containers.

14.3. LIMIT RANGES

A limit range, defined by a **LimitRange** object, enumerates [compute resource constraints](#) in a [project](#) at the pod, container, image, image stream, and persistent volume claim level, and specifies the amount of resources that a pod, container, image, image stream, or persistent volume claim can consume.

All resource create and modification requests are evaluated against each **LimitRange** object in the project. If the resource violates any of the enumerated constraints, then the resource is rejected. If the resource does not set an explicit value, and if the constraint supports a default value, then the default value is applied to the resource.



NOTE

Limit ranges are set by cluster administrators and are scoped to a given project.

14.3.1. Viewing Limit Ranges

You can view any limit ranges defined in a project by navigating in the web console to the project's **Quota** page.

You can also use the CLI to view limit range details:

1. First, get the list of limit ranges defined in the project. For example, for a project called **demoproject**:

```
$ oc get limits -n demoproject
NAME          AGE
resource-limits 6d
```

2. Then, describe the limit range you are interested in, for example the **resource-limits** limit range:

```
$ oc describe limits resource-limits -n demoproject
Name:          resource-limits
Namespace:     demoproject
Type           Resource      Min  Max  Default Request Default Limit  Max
Limit/Request Ratio
-----
Pod            cpu           200m 2    -    -      -
Pod            memory        6Mi  1Gi  -    -      -
Container     cpu           100m 2    200m 300m   10
Container     memory        4Mi  1Gi  100Mi 200Mi  -
openshift.io/Image      storage      -    1Gi  -    -      -
openshift.io/ImageStream  openshift.io/image -    12  -    -      -
openshift.io/ImageStream  openshift.io/image-tags -    10  -    -      -
```

Full limit range definitions can be viewed by running **oc export** on the object. The following shows an example limit range definition:



IMPORTANT

For OpenShift Online Pro, the maximum pod memory is 3Gi. The minimum pod or container memory that you can specify is 100Mi.

For OpenShift Online Starter, the maximum pod memory is 1Gi. The minimum pod or container memory that you can specify is 200Mi.

Core Limit Range Object Definition

```

apiVersion: "v1"
kind: "LimitRange"
metadata:
  name: "core-resource-limits" 1
spec:
  limits:
    - type: "Pod"
      max:
        cpu: "2" 2
        memory: "1Gi" 3
      min:
        cpu: "200m" 4
        memory: "6Mi" 5
    - type: "Container"
      max:
        cpu: "2" 6
        memory: "1Gi" 7
      min:
        cpu: "100m" 8
        memory: "4Mi" 9
      default:
        cpu: "300m" 10
        memory: "200Mi" 11
      defaultRequest:
        cpu: "200m" 12
        memory: "100Mi" 13
      maxLimitRequestRatio:
        cpu: "10" 14
  
```

- 1 The name of the limit range object.
- 2 The maximum amount of CPU that a pod can request on a node across all containers.
- 3 The maximum amount of memory that a pod can request on a node across all containers.
- 4 The minimum amount of CPU that a pod can request on a node across all containers.
- 5 The minimum amount of memory that a pod can request on a node across all containers.
- 6 The maximum amount of CPU that a single container in a pod can request.
- 7 The maximum amount of memory that a single container in a pod can request.
- 8 The minimum amount of CPU that a single container in a pod can request.

- 9 The minimum amount of memory that a single container in a pod can request.
- 10 The default amount of CPU that a container will be limited to use if not specified.
- 11 The default amount of memory that a container will be limited to use if not specified.
- 12 The default amount of CPU that a container will request to use if not specified.
- 13 The default amount of memory that a container will request to use if not specified.
- 14 The maximum amount of CPU burst that a container can make as a ratio of its limit over request.

For more information on how CPU and memory are measured, see [Compute Resources](#).

14.3.2. Container Limits

Supported Resources:

- CPU
- Memory

Supported Constraints:

Per container, the following must hold true if specified:

Table 14.4. Container

Constraint	Behavior
Min	<p>Min[resource] less than or equal to container.resources.requests[resource] (required) less than or equal to container/resources.limits[resource] (optional)</p> <p>If the configuration defines a min CPU, then the request value must be greater than the CPU value. A limit value does not need to be specified.</p>
Max	<p>container.resources.limits[resource] (required) less than or equal to Max[resource]</p> <p>If the configuration defines a max CPU, then you do not need to define a request value, but a limit value does need to be set that satisfies the maximum CPU constraint.</p>

Constraint	Behavior
MaxLimitRequestRatio	<p>MaxLimitRequestRatio[resource] less than or equal to (container.resources.limits[resource] / container.resources.requests[resource])</p> <p>If a configuration defines a maxLimitRequestRatio value, then any new containers must have both a request and limit value. Additionally, OpenShift Online calculates a limit to request ratio by dividing the limit by the request. This value should be a non-negative integer greater than 1.</p> <p>For example, if a container has cpu: 500 in the limit value, and cpu: 100 in the request value, then its limit to request ratio for cpu is 5. This ratio must be less than or equal to the maxLimitRequestRatio.</p>

Supported Defaults:

Default[resource]

Defaults **container.resources.limit[resource]** to specified value if none.

Default Requests[resource]

Defaults **container.resources.requests[resource]** to specified value if none.

14.3.3. Pod Limits

Supported Resources:

- CPU
- Memory

Supported Constraints:

Across all containers in a pod, the following must hold true:

Table 14.5. Pod

Constraint	Enforced Behavior
Min	Min[resource] less than or equal to container.resources.requests[resource] (required) less than or equal to container.resources.limits[resource] (optional)
Max	container.resources.limits[resource] (required) less than or equal to Max[resource]
MaxLimitRequestRatio	MaxLimitRequestRatio[resource] less than or equal to (container.resources.limits[resource] / container.resources.requests[resource])

14.4. COMPUTE RESOURCES

Each container running on a node consumes compute resources, which are measurable quantities that can be requested, allocated, and consumed.

When authoring a pod configuration file, you can optionally specify how much CPU and memory (RAM) each container needs in order to better schedule pods in the cluster and ensure satisfactory performance.

CPU is measured in units called millicores. Each node in a cluster inspects the operating system to determine the amount of CPU cores on the node, then multiplies that value by 1000 to express its total capacity. For example, if a node has 2 cores, the node's CPU capacity would be represented as 2000m. If you wanted to use 1/10 of a single core, it would be represented as 100m.

Memory is measured in bytes. In addition, it may be used with SI suffices (E, P, T, G, M, K) or their power-of-two-equivalents (Ei, Pi, Ti, Gi, Mi, Ki).

```
apiVersion: v1
kind: Pod
spec:
  containers:
  - image: openshift/hello-openshift
    name: hello-openshift
    resources:
      requests:
        cpu: 100m ①
        memory: 200Mi ②
      limits:
        cpu: 200m ③
        memory: 400Mi ④
```

- ① The container requests 100m CPU.
- ② The container requests 200Mi memory.
- ③ The container limits 200m CPU.
- ④ The container limits 400Mi memory.

14.4.1. CPU Requests

Each container in a pod can specify the amount of CPU it requests on a node. The scheduler uses CPU requests to find a node with an appropriate fit for a container.

The CPU request represents a minimum amount of CPU that your container may consume, but if there is no contention for CPU, it can use all available CPU on the node. If there is CPU contention on the node, CPU requests provide a relative weight across all containers on the system for how much CPU time the container may use.

On the node, CPU requests map to Kernel CFS shares to enforce this behavior.



NOTE

In OpenShift Online, CPU requests are set automatically based on the memory limit specified. If no memory limit is specified, a CPU request of **60m** is set.

14.4.2. Viewing Compute Resources

To view compute resources for a pod:

```
$ oc describe pod ruby-hello-world-tfjxt
Name:      ruby-hello-world-tfjxt
Namespace: default
Image(s):  ruby-hello-world
Node:      /
Labels:    run=ruby-hello-world
Status:    Pending
Reason:
Message:
IP:
Replication Controllers: ruby-hello-world (1/1 replicas created)
Containers:
  ruby-hello-world:
    Container ID:
    Image ID:
    Image: ruby-hello-world
    QoS Tier:
      cpu: Burstable
      memory: Burstable
    Limits:
      cpu: 200m
      memory: 400Mi
    Requests:
      cpu: 100m
      memory: 200Mi
    State: Waiting
    Ready: False
    Restart Count: 0
    Environment Variables:
```

14.4.3. CPU Limits

Each container in a pod can specify the amount of CPU it is limited to use on a node. CPU limits control the maximum amount of CPU that your container may use independent of contention on the node. If a container attempts to exceed the specified limit, the system will throttle the container. This allows the container to have a consistent level of service independent of the number of pods scheduled to the node.



NOTE

In OpenShift Online, CPU limits are set automatically based on the memory limit specified. If no memory limit is specified, a CPU limit of **1** core is set.

14.4.4. Memory Requests

By default, a container is able to consume as much memory on the node as possible. In order to improve placement of pods in the cluster, specify the amount of memory required for a container to run. The scheduler will then take available node memory capacity into account prior to binding your pod to a node. A container is still able to consume as much memory on the node as possible even when specifying a request.

**NOTE**

In OpenShift Online, memory requests are set automatically based on the memory limit specified. If no memory limit is specified, a memory request of **307Mi** is assumed.

14.4.5. Memory Limits

If you specify a memory limit, you can constrain the amount of memory the container can use. For example, if you specify a limit of 200Mi, a container will be limited to using that amount of memory on the node. If the container exceeds the specified memory limit, it will be terminated and potentially restarted dependent upon the container restart policy.

**NOTE**

In OpenShift Online, the memory request, CPU request, and CPU limit will automatically be determined and set appropriately based off of the specified memory limit. If no memory limit is specified, a memory limit of **512Mi** is assumed.

14.4.6. Quality of Service Tiers

When created, a compute resource is classified with a *quality of service* (QoS). There are three tiers, and each is based on the request and limit value specified for each resource:

Quality of Service	Description
BestEffort	Provided when a request and limit are not specified.
Burstable	Provided when a request is specified that is less than an optionally specified limit.
Guaranteed	Provided when a limit is specified that is equal to an optionally specified request.

If a container has requests and limits set that would result in a different quality of service for each compute resource, it will be classified as **Burstable**.

The quality of service has different impacts on different resources, depending on whether the resource is compressible or not. CPU is a compressible resource, whereas memory is an incompressible resource.

With CPU Resources:

- A **BestEffort CPU** container is able to consume as much CPU as is available on a node but runs with the lowest priority.
- A **Burstable CPU** container is guaranteed to get the minimum amount of CPU requested, but it may or may not get additional CPU time. Excess CPU resources are distributed based on the amount requested across all containers on the node.
- A **Guaranteed CPU** container is guaranteed to get the amount requested and no more, even if there are additional CPU cycles available. This provides a consistent level of performance independent of other activity on the node.

With Memory Resources:

- A **BestEffort memory** container is able to consume as much memory as is available on the node, but there are no guarantees that the scheduler will place that container on a node with enough memory to meet its needs. In addition, a **BestEffort** container has the greatest chance of being killed if there is an out of memory event on the node.
- A **Burstable memory** container is scheduled on the node to get the amount of memory requested, but it may consume more. If there is an out of memory event on the node, **Burstable** containers are killed after **BestEffort** containers when attempting to recover memory.
- A **Guaranteed memory** container gets the amount of memory requested, but no more. In the event of an out of memory event, it will only be killed if there are no more **BestEffort** or **Burstable** containers on the system.

14.4.7. Specifying Compute Resources via CLI

To specify compute resources via the CLI:

```
$ oc run ruby-hello-world --image=ruby-hello-world --limits=memory=400Mi
```

CHAPTER 15. ROUTES

15.1. OVERVIEW

An OpenShift Online [route](#) exposes a [service](#) at a host name, like `www.example.com`, so that external clients can reach it by name.

DNS resolution for a host name is handled separately from routing; your administrator may have configured a cloud domain that will always correctly resolve to the OpenShift Online router, or if using an unrelated host name you may need to modify its DNS records independently to resolve to the router.

15.2. CREATING ROUTES

You can create unsecured and secured routes using the web console or the CLI.

Using the web console, you can navigate to the **Routes** page, found under the **Applications** section of the navigation.

Click **Create Route** to define and create a route in your project:

Figure 15.1. Creating a Route Using the Web Console

OPENSIFT My Project Add to Project

Routes > Create Route

Create Route

Routing is a way to make your application publicly visible.

*** Name**

 A unique name for the route within the project.

Hostname

 Public hostname for the route. If not specified, a hostname is generated.
 The hostname can't be changed after the route is created.

Path

 Path that the router watches to route traffic to the service.

*** Service**

 Service to route to.

Target Port

 Target port for traffic.

Alternate Services
 Split traffic across multiple services
 Routes can direct traffic to multiple services for A/B testing. Each service has a weight controlling how much traffic it gets.

Security
 Secure route
 Routes can be secured using several TLS termination types for serving certificates.

Labels [About Labels](#)
 Labels for this route.
 ×
[Add Label](#)

Using the CLI, create an unsecured route. For OpenShift Online Starter, follow this example:

```
$ oc expose svc/frontend
```

For OpenShift Online Pro, follow this example, with **--hostname** being optional:

```
$ oc expose svc/frontend --hostname=www.example.com
```

The new route inherits the name from the service unless you specify one using the **--name** option.

YAML Definition of the Unsecured Route Created Above

```
apiVersion: v1
kind: Route
metadata:
  name: frontend
spec:
  to:
    kind: Service
    name: frontend
```

For information on configuring routes using the CLI, see [Route Types](#).

Unsecured routes are the default configuration, and are therefore the simplest to set up. However, [secured routes](#) offer security for connections to remain private. To create a secured HTTPS route encrypted with the default certificate for OpenShift Online 3 you can use the **create route** command.



NOTE

[TLS](#) is the replacement of SSL for HTTPS and other encrypted protocols.

For OpenShift Online Starter:

```
$ oc create route edge --service=frontend
```

YAML Definition of the Secured Route Created Above

```
apiVersion: v1
kind: Route
metadata:
  name: frontend
spec:
  to:
    kind: Service
    name: frontend
  tls:
    termination: edge
```

For OpenShift Online Pro, you can use your own certificate and key files from a CA. However, you can still omit the certificate and key files if you want to use the default certificate. With OpenShift Online Starter, you cannot specify a certificate and key.

For OpenShift Online Pro:

```
$ oc create route edge --service=frontend \
  --cert=example.crt \
  --key=example.key \
  --ca-cert=ca.crt \
  --hostname=www.example.com
```

YAML Definition of the Secured Route Created Above

```
apiVersion: v1
```

```

kind: Route
metadata:
  name: frontend
spec:
  host: www.example.com
  to:
    kind: Service
    name: frontend
  tls:
    termination: edge
    key: |-
      -----BEGIN PRIVATE KEY-----
      [...]
      -----END PRIVATE KEY-----
    certificate: |-
      -----BEGIN CERTIFICATE-----
      [...]
      -----END CERTIFICATE-----
    caCertificate: |-
      -----BEGIN CERTIFICATE-----
      [...]
      -----END CERTIFICATE-----

```

Currently, password protected key files are not supported. To remove a passphrase from a keyfile, you can run:

```
# openssl rsa -in <passwordProtectedKey.key> -out <new.key>
```

Further information on all types of [TLS termination](#) as well as [path-based routing](#) are available in the [Architecture section](#).

15.3. ALLOWING ROUTE ENDPOINTS TO CONTROL COOKIE NAMES

OpenShift Online provides sticky sessions, which enables stateful application traffic by ensuring all traffic hits the same endpoint. However, if the endpoint pod terminates, whether through restart, scaling, or a change in configuration, this statefulness can disappear.

OpenShift Online can use cookies to configure session persistence. The router selects an endpoint to handle any user requests, and creates a cookie for the session. The cookie is passed back in the response to the request and the user sends the cookie back with the next request in the session. The cookie tells the router which endpoint is handling the session, ensuring that client requests use the cookie so that they are routed to the same pod.

You can set a cookie name to overwrite the default, auto-generated one for the route. By deleting the cookie it can force the next request to re-choose an endpoint. So, if a server was overloaded it tries to remove the requests from the client and redistribute them.

1. Annotate the route with the desired cookie name:

```
$ oc annotate route <route_name> router.openshift.io/cookie_name="<your_cookie_name>"
```

For example, to specify **my_cookie** as your new cookie name:

```
$ oc annotate route my_route router.openshift.io/cookie_name="my_cookie"
```

2. Save the cookie, and access the route:

```
$ curl $my_route -k -c /tmp/my_cookie
```

15.4. RESTRICTIONS

Routes are restricted in OpenShift Online Starter, but are not restricted in OpenShift Online Pro. Custom route hosts are permitted in OpenShift Online Pro. If using OpenShift Online Starter, the following host template is enforced on all user routes:

```
<route-name>-<namespace>.<external-address>
```

For example:

```
<route-name>-<namespace>.44fs.preview.openshiftapps.com
```

To determine the external address, run:

```
$ oc get route/<route-name>
```

Custom certificates are permitted in OpenShift Online Pro. In OpenShift Online Starter, only unencrypted routes, edge routes using the default certificate, and passthrough routes work. Edge and re-encrypt routes with custom certificates do not work in OpenShift Online Starter.

These restrictions are enforced by the API. Attempts to create routes with custom hosts or certificates will be rejected in OpenShift Online Starter. In OpenShift Online Pro, a default host is provided if the user does not specify a custom host.

15.5. UPDATE DNS FOR CUSTOM ROUTES

Once your custom route is created in OpenShift Online Pro, you must update your DNS provider by creating a canonical name (CNAME) record. Your CNAME record should point your custom domain to the OpenShift Online router as the alias. The OpenShift Online router's domain is different for every cluster.



NOTE

CNAME records cannot be set for a naked domain (**example.com**). A subdomain must be specified (**www.example.com**).

In OpenShift Online Pro, you can view a created custom route to see the CNAME record that you must provide to your DNS provider.

[Routes](#) » [my-route](#)**my-route** created a day ago

Actions ▾

app **ruby-ex**<https://ruby-ex.localhost.dev>

✓ Exposed on router 'router' a day ago



The DNS admin should set up a CNAME from the route's hostname, `ruby-ex.localhost.dev`, to the router's canonical hostname, `router.example.com`. [Don't Show Me Again](#)

Details

Path: *none*
Service: [ruby-ex](#)
Target Port: 8080-tcp

This target port will route to Service Port 8080 → Container Port 8080 (TCP).

TLS Settings

Termination Type: Edge
Insecure Traffic: Redirect
Certificate: *none*
Key: *none*
CA Certificate: *none*
Destination CA Cert: *none*

CHAPTER 16. INTEGRATING EXTERNAL SERVICES

16.1. OVERVIEW

Many OpenShift Online applications use external resources, such as external databases, or an external SaaS endpoint. These external resources can be modeled as native OpenShift Online services, so that applications can work with them as they would any other internal service.

16.2. DEFINING A SERVICE FOR AN EXTERNAL DATABASE

One of the most common types of external services is an external database. To support an external database, an application needs:

1. An endpoint to communicate with.
2. A set of credentials and coordinates, including:
 - A user name
 - A passphrase
 - A database name

The solution for integrating with an external database includes:

- A **Service** object to represent the SaaS provider as an OpenShift Online service.
- One or more **Endpoints** for the service.
- Environment variables in the appropriate pods containing the credentials.

The following steps outline a scenario for integrating with an external MySQL database:

16.2.1. Step 1: Define a Service

You can define a service either by providing an IP address and endpoints, or by providing a Fully qualified domain name (FQDN).

16.2.1.1. Using an IP address

1. Create an [OpenShift Online service](#) to represent your external database. This is similar to creating an internal service; the difference is in the service's **Selector** field. Internal OpenShift Online services use the **Selector** field to associate pods with services using [labels](#). The **EndpointsController** system component synchronizes the endpoints for services that specify selectors with the pods that match the selector. The [service proxy](#) and OpenShift Online [router](#) load-balance requests to the service amongst the service's endpoints.

Services that represent an external resource do not require associated pods. Instead, leave the **Selector** field unset. This represents the external service, making the **EndpointsController** ignore the service and allows you to specify endpoints manually:

```
kind: "Service"
apiVersion: "v1"
metadata:
```

```

name: "external-mysql-service"
spec:
  ports:
  -
    name: "mysql"
    protocol: "TCP"
    port: 3306
    targetPort: 3306 ❶
    nodePort: 0
  selector: {} ❷

```

❶ Optional: The port on the backing pods to which the service forwards connections.

❷ The **selector** field to leave blank.

- Next, create the required endpoints for the service. This gives the service proxy and router the location to send traffic directed to the service:

```

kind: "Endpoints"
apiVersion: "v1"
metadata:
  name: "external-mysql-service" ❶
subsets: ❷
-
  addresses:
  -
    ip: "10.0.0.0" ❸
  ports:
  -
    port: 3306 ❹
    name: "mysql"

```

❶ The name of the **Service** instance, as defined in the previous step.

❷ Traffic to the service will be load-balanced between the supplied **Endpoints** if more than one is supplied.

❸ Endpoints IPs **cannot be** loopback (127.0.0.0/8), link-local (169.254.0.0/16), or link-local multicast (224.0.0.0/24).

❹ The **port** and **name** definition must match the **port** and **name** value in the service defined in the previous step.

16.2.1.2. Using an External Domain Name

Using external domain names make it easier to manage an external service linkage, because you do not have to worry about the external service's IP addresses changing.

ExternalName services do not have selectors, or any defined ports or endpoints, therefore, you can use an **ExternalName** service to direct traffic to an external service.

```

kind: "Service"
apiVersion: "v1"

```

```

metadata:
  name: "external-mysql-service"
spec:
  type: ExternalName
  externalName: example.domain.name
selector: {} 1

```

- 1 The **selector** field to leave blank.

Using an external domain name service tells the system that the DNS name in the **externalName** field (**example.domain.name** in the previous example) is the location of the resource that backs the service. When a DNS request is made against the Kubernetes DNS server, it returns the **externalName** in a CNAME record telling the client to look up the returned name to get the IP address.

16.2.2. Step 2: Consume a Service

Now that the service and endpoints are defined, give the appropriate pods access to the credentials to use the service by setting environment variables in the appropriate containers:

```

kind: "DeploymentConfig"
apiVersion: "v1"
metadata:
  name: "my-app-deployment"
spec: 1
  strategy:
    type: "Rolling"
    rollingParams:
      updatePeriodSeconds: 1 2
      intervalSeconds: 1 3
      timeoutSeconds: 120
  replicas: 2
  selector:
    name: "frontend"
  template:
    metadata:
      labels:
        name: "frontend"
    spec:
      containers:
        -
          name: "helloworld"
          image: "origin-ruby-sample"
          ports:
            -
              containerPort: 3306
              protocol: "TCP"
          env:
            -
              name: "MYSQL_USER"
              value: "${MYSQL_USER}" 4
            -
              name: "MYSQL_PASSWORD"
              value: "${MYSQL_PASSWORD}" 5

```



```

-
  name: "MYSQL_DATABASE"
  value: "${MYSQL_DATABASE}" 6

```

- 1 Other fields on the **DeploymentConfig** are omitted
- 2 The time to wait between individual pod updates.
- 3 The time to wait between polling the deployment status after update.
- 4 The user name to use with the service.
- 5 The passphrase to use with the service.
- 6 The database name.

External Database Environment Variables

Using an external service in your application is similar to using an internal service. Your application will be assigned environment variables for the service and the additional environment variables with the credentials described in the previous step. For example, a MySQL container receives the following environment variables:

- **EXTERNAL_MYSQL_SERVICE_SERVICE_HOST=<ip_address>**
- **EXTERNAL_MYSQL_SERVICE_SERVICE_PORT=<port_number>**
- **MYSQL_USERNAME=<mysql_username>**
- **MYSQL_PASSWORD=<mysql_password>**
- **MYSQL_DATABASE_NAME=<mysql_database>**

The application is responsible for reading the coordinates and credentials for the service from the environment and establishing a connection with the database via the service.

16.3. EXTERNAL SAAS PROVIDER

A common type of external service is an external SaaS endpoint. To support an external SaaS provider, an application needs:

1. An endpoint to communicate with
2. A set of credentials, such as:
 - a. An API key
 - b. A user name
 - c. A passphrase

The following steps outline a scenario for integrating with an external SaaS provider:

16.3.1. Using an IP address and Endpoints

1. Create an [OpenShift Online service](#) to represent the external service. This is similar to creating an internal service; however the difference is in the service's **Selector** field. Internal OpenShift Online services use the **Selector** field to associate pods with services using [labels](#). A system component called **EndpointsController** synchronizes the endpoints for services that specify selectors with the pods that match the selector. The [service proxy](#) and OpenShift Online [router](#) load-balance requests to the service amongst the service's endpoints.

Services that represents an external resource do not require that pods be associated with it. Instead, leave the **Selector** field unset. This makes the **EndpointsController** ignore the service and allows you to specify endpoints manually:

```
kind: "Service"
apiVersion: "v1"
metadata:
  name: "example-external-service"
spec:
  ports:
  -
    name: "mysql"
    protocol: "TCP"
    port: 3306
    targetPort: 3306 1
    nodePort: 0
  selector: {} 2
```

1 Optional: The port on the backing pods to which the service forwards connections.

2 The **selector** field to leave blank.

2. Next, create endpoints for the service containing the information about where to send traffic directed to the service proxy and the router:

```
kind: "Endpoints"
apiVersion: "v1"
metadata:
  name: "example-external-service" 1
subsets: 2
- addresses:
  - ip: "10.10.1.1"
  ports:
  - name: "mysql"
    port: 3306
```

1 The name of the **Service** instance.

2 Traffic to the service is load-balanced between the **subsets** supplied here.

3. Now that the service and endpoints are defined, give pods the credentials to use the service by setting environment variables in the appropriate containers:

```
kind: "DeploymentConfig"
apiVersion: "v1"
metadata:
```

```

name: "my-app-deployment"
spec: ❶
  strategy:
    type: "Rolling"
    rollingParams:
      timeoutSeconds: 120
  replicas: 1
  selector:
    name: "frontend"
  template:
    metadata:
      labels:
        name: "frontend"
    spec:
      containers:
        -
          name: "helloworld"
          image: "openshift/openshift/origin-ruby-sample"
          ports:
            -
              containerPort: 3306
              protocol: "TCP"
          env:
            -
              name: "SAAS_API_KEY" ❷
              value: "<SaaS service API key>"
            -
              name: "SAAS_USERNAME" ❸
              value: "<SaaS service user>"
            -
              name: "SAAS_PASSPHRASE" ❹
              value: "<SaaS service passphrase>"

```

- ❶ Other fields on the **DeploymentConfig** are omitted.
- ❷ **SAAS_API_KEY**: The API key to use with the service.
- ❸ **SAAS_USERNAME**: The user name to use with the service.
- ❹ **SAAS_PASSPHRASE**: The passphrase to use with the service.

These variables get added to the containers as environment variables. Using environment variables allows service-to-service communication and it may or may not require additional parameters such as API keys, user name and password authentication, or certificates.

External SaaS Provider Environment Variables

Similarly, when using an internal service, your application is assigned environment variables for the service and the additional environment variables with the credentials described in the previous steps. In the previous example, the container receives the following environment variables:

- **EXAMPLE_EXTERNAL_SERVICE_SERVICE_HOST=<ip_address>**
- **EXAMPLE_EXTERNAL_SERVICE_SERVICE_PORT=<port_number>**

- **SAAS_API_KEY=<saas_api_key>**
- **SAAS_USERNAME=<saas_username>**
- **SAAS_PASSPHRASE=<saas_passphrase>**

The application reads the coordinates and credentials for the service from the environment and establishes a connection with the service.

16.3.2. Using an External Domain Name

ExternalName services do not have selectors, or any defined ports or endpoints. You can use an **ExternalName** service to assign traffic to an external service outside the cluster.

```
kind: "Service"
apiVersion: "v1"
metadata:
  name: "external-mysql-service"
spec:
  type: ExternalName
  externalName: example.domain.name
  selector: {} 1
```

- 1** The **selector** field to leave blank.

Using an **ExternalName** service maps the service to the value of the **externalName** field (**example.domain.name** in the previous example), by automatically injecting a CNAME record, mapping the service name directly to an outside DNS address, and bypassing the need for endpoint records.

CHAPTER 17. SECRETS

17.1. USING SECRETS

This topic discusses important properties of secrets and provides an overview on how developers can use them.

The **Secret** object type provides a mechanism to hold sensitive information such as passwords, OpenShift Online client configuration files, **dockercfg** files, private source repository credentials, and so on. Secrets decouple sensitive content from the pods. You can mount secrets into containers using a volume plug-in or the system can use secrets to perform actions on behalf of a pod.

YAML Secret Object Definition

```
apiVersion: v1
kind: Secret
metadata:
  name: test-secret
  namespace: my-namespace
type: Opaque 1
data: 2
  username: dmFsdWUtMQ0K 3
  password: dmFsdWUtMg0KDQo=
stringData: 4
  hostname: myapp.mydomain.com 5
```

- 1** Indicates the [structure of the secret's key names and values](#).
- 2** The allowable format for the keys in the **data** field must meet the guidelines in the **DNS_SUBDOMAIN** value in [the Kubernetes identifiers glossary](#).
- 3** The value associated with keys in the the **data** map must be base64 encoded.
- 4** The value associated with keys in the the **stringData** map is made up of plain text strings.
- 5** Entries in the **stringData** map are converted to base64 and the entry will then be moved to the **data** map automatically. This field is write-only; the value will only be returned via the **data** field.

1. Create the secret from your local **.docker/config.json** file:

```
$ oc create secret generic dockerhub \
  --from-file=.dockerconfigjson=<path/to/.docker/config.json> \
  --type=kubernetes.io/dockerconfigjson
```

This command generates a JSON specification of the secret named **dockerhub** and creates the object.

YAML Opaque Secret Object Definition

```
apiVersion: v1
kind: Secret
metadata:
  name: mysecret
```

```
type: Opaque 1
data:
  username: dXNlci1uYW1l
  password: cGFzc3dvcmQ=
```

- 1** Specifies an *opaque* secret.

Docker Configuration JSON File Secret Object Definition

```
apiVersion: v1
kind: Secret
metadata:
  name: aregistrykey
  namespace: myapps
type: kubernetes.io/dockerconfigjson 1
data:
  .dockerconfigjson:bm5ubm5ubm5ubm5ubm5ubm5ubmdnZ2dnZ2dnZ2dnZ2dnZ2cgYXV0aC
  BrZXlzCg== 2
```

- 1** Specifies that the secret is using a Docker configuration JSON file.
- 2** The output of a base64-encoded the Docker configuration JSON file

17.1.1. Properties of Secrets

Key properties include:

- Secret data can be referenced independently from its definition.
- Secret data volumes are backed by temporary file-storage facilities (tmpfs) and never come to rest on a node.
- Secret data can be shared within a namespace.

17.1.2. Creating Secrets

You must create a secret before creating the pods that depend on that secret.

When creating secrets:

- Create a secret object with secret data.
- Update the pod's service account to allow the reference to the secret.
- Create a pod, which consumes the secret as an environment variable or as a file (using a **secret** volume).

You can use the `create` command to create a secret object from a JSON or YAML file:

```
$ oc create -f <filename>
```

17.1.3. Types of Secrets

The value in the **type** field indicates the structure of the secret's key names and values. The type can be used to enforce the presence of user names and keys in the secret object. If you do not want validation, use the **opaque** type, which is the default.

Specify one of the following types to trigger minimal server-side validation to ensure the presence of specific key names in the secret data:

- **kubernetes.io/service-account-token**. service account token.
- **kubernetes.io/dockercfg**. Uses the [.dockercfg](#) file for required Docker credentials.
- **kubernetes.io/dockerconfigjson**. Uses the [.docker/config.json](#) file for required Docker credentials.
- **kubernetes.io/basic-auth**. Use with [Basic Authentication](#).
- **kubernetes.io/ssh-auth**. Use with [SSH Key Authentication](#).
- **kubernetes.io/tls**. Use with [TLS certificate authorities](#)

Specify **type= Opaque** if you do not want validation, which means the secret does not claim to conform to any convention for key names or values. An *opaque* secret, allows for unstructured **key:value** pairs that can contain arbitrary values.



NOTE

You can specify other arbitrary types, such as **example.com/my-secret-type**. These types are not enforced server-side, but indicate that the creator of the secret intended to conform to the key/value requirements of that type.

For examples of different secret types, see the [code samples](#) in *Using Secrets*.

17.1.4. Updating Secrets

When you modify the value of a secret, the value (used by an already running pod) will not dynamically change. To change a secret, you must delete the original pod and create a new pod (perhaps with an identical PodSpec).

Updating a secret follows the same workflow as deploying a new container image. You can use the **kubectl rolling-update** command.

The **resourceVersion** value in a secret is not specified when it is referenced. Therefore, if a secret is updated at the same time as pods are starting, then the version of the secret will be used for the pod will not be defined.



NOTE

Currently, it is not possible to check the resource version of a secret object that was used when a pod was created. It is planned that pods will report this information, so that a controller could restart ones using a old **resourceVersion**. In the interim, do not update the data of existing secrets, but create new ones with distinct names.

17.2. SECRETS IN VOLUMES AND ENVIRONMENT VARIABLES

See [examples](#) of YAML files with secret data.

After you [create a secret](#), you can:

1. Create the pod to reference your secret:

```
$ oc create -f <your_yaml_file>.yaml
```

2. Get the logs:

```
$ oc logs secret-example-pod
```

3. Delete the pod:

```
$ oc delete pod secret-example-pod
```

17.3. IMAGE PULL SECRETS

See [Using Image Pull Secrets](#) for more information.

17.4. SOURCE CLONE SECRETS

See [Build Inputs](#) for more information about using source clone secrets during a build.

17.5. SERVICE SERVING CERTIFICATE SECRETS

Service serving certificate secrets are intended to support complex middleware applications that need out-of-the-box certificates. It has the same settings as the server certificates generated by the administrator tooling for nodes and masters.

To secure communication to your service, have the cluster generate a signed serving certificate/key pair into a secret in your namespace. To do this, set the **service.alpha.openshift.io/serving-cert-secret-name** annotation on your service with the value set to the name you want to use for your secret. Then, your **PodSpec** can mount that secret. When it is available, your pod will run. The certificate will be good for the internal service DNS name, **<service.name>.<service.namespace>.svc**.

The certificate and key are in PEM format, stored in **tls.crt** and **tls.key** respectively. The certificate/key pair is automatically replaced when it gets close to expiration. View the expiration date in the **service.alpha.openshift.io/expiry** annotation on the secret, which is in RFC3339 format.

Other pods can trust cluster-created certificates (which are only signed for internal DNS names), by using the CA bundle in the **/var/run/secrets/kubernetes.io/serviceaccount/service-ca.crt** file that is automatically mounted in their pod.

The signature algorithm for this feature is **x509.SHA256WithRSA**. To manually rotate, delete the generated secret. A new certificate is created.

17.6. RESTRICTIONS

To use a secret, a pod needs to reference the secret. A secret can be used with a pod in three ways:

- to populate environment variables for containers.

- as files in a volume mounted on one or more of its containers.
- by kubelet when pulling images for the pod.

Volume type secrets write data into the container as a file using the volume mechanism.

imagePullSecrets use service accounts for the automatic injection of the secret into all pods in a namespace.

When a template contains a secret definition, the only way for the template to use the provided secret is to ensure that the secret volume sources are validated and that the specified object reference actually points to an object of type **Secret**. Therefore, a secret needs to be created before any pods that depend on it. The most effective way to ensure this is to have it get injected automatically through the use of a service account.

Secret API objects reside in a namespace. They can only be referenced by pods in that same namespace.

Individual secrets are limited to 1MB in size. This is to discourage the creation of large secrets that would exhaust apiserver and kubelet memory. However, creation of a number of smaller secrets could also exhaust memory.

17.6.1. Secret Data Keys

Secret keys must be in a DNS subdomain.

17.7. EXAMPLES

Example 17.1. YAML Secret That Will Create Four Files

```

apiVersion: v1
kind: Secret
metadata:
  name: test-secret
data:
  username: dmFsdWUtMQ0K 1
  password: dmFsdWUtMQ0KDQo= 2
stringData:
  hostname: myapp.mydomain.com 3
secret.properties: |- 4
  property1=valueA
  property2=valueB

```

- 1** File contains decoded values.
- 2** File contains decoded values.
- 3** File contains the provided string.
- 4** File contains the provided data.

Example 17.2. YAML of a Pod Populating Files in a Volume with Secret Data

```

apiVersion: v1
kind: Pod
metadata:
  name: secret-example-pod
spec:
  containers:
  - name: secret-test-container
    image: busybox
    command: [ "/bin/sh", "-c", "cat /etc/secret-volume/*" ]
    volumeMounts:
      # name must match the volume name below
      - name: secret-volume
        mountPath: /etc/secret-volume
        readOnly: true
  volumes:
  - name: secret-volume
    secret:
      secretName: test-secret
  restartPolicy: Never

```

Example 17.3. YAML of a Pod Populating Environment Variables with Secret Data

```

apiVersion: v1
kind: Pod
metadata:
  name: secret-example-pod
spec:
  containers:
  - name: secret-test-container
    image: busybox
    command: [ "/bin/sh", "-c", "export" ]
    env:
      - name: TEST_SECRET_USERNAME_ENV_VAR
        valueFrom:
          secretKeyRef:
            name: test-secret
            key: username
  restartPolicy: Never

```

Example 17.4. YAML of a Build Config Populating Environment Variables with Secret Data

```

apiVersion: v1
kind: BuildConfig
metadata:
  name: secret-example-bc
spec:
  strategy:
    sourceStrategy:
      env:
        - name: TEST_SECRET_USERNAME_ENV_VAR
          valueFrom:

```

```
secretKeyRef:  
  name: test-secret  
  key: username
```

17.8. TROUBLESHOOTING

If a [service certificate generations](#) fails with (service's **service.alpha.openshift.io/serving-cert-generation-error** annotation contains):

```
secret/ssl-key references serviceUID 62ad25ca-d703-11e6-9d6f-0e9c0057b608, which does not  
match 77b6dd80-d716-11e6-9d6f-0e9c0057b60
```

The service that generated the certificate no longer exists, or has a different **serviceUID**. You must force certificates regeneration by removing the old secret, and clearing the following annotations on the service **service.alpha.openshift.io/serving-cert-generation-error**, **service.alpha.openshift.io/serving-cert-generation-error-num**:

```
$ oc delete secret <secret_name>  
$ oc annotate service <service_name> service.alpha.openshift.io/serving-cert-generation-error-  
$ oc annotate service <service_name> service.alpha.openshift.io/serving-cert-generation-error-num-
```



NOTE

The command removing annotation has a - after the annotation name to be removed.

CHAPTER 18. CONFIGMAPS

18.1. OVERVIEW

Many applications require configuration using some combination of configuration files, command line arguments, and environment variables. These configuration artifacts should be decoupled from image content in order to keep containerized applications portable.

The **ConfigMap** object provides mechanisms to inject containers with configuration data while keeping containers agnostic of OpenShift Online. A **ConfigMap** 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. **ConfigMap** is similar to [secrets](#), but designed to more conveniently support working with strings that do not contain sensitive information.

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
```

① Contains the configuration data.

Configuration data can be consumed in pods in a variety of ways. A **ConfigMap** can be used to:

1. Populate the value of environment variables.
2. Set command-line arguments in a container.
3. Populate configuration files in a volume.

Both users and system components may store configuration data in a **ConfigMap**.

18.2. CREATING CONFIGMAPS

You can use the following command to create a **ConfigMap** easily from directories, specific files, or literal values:

```
$ oc create configmap <configmap_name> [options]
```

The following sections cover the different ways you can create a **ConfigMap**.

18.2.1. Creating from Directories

Consider a directory with some files that already contain the data with which you want to populate a **ConfigMap**:

```
$ ls example-files
game.properties
ui.properties

$ cat example-files/game.properties
enemies=aliens
lives=3
enemies.cheat=true
enemies.cheat.level=noGoodRotten
secret.code.passphrase=UUDDLRLRBABAS
secret.code.allowed=true
secret.code.lives=30

$ cat example-files/ui.properties
color.good=purple
color.bad=yellow
allow.textmode=true
how.nice.to.look=fairlyNice
```

You can use the following command to create a **ConfigMap** holding the content of each file in this directory:

```
$ oc create configmap game-config \
  --from-file=example-files/
```

When the **--from-file** option points to a directory, each file directly in that directory is used to populate a key in the **ConfigMap**, where the name of the key is the file name, and the value of the key is the content of the file.

For example, the above command creates the following **ConfigMap**:

```
$ oc describe configmaps game-config
Name:      game-config
Namespace: default
Labels:    <none>
Annotations: <none>

Data

game.properties: 121 bytes
ui.properties:   83 bytes
```

You can see the two keys in the map are created from the file names in the directory specified in the command. Because the content of those keys may be large, the output of **oc describe** only shows the names of the keys and their sizes.

If you want to see the values of the keys, you can **oc get** the object with the **-o** option:

```
$ oc get configmaps game-config -o yaml
```

```
apiVersion: v1
data:
  game.properties: |-
    enemies=aliens
    lives=3
    enemies.cheat=true
    enemies.cheat.level=noGoodRotten
    secret.code.passphrase=UUDDLRLRBABAS
    secret.code.allowed=true
    secret.code.lives=30
  ui.properties: |
    color.good=purple
    color.bad=yellow
    allow.textmode=true
    how.nice.to.look=fairlyNice
kind: ConfigMap
metadata:
  creationTimestamp: 2016-02-18T18:34:05Z
  name: game-config
  namespace: default
  resourceVersion: "407"-
  selflink: /api/v1/namespaces/default/configmaps/game-config
  uid: 30944725-d66e-11e5-8cd0-68f728db1985
```

18.2.2. Creating from Files

You can also pass the **--from-file** option with a specific file, and pass it multiple times to the CLI. The following yields equivalent results to the [Creating from Directories](#) example:

1. Create the **ConfigMap** specifying a specific file:

```
$ oc create configmap game-config-2 \
  --from-file=example-files/game.properties \
  --from-file=example-files/ui.properties
```

2. Verify the results:

```
$ oc get configmaps game-config-2 -o yaml

apiVersion: v1
data:
  game.properties: |-
    enemies=aliens
    lives=3
    enemies.cheat=true
    enemies.cheat.level=noGoodRotten
    secret.code.passphrase=UUDDLRLRBABAS
    secret.code.allowed=true
    secret.code.lives=30
  ui.properties: |
    color.good=purple
    color.bad=yellow
    allow.textmode=true
```

```

    how.nice.to.look=fairlyNice
kind: ConfigMap
metadata:
  creationTimestamp: 2016-02-18T18:52:05Z
  name: game-config-2
  namespace: default
  resourceVersion: "516"
  selflink: /api/v1/namespaces/default/configmaps/game-config-2
  uid: b4952dc3-d670-11e5-8cd0-68f728db1985

```

You can also set the key to use for an individual file with the **--from-file** option by passing an expression of **key=value**. For example:

1. Create the **ConfigMap** specifying a key-value pair:

```

$ oc create configmap game-config-3 \
  --from-file=game-special-key=example-files/game.properties

```

2. Verify the results:

```

$ oc get configmaps game-config-3 -o yaml

apiVersion: v1
data:
  game-special-key: |-
    enemies=aliens
    lives=3
    enemies.cheat=true
    enemies.cheat.level=noGoodRotten
    secret.code.passphrase=UUDDLRLRBABAS
    secret.code.allowed=true
    secret.code.lives=30
kind: ConfigMap
metadata:
  creationTimestamp: 2016-02-18T18:54:22Z
  name: game-config-3
  namespace: default
  resourceVersion: "530"
  selflink: /api/v1/namespaces/default/configmaps/game-config-3
  uid: 05f8da22-d671-11e5-8cd0-68f728db1985

```

18.2.3. Creating from Literal Values

You can also supply literal values for a **ConfigMap**. The **--from-literal** option takes a **key=value** syntax that allows literal values to be supplied directly on the command line:

1. Create the **ConfigMap** specifying a literal value:

```

$ oc create configmap special-config \
  --from-literal=special.how=very \
  --from-literal=special.type=charm

```

2. Verify the results:

```
$ oc get configmaps special-config -o yaml

apiVersion: v1
data:
  special.how: very
  special.type: charm
kind: ConfigMap
metadata:
  creationTimestamp: 2016-02-18T19:14:38Z
  name: special-config
  namespace: default
  resourceVersion: "651"
  selflink: /api/v1/namespaces/default/configmaps/special-config
  uid: dadce046-d673-11e5-8cd0-68f728db1985
```

18.3. USE CASES: CONSUMING CONFIGMAPS IN PODS

The following sections describe some uses cases when consuming **ConfigMap** objects in pods.

18.3.1. Consuming in Environment Variables

ConfigMaps can be used to populate individual environment variables or can populate environment variables from all keys that form valid environment variable names. As an example, consider the following **ConfigMaps**:

ConfigMap with two environment variables

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: special-config 1
  namespace: default
data:
  special.how: very 2
  special.type: charm 3
```

1 Name of the **ConfigMap**.

2 3 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 **ConfigMap**.

- 2 Environment variable to inject.

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
      valueFrom:
        configMapKeyRef:
          name: special-config 2
          key: special.how 3
    - name: SPECIAL_TYPE_KEY
      valueFrom:
        configMapKeyRef:
          name: special-config 4
          key: special.type 5
          optional: true 6
      envFrom: 7
      - configMapRef:
          name: env-config 8
  restartPolicy: Never

```

- 1 Stanza to pull the specified environment variables from a **ConfigMap**.
- 2 4 Name of the **ConfigMap** to pull specific environment variables from.
- 3 5 Environment variable to pull from the **ConfigMap**.
- 6 Makes the environment variable optional. As optional, the pod will be started even if the specified **ConfigMap** and keys do not exist.
- 7 Stanza to pull all environment variables from a **ConfigMap**.
- 8 Name of the **ConfigMap** to pull all environment variables.

When this pod is run, its output will include the following lines:

```

SPECIAL_LEVEL_KEY=very
log_level=INFO

```

18.3.2. Setting Command-line Arguments

A **ConfigMap** can also be used to set the value of the command or arguments in a container. This is accomplished using the Kubernetes substitution syntax **\$(VAR_NAME)**. Consider the following **ConfigMaps**:

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: special-config
  namespace: default
data:
  special.how: very
  special.type: charm
```

To inject values into the command line, you must consume the keys you want to use as environment variables, as in the [Consuming 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)" ]
    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
```

When this pod is run, the output from the **test-container** container will be:

```
very charm
```

18.3.3. Consuming in Volumes

A **ConfigMap** can also be consumed in volumes. Returning again to the following example **ConfigMap**:

```
apiVersion: v1
kind: ConfigMap
metadata:
  name: special-config
  namespace: default
```

```
data:
  special.how: very
  special.type: charm
```

You have a couple different options for consuming this **ConfigMap** in a volume. The most basic way 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
      restartPolicy: Never
```

When this pod is run, the output will be:

```
very
```

You can also control the paths within the volume where **ConfigMap** 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
      restartPolicy: Never
```

When this pod is run, the output will be:

```
■
```

very

18.4. EXAMPLE: CONFIGURING REDIS

For a real-world example, you can configure Redis using a **ConfigMap**. To inject Redis with the recommended configuration for using Redis as a cache, the Redis configuration file should contain the following:

```
maxmemory 2mb
maxmemory-policy allkeys-lru
```

If your configuration file is located at *example-files/redis/redis-config*, create a **ConfigMap** with it:

1. Create the **ConfigMap** specifying the configuration file:

```
$ oc create configmap example-redis-config \
  --from-file=example-files/redis/redis-config
```

2. Verify the results:

```
$ oc get configmap example-redis-config -o yaml

apiVersion: v1
data:
  redis-config: |
    maxmemory 2mb
    maxmemory-policy allkeys-lru
kind: ConfigMap
metadata:
  creationTimestamp: 2016-04-06T05:53:07Z
  name: example-redis-config
  namespace: default
  resourceVersion: "2985"
  selflink: /api/v1/namespaces/default/configmaps/example-redis-config
  uid: d65739c1-fbbb-11e5-8a72-68f728db1985
```

Now, create a pod that uses this **ConfigMap**:

1. Create a pod definition like the following and save it to a file, for example *redis-pod.yaml*:

```
apiVersion: v1
kind: Pod
metadata:
  name: redis
spec:
  containers:
  - name: redis
    image: kubernetes/redis:v1
    env:
    - name: MASTER
      value: "true"
  ports:
  - containerPort: 6379
resources:
```

```

limits:
  cpu: "0.1"
volumeMounts:
- mountPath: /redis-master-data
  name: data
- mountPath: /redis-master
  name: config
volumes:
- name: data
  emptyDir: {}
- name: config
  configMap:
    name: example-redis-config
    items:
    - key: redis-config
      path: redis.conf

```

2. Create the pod:

```
$ oc create -f redis-pod.yaml
```

The newly-created pod has a **ConfigMap** volume that places the **redis-config** key of the **example-redis-config ConfigMap** into a file called **redis.conf**. This volume is mounted into the **/redis-master** directory in the Redis container, placing our configuration file at **/redis-master/redis.conf**, which is where the image looks for the Redis configuration file for the master.

If you **oc exec** into this pod and run the **redis-cli** tool, you can check that the configuration was applied correctly:

```

$ oc exec -it redis redis-cli
127.0.0.1:6379> CONFIG GET maxmemory
1) "maxmemory"
2) "2097152"
127.0.0.1:6379> CONFIG GET maxmemory-policy
1) "maxmemory-policy"
2) "allkeys-lru"

```

18.5. RESTRICTIONS

A **ConfigMap** must be created before they are consumed in pods. Controllers can be written to tolerate missing configuration data; consult individual components configured via **ConfigMap** 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 use of a **ConfigMap** for pods it gets from the API server. This includes any pods created using the CLI, or indirectly from a replication controller. It does not include pods created using the OpenShift Online node's **--manifest-url** flag, its **--config** flag, or its REST API (these are not common ways to create pods).

CHAPTER 19. POD AUTOSCALING

19.1. OVERVIEW

A horizontal pod autoscaler, defined by a **HorizontalPodAutoscaler** object, specifies how the system should automatically increase or decrease the scale of a replication controller or deployment configuration, based on metrics collected from the pods that belong to that replication controller or deployment configuration.

19.2. SUPPORTED METRICS

The following metrics are supported by horizontal pod autoscalers:

Table 19.1. Metrics

Metric	Description	API version
CPU utilization	Percentage of the requested CPU	autoscaling/v1, autoscaling/v2beta1
Memory utilization	Percentage of the requested memory.	autoscaling/v2beta1

19.3. AUTOSCALING

You can create a horizontal pod autoscaler with the **oc autoscale** command and specify the minimum and maximum number of pods you want to run, as well as the [CPU utilization](#) or [memory utilization](#) your pods should target.



IMPORTANT

Autoscaling for Memory Utilization is a Technology Preview feature only.

After a horizontal pod autoscaler is created, it begins attempting to query Heapster for metrics on the pods. It may take one to two minutes before Heapster obtains the initial metrics.

After metrics are available in Heapster, the horizontal pod autoscaler computes the ratio of the current metric utilization with the desired metric utilization, and scales up or down accordingly. The scaling will occur at a regular interval, but it may take one to two minutes before metrics make their way into Heapster.

For replication controllers, this scaling corresponds directly to the replicas of the replication controller. For deployment configurations, scaling corresponds directly to the replica count of the deployment configuration. Note that autoscaling applies only to the latest deployment in the **Complete** phase.

19.4. AUTOSCALING FOR CPU UTILIZATION

Use the **oc autoscale** command and specify at least the maximum number of pods you want to run at any given time. You can optionally specify the minimum number of pods and the average CPU utilization your pods should target, otherwise those are given default values from the OpenShift Online server.

For example:

```
$ oc autoscale dc/frontend --min 1 --max 10 --cpu-percent=80
deploymentconfig "frontend" autoscaled
```

The above example creates a horizontal pod autoscaler with the following definition when using the **autoscaling/v1** version of the horizontal pod autoscaler:

Example 19.1. Horizontal Pod Autoscaler Object Definition

```
apiVersion: autoscaling/v1
kind: HorizontalPodAutoscaler
metadata:
  name: frontend 1
spec:
  scaleTargetRef:
    kind: DeploymentConfig 2
    name: frontend 3
    apiVersion: apps/v1 4
    subresource: scale
  minReplicas: 1 5
  maxReplicas: 10 6
  targetCPUUtilizationPercentage: 80 7
```

- 1 The name of this horizontal pod autoscaler object
- 2 The kind of object to scale
- 3 The name of the object to scale
- 4 The API version of the object to scale
- 5 The minimum number of replicas to which to scale down
- 6 The maximum number of replicas to which to scale up
- 7 The percentage of the requested CPU that each pod should ideally be using

Alternatively, the **oc autoscale** command creates a horizontal pod autoscaler with the following definition when using the **v2beta1** version of the horizontal pod autoscaler:

```
apiVersion: autoscaling/v2beta1
kind: HorizontalPodAutoscaler
metadata:
  name: hpa-resource-metrics-cpu 1
spec:
  scaleTargetRef:
    apiVersion: apps/v1 2
    kind: ReplicationController 3
    name: hello-hpa-cpu 4
  minReplicas: 1 5
  maxReplicas: 10 6
  metrics:
```

```
- type: Resource
  resource:
    name: cpu
    targetAverageUtilization: 50 7
```

- 1** The name of this horizontal pod autoscaler object
- 2** The API version of the object to scale
- 3** The kind of object to scale
- 4** The name of the object to scale
- 5** The minimum number of replicas to which to scale down
- 6** The maximum number of replicas to which to scale up
- 7** The average percentage of the requested CPU that each pod should be using

19.5. AUTOSCALING FOR MEMORY UTILIZATION



IMPORTANT

Autoscaling for Memory Utilization is a Technology Preview feature only.

Unlike CPU-based autoscaling, memory-based autoscaling requires specifying the autoscaler using YAML instead of using the **oc autoscale** command. Optionally, you can specify the minimum number of pods and the average memory utilization your pods should target as well, otherwise those are given default values from the OpenShift Online server.

1. Memory-based autoscaling is only available with the **v2beta1** version of the autoscaling API. Enable memory-based autoscaling by adding the following to your cluster's **master-config.yaml** file:

```
...
apiServerArguments:
  runtime-config:
    - apis/autoscaling/v2beta1=true
...
```

2. Place the following in a file, such as **hpa.yaml**:

```
apiVersion: autoscaling/v2beta1
kind: HorizontalPodAutoscaler
metadata:
  name: hpa-resource-metrics-memory 1
spec:
  scaleTargetRef:
    apiVersion: apps/v1 2
    kind: ReplicationController 3
    name: hello-hpa-memory 4
  minReplicas: 1 5
  maxReplicas: 10 6
```



```
metrics:
- type: Resource
  resource:
    name: memory
    targetAverageUtilization: 50 7
```

- 1 The name of this horizontal pod autoscaler object
- 2 The API version of the object to scale
- 3 The kind of object to scale
- 4 The name of the object to scale
- 5 The minimum number of replicas to which to scale down
- 6 The maximum number of replicas to which to scale up
- 7 The average percentage of the requested memory that each pod should be using

3. Then, create the autoscaler from the above file:

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

IMPORTANT

For memory-based autoscaling to work, memory usage must increase and decrease proportionally to the replica count. On average:

- An increase in replica count must lead to an overall decrease in memory (working set) usage per-pod.
- A decrease in replica count must lead to an overall increase in per-pod memory usage.

Use the OpenShift web console to check the memory behavior of your application and ensure that your application meets these requirements before using memory-based autoscaling.

19.6. VIEWING A HORIZONTAL POD AUTOSCALER

To view the status of a horizontal pod autoscaler:

- Use the **oc get** command to view information on the CPU utilization and pod limits:

```
$ oc get hpa/hpa-resource-metrics-cpu
NAME                                REFERENCE                                TARGET  CURRENT  MINPODS
MAXPODS  AGE
hpa-resource-metrics-cpu  DeploymentConfig/default/frontend/scale  80%    79%    1
10      8d
```

The output includes the following:

- **Target.** The targeted average CPU utilization across all pods controlled by the deployment configuration.
 - **Current.** The current CPU utilization across all pods controlled by the deployment configuration.
 - **Minpods/Maxpods.** The minimum and maximum number of replicas that can be set by the autoscaler.
- Use the **oc describe** command for detailed information on the horizontal pod autoscaler object.

```
$ oc describe hpa/hpa-resource-metrics-cpu
Name:                hpa-resource-metrics-cpu
Namespace:           default
Labels:              <none>
CreationTimestamp:   Mon, 26 Oct 2015 21:13:47 -0400
Reference:           DeploymentConfig/default/frontend/scale
Target CPU utilization: 80% 1
Current CPU utilization: 79% 2
Min replicas:        1 3
Max replicas:        4 4
ReplicationController pods: 1 current / 1 desired
Conditions: 5
  Type                Status Reason          Message
  ----                -
  AbleToScale         True   ReadyForNewScale    the last scale time was sufficiently old
as to warrant a new scale
  ScalingActive       True   ValidMetricFound    the HPA was able to successfully calculate
a replica count from pods metric http_requests
  ScalingLimited      False  DesiredWithinRange  the desired replica count is within the
acceptable range
Events:
```

- 1** The average percentage of the requested memory that each pod should be using.
- 2** The current CPU utilization across all pods controlled by the deployment configuration.
- 3** The minimum number of replicas to scale down to.
- 4** The maximum number of replicas to scale up to.
- 5** If the object used the **v2alpha1** API, [status conditions](#) are displayed.

19.6.1. Viewing Horizontal Pod Autoscaler Status Conditions

You can use the status conditions set to determine whether or not the horizontal pod autoscaler is able to scale and whether or not it is currently restricted in any way.

The horizontal pod autoscaler status conditions are available with the **v2beta1** version of the autoscaling API:

```
kubernetesMasterConfig:
...
apiServerArguments:
```

```
runtime-config:
- apis/autoscaling/v2beta1=true
```

The following status conditions are set:

- **AbleToScale** indicates whether the horizontal pod autoscaler is able to fetch and update scales, and whether any backoff conditions are preventing scaling.
 - A **True** condition indicates scaling is allowed.
 - A **False** condition indicates scaling is not allowed for the reason specified.
- **ScalingActive** indicates whether the horizontal pod autoscaler is enabled (the replica count of the target is not zero) and is able to calculate desired scales.
 - A **True** condition indicates metrics is working properly.
 - A **False** condition generally indicates a problem with fetching metrics.
- **ScalingLimited** indicates that autoscaling is not allowed because a maximum or minimum replica count was reached.
 - A **True** condition indicates that you need to raise or lower the minimum or maximum replica count in order to scale.
 - A **False** condition indicates that the requested scaling is allowed.

If you need to add or edit this line, restart the OpenShift Online services:

To see the conditions affecting a horizontal pod autoscaler, use **oc describe hpa**. Conditions appear in the **status.conditions** field:

```
$ oc describe hpa cm-test
Name:                cm-test
Namespace:           prom
Labels:              <none>
Annotations:         <none>
CreationTimestamp:   Fri, 16 Jun 2017 18:09:22 +0000
Reference:           ReplicationController/cm-test
Metrics:             ( current / target )
"http_requests" on pods: 66m / 500m
Min replicas:        1
Max replicas:        4
ReplicationController pods: 1 current / 1 desired
Conditions: 1
  Type          Status Reason          Message
  ----          -
  AbleToScale   True    ReadyForNewScale    the last scale time was sufficiently old as to warrant
a new scale
  ScalingActive True    ValidMetricFound    the HPA was able to successfully calculate a replica
count from pods metric http_request
  ScalingLimited False   DesiredWithinRange  the desired replica count is within the acceptable
range
Events:
```

1 The horizontal pod autoscaler status messages.

- The **AbleToScale** condition indicates whether HPA is able to fetch and update scales, as well as whether any backoff-related conditions would prevent scaling.
- The **ScalingActive** condition indicates whether the HPA is enabled (for example, the replica count of the target is not zero) and is able to calculate desired scales. A `False`` status generally indicates problems with fetching metrics.
- The **ScalingLimited** condition indicates that the desired scale was capped by the maximum or minimum of the horizontal pod autoscaler. A **True** status generally indicates that you might need to raise or lower the minimum or maximum replica count constraints on your horizontal pod autoscaler.

The following is an example of a pod that is unable to scale:

Conditions:

Type	Status	Reason	Message
AbleToScale	False	FailedGetScale	the HPA controller was unable to get the target's current scale: replicationcontrollers/scale.extensions "hello-hpa-cpu" not found

The following is an example of a pod that could not obtain the needed metrics for scaling:

Conditions:

Type	Status	Reason	Message
AbleToScale	True	SucceededGetScale	the HPA controller was able to get the target's current scale
ScalingActive	False	FailedGetResourceMetric	the HPA was unable to compute the replica count: unable to get metrics for resource cpu: no metrics returned from heapster

The following is an example of a pod where the requested autoscaling was less than the required minimums:

Conditions:

Type	Status	Reason	Message
AbleToScale	True	ReadyForNewScale	the last scale time was sufficiently old as to warrant a new scale
ScalingActive	True	ValidMetricFound	the HPA was able to successfully calculate a replica count from pods metric http_request
ScalingLimited	False	DesiredWithinRange	the desired replica count is within the acceptable range

Events:

CHAPTER 20. MANAGING VOLUMES

20.1. OVERVIEW

Containers are not persistent by default; on restart, their contents are cleared. Volumes are mounted file systems available to pods and their containers which may be backed by a number of host-local or network attached storage endpoints.

To ensure that the file system on the volume contains no errors and, if errors are present, to repair them when possible, OpenShift Online invokes the **fsck** utility prior to the **mount** utility. This occurs when either adding a volume or updating an existing volume.

The simplest volume type is **emptyDir**, which is a temporary directory on a single machine. Administrators may also allow you to request a [persistent volume](#) that is automatically attached to your pods.



NOTE

emptyDir volume storage may be restricted by a quota based on the pod's FSGroup, if the FSGroup parameter is enabled by your cluster administrator.

You can use the CLI command **oc volume** to [add](#), [update](#), or [remove](#) volumes and volume mounts for any object that has a pod template like [replication controllers](#) or [deployment configurations](#). You can also [list](#) volumes in pods or any object that has a pod template.

20.2. GENERAL CLI USAGE

The **oc volume** command uses the following general syntax:

```
$ oc volume <object_selection> <operation> <mandatory_parameters> <optional_parameters>
```

This topic uses the form **<object_type>/<name>** for **<object_selection>** in later examples. However, you can choose one of the following options:

Table 20.1. Object Selection

Syntax	Description	Example
<object_type> <name>	Selects <name> of type <object_type> .	deploymentConfig registry
<object_type>/<name>	Selects <name> of type <object_type> .	deploymentConfig/registry
<object_type>--selector=<object_label_selector>	Selects resources of type <object_type> that matched the given label selector.	deploymentConfig--selector="name=registry"
<object_type> --all	Selects all resources of type <object_type> .	deploymentConfig --all

Syntax	Description	Example
-f or --filename=<file_name>	File name, directory, or URL to file to use to edit the resource.	-f registry-deployment-config.json

The **<operation>** can be one of **--add**, **--remove**, or **--list**.

Any **<mandatory_parameters>** or **<optional_parameters>** are specific to the selected operation and are discussed in later sections.

20.3. ADDING VOLUMES

To add a volume, a volume mount, or both to pod templates:

```
$ oc volume <object_type>/<name> --add [options]
```

Table 20.2. Supported Options for Adding Volumes

Option	Description	Default
--name	Name of the volume.	Automatically generated, if not specified.
-t, --type	Name of the volume source. Supported values: emptyDir , hostPath , secret , configmap , persistentVolumeClaim or projected .	emptyDir
-c, --containers	Select containers by name. It can also take wildcard '*' that matches any character.	'*'
-m, --mount-path	Mount path inside the selected containers.	
--path	Host path. Mandatory parameter for --type=hostPath .	
--secret-name	Name of the secret. Mandatory parameter for --type=secret .	
--configmap-name	Name of the configmap. Mandatory parameter for --type=configmap .	

Option	Description	Default
--claim-name	Name of the persistent volume claim. Mandatory parameter for --type=persistentVolumeClaim .	
--source	Details of volume source as a JSON string. Recommended if the desired volume source is not supported by --type .	
-o, --output	Display the modified objects instead of updating them on the server. Supported values: json , yaml .	
--output-version	Output the modified objects with the given version.	api-version

Examples

Add a new volume source **emptyDir** to deployment configuration **registry**:

```
$ oc volume dc/registry --add
```

Add volume **v1** with secret **\$secret** for replication controller **r1** and mount inside the containers at **/data**:

```
$ oc volume rc/r1 --add --name=v1 --type=secret --secret-name='$secret' --mount-path=/data
```

Add existing persistent volume **v1** with claim name **pvc1** to deployment configuration **dc.json** on disk, mount the volume on container **c1** at **/data**, and update the deployment configuration on the server:

```
$ oc volume -f dc.json --add --name=v1 --type=persistentVolumeClaim \
  --claim-name=pvc1 --mount-path=/data --containers=c1
```

Add volume **v1** based on Git repository **https://github.com/namespace1/project1** with revision **5125c45f9f563** for all replication controllers:

```
$ oc volume rc --all --add --name=v1 \
  --source='{ "gitRepo": {
    "repository": "https://github.com/namespace1/project1",
    "revision": "5125c45f9f563"
  } }'
```

20.4. UPDATING VOLUMES

Updating existing volumes or volume mounts is the same as [adding volumes](#), but with the **--overwrite** option:

```
$ oc volume <object_type>/<name> --add --overwrite [options]
```

Examples

Replace existing volume **v1** for replication controller **r1** with existing persistent volume claim **pvc1**:

```
$ oc volume rc/r1 --add --overwrite --name=v1 --type=persistentVolumeClaim --claim-name=pvc1
```

Change deployment configuration **d1** mount point to **/opt** for volume **v1**:

```
$ oc volume dc/d1 --add --overwrite --name=v1 --mount-path=/opt
```

20.5. REMOVING VOLUMES

To remove a volume or volume mount from pod templates:

```
$ oc volume <object_type>/<name> --remove [options]
```

Table 20.3. Supported Options for Removing Volumes

Option	Description	Default
--name	Name of the volume.	
-c, --containers	Select containers by name. It can also take wildcard ** that matches any character.	**
--confirm	Indicate that you want to remove multiple volumes at once.	
-o, --output	Display the modified objects instead of updating them on the server. Supported values: json , yaml .	
--output-version	Output the modified objects with the given version.	api-version

Examples

Remove a volume **v1** from deployment configuration **d1**:

```
$ oc volume dc/d1 --remove --name=v1
```

Unmount volume **v1** from container **c1** for deployment configuration **d1** and remove the volume **v1** if it is not referenced by any containers on **d1**:

```
$ oc volume dc/d1 --remove --name=v1 --containers=c1
```

Remove all volumes for replication controller **r1**:

▪


```
$ oc volume rc/r1 --remove --confirm
```

20.6. LISTING VOLUMES

To list volumes or volume mounts for pods or pod templates:

```
$ oc volume <object_type>/<name> --list [options]
```

List volume supported options:

Option	Description	Default
--name	Name of the volume.	
-c, --containers	Select containers by name. It can also take wildcard ** that matches any character.	**

Examples

List all volumes for pod **p1**:

```
$ oc volume pod/p1 --list
```

List volume **v1** defined on all deployment configurations:

```
$ oc volume dc --all --name=v1
```

20.7. SPECIFYING A SUB-PATH

Use the **volumeMounts.subPath** property to specify a **subPath** inside a volume instead of the volume's root. **subPath** allows you to share one volume for multiple uses in a single pod.

To view the list of files in the volume, run the **oc rsh** command:

```
$ oc rsh <pod>
sh-4.2$ ls /path/to/volume/subpath/mount
example_file1 example_file2 example_file3
```

Specify the **subPath**:

Example subPath Usage

```
apiVersion: v1
kind: Pod
metadata:
  name: my-site
spec:
  containers:
  - name: mysql
    image: mysql
```

```
volumeMounts:  
- mountPath: /var/lib/mysql  
  name: site-data  
  subPath: mysql 1  
- name: php  
  image: php  
  volumeMounts:  
- mountPath: /var/www/html  
  name: site-data  
  subPath: html 2  
volumes:  
- name: site-data  
  persistentVolumeClaim:  
    claimName: my-site-data
```

- 1** Databases are stored in the **mysql** folder.
- 2** HTML content is stored in the **html** folder.

CHAPTER 21. USING PERSISTENT VOLUMES

21.1. OVERVIEW

A **PersistentVolume** object is a storage resource in an OpenShift Online cluster. Storage is provisioned by your cluster administrator by creating **PersistentVolume** objects from sources such as GCE Persistent Disk, AWS Elastic Block Store (EBS), and NFS mounts.

Storage can be made available to you by laying claims to the resource. You can make a request for storage resources using a **PersistentVolumeClaim** object; the claim is paired with a volume that generally matches your request.

21.2. REQUESTING STORAGE

You can request storage by creating **PersistentVolumeClaim** objects in your projects:

Persistent Volume Claim Object Definition

```
apiVersion: "v1"
kind: "PersistentVolumeClaim"
metadata:
  name: "claim1"
spec:
  accessModes:
    - "ReadWriteOnce"
  resources:
    requests:
      storage: "1Gi"
  volumeName: "pv0001"
```



IMPORTANT

See the [Storage](#) topic for information about restrictions when using persistent volumes with OpenShift Online.

21.3. VOLUME AND CLAIM BINDING

A **PersistentVolume** is a specific resource. A **PersistentVolumeClaim** is a request for a resource with specific attributes, such as storage size. In between the two is a process that matches a claim to an available volume and binds them together. This allows the claim to be used as a volume in a pod. OpenShift Online finds the volume backing the claim and mounts it into the pod.

You can tell whether a claim or volume is bound by querying using the CLI:

```
$ oc get pvc
NAME      LABELS   STATUS   VOLUME
claim1    map[]    Bound    pv0001

$ oc get pv
NAME      LABELS           CAPACITY   ACCESSMODES   STATUS   CLAIM
pv0001    map[]            5368709120  RWO           Bound    yournamespace / claim1
```

21.4. CLAIMS AS VOLUMES IN PODS

A **PersistentVolumeClaim** is used by a pod as a volume. OpenShift Online finds the claim with the given name in the same namespace as the pod, then uses the claim to find the corresponding volume to mount.

Pod Definition with a Claim

```
apiVersion: "v1"
kind: "Pod"
metadata:
  name: "mypod"
  labels:
    name: "frontendhttp"
spec:
  containers:
  -
    name: "myfrontend"
    image: openshift/hello-openshift
    ports:
    -
      containerPort: 80
      name: "http-server"
    volumeMounts:
    -
      mountPath: "/var/www/html"
      name: "pvol"
  volumes:
  -
    name: "pvol"
    persistentVolumeClaim:
      claimName: "claim1"
```

21.5. VOLUME AND CLAIM PRE-BINDING

If you know exactly what **PersistentVolume** you want your **PersistentVolumeClaim** to bind to, you can specify the PV in your PVC using the **volumeName** field. This method skips the normal matching and binding process. The PVC will only be able to bind to a PV that has the same name specified in **volumeName**. If such a PV with that name exists and is **Available**, the PV and PVC will be bound regardless of whether the PV satisfies the PVC's label selector, access modes, and resource requests.

Example 21.1. Persistent Volume Claim Object Definition with volumeName

```
apiVersion: "v1"
kind: "PersistentVolumeClaim"
metadata:
  name: "claim1"
spec:
  accessModes:
  - "ReadWriteOnce"
  resources:
    requests:
      storage: "1Gi"
  volumeName: "pv0001"
```



IMPORTANT

The ability to set **claimRefs** is a temporary workaround for the described use cases. A long-term solution for limiting who can claim a volume is in development.

You may also want your cluster administrator to "reserve" the volume for only your claim so that nobody else's claim can bind to it before yours does. In this case, the administrator can specify the PVC in the PV using the **claimRef** field. The PV will only be able to bind to a PVC that has the same name and namespace specified in **claimRef**. The PVC's access modes and resource requests must still be satisfied in order for the PV and PVC to be bound, though the label selector is ignored.

Persistent Volume Object Definition with claimRef

```
apiVersion: v1
kind: PersistentVolume
metadata:
  name: pv0001
spec:
  capacity:
    storage: 1Gi
  accessModes:
    - ReadWriteOnce
  nfs:
    path: /tmp
    server: 172.17.0.2
  persistentVolumeReclaimPolicy: Recycle
  claimRef:
    name: claim1
    namespace: default
```

Specifying a **volumeName** in your PVC does not prevent a different PVC from binding to the specified PV before yours does. Your claim will remain **Pending** until the PV is **Available**.

Specifying a **claimRef** in a PV does not prevent the specified PVC from being bound to a different PV. The PVC is free to choose another PV to bind to according to the normal binding process. Therefore, to avoid these scenarios and ensure your claim gets bound to the volume you want, you must ensure that both **volumeName** and **claimRef** are specified.

You can tell that your setting of **volumeName** and/or **claimRef** influenced the matching and binding process by inspecting a **Bound** PV and PVC pair for the **pv.kubernetes.io/bound-by-controller** annotation. The PVs and PVCs where you set the **volumeName** and/or **claimRef** yourself will have no such annotation, but ordinary PVs and PVCs will have it set to **"yes"**.

When a PV has its **claimRef** set to some PVC name and namespace, and is reclaimed according to a **Retain** or **Recycle** reclaim policy, its **claimRef** will remain set to the same PVC name and namespace even if the PVC or the whole namespace no longer exists.

CHAPTER 22. STORAGE CLASSES

22.1. OVERVIEW

The **StorageClass** resource object describes and classifies storage that can be requested, as well as provides a means for passing parameters for dynamically provisioned storage on demand.

StorageClass objects can also serve as a management mechanism for controlling different levels of storage and access to the storage. Cluster administrators (users with **cluster-admin** privileges) or storage administrators (users with **storage-admin** privileges) define and create the **StorageClass** objects that users can request without needing any intimate knowledge about the underlying storage volume sources.

In OpenShift Online, the storage class is configured and a single option is available to the user based on the underlying cloud provider.

CHAPTER 23. SELECTOR AND LABEL VOLUME BINDING

23.1. OVERVIEW

You can enable binding of persistent volume claims (PVCs) to persistent volumes (PVs) via **selector** and **label** attributes. By implementing selectors and labels, regular users are able to target [provisioned storage](#) by identifiers defined by a cluster administrator.

23.2. MOTIVATION

In cases of statically provisioned storage, developers seeking persistent storage are required to know a handful identifying attributes of a PV in order to deploy and bind a PVC. This creates several problematic situations. Regular users might have to contact a cluster administrator to either deploy the PVC or provide the PV values. PV attributes alone do not convey the intended use of the storage volumes, nor do they provide methods by which volumes can be grouped.

Selector and label attributes can be used to abstract away PV details from the user while providing cluster administrators a way of identifying volumes by a descriptive and customizable tag. Through the selector-label method of binding, users are only required to know which labels are defined by the administrator.



NOTE

The selector-label feature is currently only available for *statically* provisioned storage and is currently not implemented for storage provisioned dynamically.

CHAPTER 24. EXECUTING REMOTE COMMANDS

24.1. OVERVIEW

You can use the CLI to execute remote commands in a container. This allows you to run general Linux commands for routine operations in the container.



IMPORTANT

For security purposes, the **oc exec** command does not work when accessing privileged containers except when the command is executed by a **cluster-admin** user. See the [CLI operations](#) topic for more information.

24.2. BASIC USAGE

Support for remote container command execution is built into [the CLI](#):

```
$ oc exec <pod> [-c <container>] <command> [<arg_1> ... <arg_n>]
```

For example:

```
$ oc exec mypod date
Thu Apr 9 02:21:53 UTC 2015
```

24.3. PROTOCOL

Clients initiate the execution of a remote command in a container by issuing a request to the Kubernetes API server:

```
/proxy/minions/<node_name>/exec/<namespace>/<pod>/<container>?command=<command>
```

In the above URL:

- **<node_name>** is the FQDN of the node.
- **<namespace>** is the namespace of the target pod.
- **<pod>** is the name of the target pod.
- **<container>** is the name of the target container.
- **<command>** is the desired command to be executed.

For example:

```
/proxy/minions/node123.openshift.com/exec/myns/mypod/mycontainer?command=date
```

Additionally, the client can add parameters to the request to indicate if:

- the client should send input to the remote container's command (stdin).
- the client's terminal is a TTY.

- the remote container's command should send output from stdout to the client.
- the remote container's command should send output from stderr to the client.

After sending an **exec** request to the API server, the client upgrades the connection to one that supports multiplexed streams; the current implementation uses **SPDY**.

The client creates one stream each for stdin, stdout, and stderr. To distinguish among the streams, the client sets the **streamType** header on the stream to one of **stdin**, **stdout**, or **stderr**.

The client closes all streams, the upgraded connection, and the underlying connection when it is finished with the remote command execution request.

CHAPTER 25. COPYING FILES TO OR FROM A CONTAINER

25.1. OVERVIEW

You can use the CLI to copy local files to or from a remote directory in a container. This is a useful tool for copying database archives to and from your pods for backup and restore purposes. It can also be used to copy source code changes into a running pod for development debugging, when the running pod supports hot reload of source files.

25.2. BASIC USAGE

Support for copying local files to or from a container is built into [the CLI](#):

```
$ oc rsync <source> <destination> [-c <container>]
```

For example, to copy a local directory to a pod directory:

```
$ oc rsync /home/user/source devpod1234:/src
```

Or to copy a pod directory to a local directory:

```
$ oc rsync devpod1234:/src /home/user/source
```

25.3. BACKING UP AND RESTORING DATABASES

Use **oc rsync** to copy database archives from an existing database container to a new database container's persistent volume directory.



NOTE

MySQL is used in the example below. Replace **mysql|MYSQL** with **pgsql|PGSQL** or **mongodb|MONGODB** and refer to [the migration guide](#) to find the exact commands for each of our supported database images. The example assumes an existing database container.

1. Back up the existing database from a running database pod:

```
$ oc rsh <existing db container>
# mkdir /var/lib/mysql/data/db_archive_dir
# mysqldump --skip-lock-tables -h ${MYSQL_SERVICE_HOST} -P
${MYSQL_SERVICE_PORT:-3306} \
-u ${MYSQL_USER} --password="${MYSQL_PASSWORD}" --all-databases >
/var/lib/mysql/data/db_archive_dir/all.sql
# exit
```

2. Remote sync the archive file to your local machine:

```
$ oc rsync <existing db container with db archive>:/var/lib/mysql/data/db_archive_dir /tmp/.
```

3. Start a second MySQL pod into which to load the database archive file created above. The MySQL pod must have a unique **DATABASE_SERVICE_NAME**.

```
$ oc new-app mysql-persistent \
  -p MYSQL_USER=<archived mysql username> \
  -p MYSQL_PASSWORD=<archived mysql password> \
  -p MYSQL_DATABASE=<archived database name> \
  -p DATABASE_SERVICE_NAME='mysql2' 1
$ oc rsync /tmp/db_archive_dir new_dbpod1234:/var/lib/mysql/data
$ oc rsh new_dbpod1234
```

1 **mysql** is the default. In this example, **mysql2** is created.

4. Use the appropriate commands to restore the database in the new database container from the copied database archive directory:

MySQL

```
$ cd /var/lib/mysql/data/db_archive_dir
$ mysql -u root
$ source all.sql
$ GRANT ALL PRIVILEGES ON <dbname>.* TO '<your username>'@'localhost'; FLUSH
PRIVILEGES;
$ cd ../; rm -rf /var/lib/mysql/data/db_backup_dir
```

You now have two MySQL database pods running in your project with the archived database.

25.4. REQUIREMENTS

The **oc rsync** command uses the local **rsync** command if present on the client's machine. This requires that the remote container also have the **rsync** command.

If **rsync** is not found locally or in the remote container, then a tar archive will be created locally and sent to the container where **tar** will be used to extract the files. If **tar** is not available in the remote container, then the copy will fail.

The **tar** copy method does not provide the same functionality as **rsync**. For example, **rsync** creates the destination directory if it does not exist and will only send files that are different between the source and the destination.



NOTE

In Windows, the **cwRsync** client should be installed and added to the PATH for use with the **oc rsync** command.

25.5. SPECIFYING THE COPY SOURCE

The source argument of the **oc rsync** command must point to either a local directory or a pod directory. Individual files are not currently supported.

When specifying a pod directory the directory name must be prefixed with the pod name:

```
<pod name>:<dir>
```

Just as with standard **rsync**, if the directory name ends in a path separator (/), only the contents of the directory are copied to the destination. Otherwise, the directory itself is copied to the destination with all its contents.

25.6. SPECIFYING THE COPY DESTINATION

The destination argument of the **oc rsync** command must point to a directory. If the directory does not exist, but **rsync** is used for copy, the directory is created for you.

25.7. DELETING FILES AT THE DESTINATION

The **--delete** flag may be used to delete any files in the remote directory that are not in the local directory.

25.8. CONTINUOUS SYNCING ON FILE CHANGE

Using the **--watch** option causes the command to monitor the source path for any file system changes, and synchronizes changes when they occur. With this argument, the command runs forever.

Synchronization occurs after short quiet periods to ensure a rapidly changing file system does not result in continuous synchronization calls.

When using the **--watch** option, the behavior is effectively the same as manually invoking **oc rsync** repeatedly, including any arguments normally passed to **oc rsync**. Therefore, you can control the behavior via the same flags used with manual invocations of **oc rsync**, such as **--delete**.

25.9. ADVANCED RSYNC FEATURES

The **oc rsync** command exposes fewer command line options than standard **rsync**. In the case that you wish to use a standard **rsync** command line option which is not available in **oc rsync** (for example the **--exclude-from=FILE** option), it may be possible to use standard **rsync**'s **--rsh (-e)** option or **RSYNC_RSH** environment variable as a workaround, as follows:

```
$ rsync --rsh='oc rsh' --exclude-from=FILE SRC POD:DEST
```

or:

```
$ export RSYNC_RSH='oc rsh'  
$ rsync --exclude-from=FILE SRC POD:DEST
```

Both of the above examples configure standard **rsync** to use **oc rsh** as its remote shell program to enable it to connect to the remote pod, and are an alternative to running **oc rsync**.

CHAPTER 26. PORT FORWARDING

26.1. OVERVIEW

OpenShift Online takes advantage of a feature built-in to [Kubernetes](#) to support port forwarding to pods.

You can use the CLI to forward one or more local ports to a pod. This allows you to listen on a given or random port locally, and have data forwarded to and from given ports in the pod.

26.2. BASIC USAGE

Support for port forwarding is built into [the CLI](#):

```
$ oc port-forward <pod> [<local_port>:]<remote_port> [...[<local_port_n>:]<remote_port_n>]
```

The CLI listens on each local port specified by the user, forwarding via the [protocol](#) described below.

Ports may be specified using the following formats:

5000	The client listens on port 5000 locally and forwards to 5000 in the pod.
6000:5000	The client listens on port 6000 locally and forwards to 5000 in the pod.
:5000 or 0:5000	The client selects a free local port and forwards to 5000 in the pod.

For example, to listen on ports **5000** and **6000** locally and forward data to and from ports **5000** and **6000** in the pod, run:

```
$ oc port-forward <pod> 5000 6000
```

To listen on port **8888** locally and forward to **5000** in the pod, run:

```
$ oc port-forward <pod> 8888:5000
```

To listen on a free port locally and forward to **5000** in the pod, run:

```
$ oc port-forward <pod> :5000
```

Or, alternatively:

```
$ oc port-forward <pod> 0:5000
```

26.3. PROTOCOL

Clients initiate port forwarding to a pod by issuing a request to the Kubernetes API server:

```
/proxy/minions/<node_name>/portForward/<namespace>/<pod>
```

■

In the above URL:

- **<node_name>** is the FQDN of the node.
- **<namespace>** is the namespace of the target pod.
- **<pod>** is the name of the target pod.

For example:

```
/proxy/minions/node123.openshift.com/portForward/myns/mypod
```

After sending a port forward request to the API server, the client upgrades the connection to one that supports multiplexed streams; the current implementation uses [SPDY](#).

The client creates a stream with the **port** header containing the target port in the pod. All data written to the stream is delivered via the Kubelet to the target pod and port. Similarly, all data sent from the pod for that forwarded connection is delivered back to the same stream in the client.

The client closes all streams, the upgraded connection, and the underlying connection when it is finished with the port forwarding request.

CHAPTER 27. SHARED MEMORY

27.1. OVERVIEW

There are two types of shared memory objects in Linux: System V and POSIX. The containers in a pod share the IPC namespace of the pod infrastructure container and so are able to share the System V shared memory objects. This document describes how they can also share POSIX shared memory objects.

27.2. POSIX SHARED MEMORY

POSIX shared memory requires that a `tmpfs` be mounted at `/dev/shm`. The containers in a pod do not share their mount namespaces so we use volumes to provide the same `/dev/shm` into each container in a pod. The following example shows how to set up POSIX shared memory between two containers.

shared-memory.yaml

```
---
apiVersion: v1
id: hello-openshift
kind: Pod
metadata:
  name: hello-openshift
  labels:
    name: hello-openshift
spec:
  volumes:
    - name: dshm
      emptyDir:
        medium: Memory
  containers:
    - image: kubernetes/pause
      name: hello-container1
      ports:
        - containerPort: 8080
          hostPort: 6061
      volumeMounts:
        - mountPath: /dev/shm
          name: dshm
    - image: kubernetes/pause
      name: hello-container2
      ports:
        - containerPort: 8081
          hostPort: 6062
      volumeMounts:
        - mountPath: /dev/shm
          name: dshm
```

1 specifies the `tmpfs` volume **dshm**.

2 enables POSIX shared memory for **hello-container1** via **dshm**.

3 enables POSIX shared memory for **hello-container2** via **dshm**.

Create the pod using the *shared-memory.yaml* file:

```
$ oc create -f shared-memory.yaml
```


CHAPTER 28. APPLICATION HEALTH

28.1. OVERVIEW

In software systems, components can become unhealthy due to transient issues (such as temporary connectivity loss), configuration errors, or problems with external dependencies. OpenShift Online applications have a number of options to detect and handle unhealthy containers.

28.2. CONTAINER HEALTH CHECKS USING PROBES

A probe is a Kubernetes action that periodically performs diagnostics on a running container. Currently, two types of probes exist, each serving a different purpose:

Liveness Probe	A liveness probe checks if the container in which it is configured is still running. If the liveness probe fails, the kubelet kills the container, which will be subjected to its restart policy. Set a liveness check by configuring the template.spec.containers.livenessprobe stanza of a pod configuration.
Readiness Probe	A readiness probe determines if a container is ready to service requests. If the readiness probe fails a container, the endpoints controller ensures the container has its IP address removed from the endpoints of all services. A readiness probe can be used to signal to the endpoints controller that even though a container is running, it should not receive any traffic from a proxy. Set a readiness check by configuring the template.spec.containers.readinessprobe stanza of a pod configuration.

The exact timing of a probe is controlled by two fields, both expressed in units of seconds:

Field	Description
initialDelaySeconds	How long to wait after the container starts to begin the probe.
timeoutSeconds	How long to wait for the probe to finish (default: 1). If this time is exceeded, OpenShift Online considers the probe to have failed.

Both probes can be configured in three ways:

HTTP Checks

The kubelet uses a web hook to determine the healthiness of the container. The check is deemed successful if the HTTP response code is between 200 and 399. The following is an example of a readiness check using the HTTP checks method:

Example 28.1. Readiness HTTP check

```
...
readinessProbe:
  httpGet:
    path: /healthz
```

```

port: 8080
initialDelaySeconds: 15
timeoutSeconds: 1
...

```

A HTTP check is ideal for applications that return HTTP status codes when completely initialized.

Container Execution Checks

The kubelet executes a command inside the container. Exiting the check with status 0 is considered a success. The following is an example of a liveness check using the container execution method:

Example 28.2. Liveness Container Execution Check

```

...
livenessProbe:
  exec:
    command:
      - cat
      - /tmp/health
    initialDelaySeconds: 15
...

```

NOTE

The **timeoutSeconds** parameter has no effect on the readiness and liveness probes for Container Execution Checks. You can implement a timeout inside the probe itself, as OpenShift Online cannot time out on an exec call into the container. One way to implement a timeout in a probe is by using the **timeout** parameter to run your liveness or readiness probe:

```

[...]
livenessProbe:
  exec:
    command:
      - /bin/bash
      - '-c'
      - timeout 60 /opt/eap/bin/livenessProbe.sh 1
    timeoutSeconds: 1
    periodSeconds: 10
    successThreshold: 1
    failureThreshold: 3
[...]
```

1 Timeout value and path to the probe script.

TCP Socket Checks

The kubelet attempts to open a socket to the container. The container is only considered healthy if the check can establish a connection. The following is an example of a liveness check using the TCP socket check method:

Example 28.3. Liveness TCP Socket Check

```
...  
livenessProbe:  
  tcpSocket:  
    port: 8080  
  initialDelaySeconds: 15  
  timeoutSeconds: 1  
...
```

A TCP socket check is ideal for applications that do not start listening until initialization is complete.

For more information on health checks, see the [Kubernetes documentation](#).

CHAPTER 29. EVENTS

29.1. OVERVIEW

Events in OpenShift Online are modeled based on events that happen to API objects in an OpenShift Online cluster. Events allow OpenShift Online to record information about real-world events in a resource-agnostic manner. They also allow developers and administrators to consume information about system components in a unified way.

29.2. VIEWING EVENTS WITH THE CLI

You can get a list of events in a given project using the following command:

```
$ oc get events [-n <project>]
```

29.3. VIEWING EVENTS IN THE CONSOLE

You can see events in your project from the web console from the **Browse → Events** page. Many other objects, such as pods and deployments, have their own **Events** tab as well, which shows events related to that object.

29.4. COMPREHENSIVE LIST OF EVENTS

This section describes the events of OpenShift Online.

Table 29.1. Configuration Events

Name	Description
FailedValidation	Failed pod configuration validation.

Table 29.2. Container Events

Name	Description
BackOff	Back-off restarting failed the container.
Created	Container created.
Failed	Pull/Create/Start failed.
Killing	Killing the container.
Started	Container started.
Preempting	Preempting other pods.

Name	Description
ExceededGracePeriod	Container runtime did not stop the pod within specified grace period.

Table 29.3. Health Events

Name	Description
Unhealthy	Container is unhealthy.

Table 29.4. Image Events

Name	Description
BackOff	Back off Ctr Start, image pull.
ErrImageNeverPull	The image's NeverPull Policy is violated.
Failed	Failed to pull the image.
InspectFailed	Failed to inspect the image.
Pulled	Successfully pulled the image or the container image is already present on the machine.
Pulling	Pulling the image.

Table 29.5. Image Manager Events

Name	Description
FreeDiskSpaceFailed	Free disk space failed.
InvalidDiskCapacity	Invalid disk capacity.

Table 29.6. Node Events

Name	Description
FailedMount	Volume mount failed.
HostNetworkNotSupported	Host network not supported.

Name	Description
HostPortConflict	Host/port conflict.
InsufficientFreeCPU	Insufficient free CPU.
InsufficientFreeMemory	Insufficient free memory.
KubeletSetupFailed	Kubelet setup failed.
NilShaper	Undefined shaper.
NodeNotReady	Node is not ready.
NodeNotSchedulable	Node is not schedulable.
NodeReady	Node is ready.
NodeSchedulable	Node is schedulable.
NodeSelectorMismatching	Node selector mismatch.
OutOfDisk	Out of disk.
Rebooted	Node rebooted.
Starting	Starting kubelet.
FailedAttachVolume	Failed to attach volume.
FailedDetachVolume	Failed to detach volume.
VolumeResizeFailed	Failed to expand/reduce volume.
VolumeResizeSuccessful	Successfully expanded/reduced volume.

Name	Description
FileSystemResizeFailed	Failed to expand/reduce file system.
FileSystemResizeSuccessful	Successfully expanded/reduced file system.
FailedUnmount	Failed to unmount volume.
FailedMapVolume	Failed to map a volume.
FailedUnmapDevice	Failed unmaped device.
AlreadyMountedVolume	Volume is already mounted.
SuccessfulDetachVolume	Volume is successfully detached.
SuccessfulMountVolume	Volume is successfully mounted.
SuccessfulUnmountVolume	Volume is successfully unmounted.
ContainerGCFailed	Container garbage collection failed.
ImageGCFailed	Image garbage collection failed.
FailedNodeAllocatableEnforcement	Failed to enforce System Reserved Cgroup limit.
NodeAllocatableEnforced	Enforced System Reserved Cgroup limit.
UnsupportedMountOption	Unsupported mount option.
SandboxChanged	Pod sandbox changed.
FailedCreatePodSandBox	Failed to create pod sandbox.

Name	Description
FailedPodSandBoxStatus	Failed pod sandbox status.

Table 29.7. Pod Worker Events

Name	Description
FailedSync	Pod sync failed.

Table 29.8. System Events

Name	Description
SystemOOM	There is an OOM (out of memory) situation on the cluster.

Table 29.9. Pod Events

Name	Description
FailedKillPod	Failed to stop a pod.
FailedCreatePodContainer	Failed to create a pod container.
Failed	Failed to make pod data directories.
NetworkNotReady	Network is not ready.
FailedCreate	Error creating: <error-msg> .
SuccessfulCreate	Created pod: <pod-name> .
FailedDelete	Error deleting: <error-msg> .
SuccessfulDelete	Deleted pod: <pod-id> .

Table 29.10. Horizontal Pod AutoScaler Events

Name	Description
SelectorRequired	Selector is required.

Name	Description
InvalidSelector	Could not convert selector into a corresponding internal selector object.
FailedGetObjectMetric	HPA was unable to compute the replica count.
InvalidMetricSourceType	Unknown metric source type.
ValidMetricFound	HPA was able to successfully calculate a replica count.
FailedConvertHPA	Failed to convert the given HPA.
FailedGetScale	HPA controller was unable to get the target's current scale.
SucceededGetScale	HPA controller was able to get the target's current scale.
FailedComputeMetricsReplicas	Failed to compute desired number of replicas based on listed metrics.
FailedRescale	New size: <size> ; reason: <msg> ; error: <error-msg> .
SuccessfulRescale	New size: <size> ; reason: <msg> .
FailedUpdateStatus	Failed to update status.

Table 29.11. Network Events (openshift-sdn)

Name	Description
Starting	Starting OpenShift-SDN.
NetworkFailed	The pod's network interface has been lost and the pod will be stopped.

Table 29.12. Network Events (kube-proxy)

Name	Description
NeedPods	The service-port <serviceName>:<port> needs pods.

Table 29.13. Volume Events

Name	Description
FailedBinding	There are no persistent volumes available and no storage class is set.
VolumeMismatch	Volume size or class is different from what is requested in claim.
VolumeFailedRecycle	Error creating recycler pod.
VolumeRecycled	Occurs when volume is recycled.
RecyclerPod	Occurs when pod is recycled.
VolumeDelete	Occurs when volume is deleted.
VolumeFailedDelete	Error when deleting the volume.
ExternalProvisioning	Occurs when volume for the claim is provisioned either manually or via external software.
ProvisioningFailed	Failed to provision volume.
ProvisioningCleanupFailed	Error cleaning provisioned volume.
ProvisioningSucceeded	Occurs when the volume is provisioned successfully.
WaitForFirstConsumer	Delay binding until pod scheduling.

Table 29.14. Lifecycle hooks

Name	Description
FailedPostStartHook	Handler failed for pod start.
FailedPreStopHook	Handler failed for pre-stop.
UnfinishedPreStopHook	Pre-stop hook unfinished.

Table 29.15. Deployments

Name	Description
DeploymentCancellationFailed	Failed to cancel deployment.
DeploymentCancelled	Cancelled deployment.
DeploymentCreated	Created new replication controller.
IngressIPRangeFull	No available ingress IP to allocate to service.

Table 29.16. Scheduler Events

Name	Description
FailedScheduling	Failed to schedule pod: <pod-namespace>/<pod-name> . This event is raised for multiple reasons, for example: AssumePodVolumes failed, Binding rejected etc.
Preempted	By <preemptor-namespace>/<preemptor-name> on node <node-name> .
Scheduled	Successfully assigned <pod-name> to <node-name> .

Table 29.17. DaemonSet Events

Name	Description
SelectingAll	This daemon set is selecting all pods. A non-empty selector is required.
FailedPlacement	Failed to place pod on <node-name> .
FailedDaemonPod	Found failed daemon pod <pod-name> on node <node-name> , will try to kill it.

Table 29.18. LoadBalancer Service Events

Name	Description
CreatingLoadBalancerFailed	Error creating load balancer.
DeletingLoadBalancer	Deleting load balancer.

Name	Description
EnsuringLoadBalancer	Ensuring load balancer.
EnsuredLoadBalancer	Ensured load balancer.
UnAvailableLoadBalancer	There are no available nodes for LoadBalancer service.
LoadBalancerSourceRanges	Lists the new LoadBalancerSourceRanges . For example, <old-source-range> → <new-source-range> .
LoadbalancerIP	Lists the new IP address. For example, <old-ip> → <new-ip> .
ExternalIP	Lists external IP address. For example, Added: <external-ip> .
UID	Lists the new UID. For example, <old-service-uid> → <new-service-uid> .
ExternalTrafficPolicy	Lists the new ExternalTrafficPolicy . For example, <old-policy> → <new-policy> .
HealthCheckNodePort	Lists the new HealthCheckNodePort . For example, <old-node-port> → new-node-port .
UpdatedLoadBalancer	Updated load balancer with new hosts.
LoadBalancerUpdateFailed	Error updating load balancer with new hosts.
DeletingLoadBalancer	Deleting load balancer.
DeletingLoadBalancerFailed	Error deleting load balancer.
DeletedLoadBalancer	Deleted load balancer.

CHAPTER 30. NOTIFICATIONS

30.1. OVERVIEW

For each of your projects, you can choose to receive email notifications about various failures, including:

- *Dead deployment*: A failed deployment in which no other deployment in the rollout history is able to remain active. The related deployment configuration has no deployments with active replicas.
- *Failed deployment*: A new deployment fails and another deployment in the rollout history is now active. The related deployment configuration has one active deployment, but it is not the latest deployment.
- *Stuck deployment*: A deployment in which the active replicas are less than the replicas defined by the deployment configuration for a significant amount of time.
- *Dead build*: Occurs when automatically triggered builds are failing for a specified build configuration that previously had successful builds.
- *Dead persistent volume claim*: A claim that is in the pending state for longer than some reasonable amount of time. These are claims whose resource requests likely do not match with any existing persistent volumes in the cluster.
- *Lost persistent volume claim*: A claim that is bound to a backing persistent volume, but the persistent volume has unexpectedly gone away.

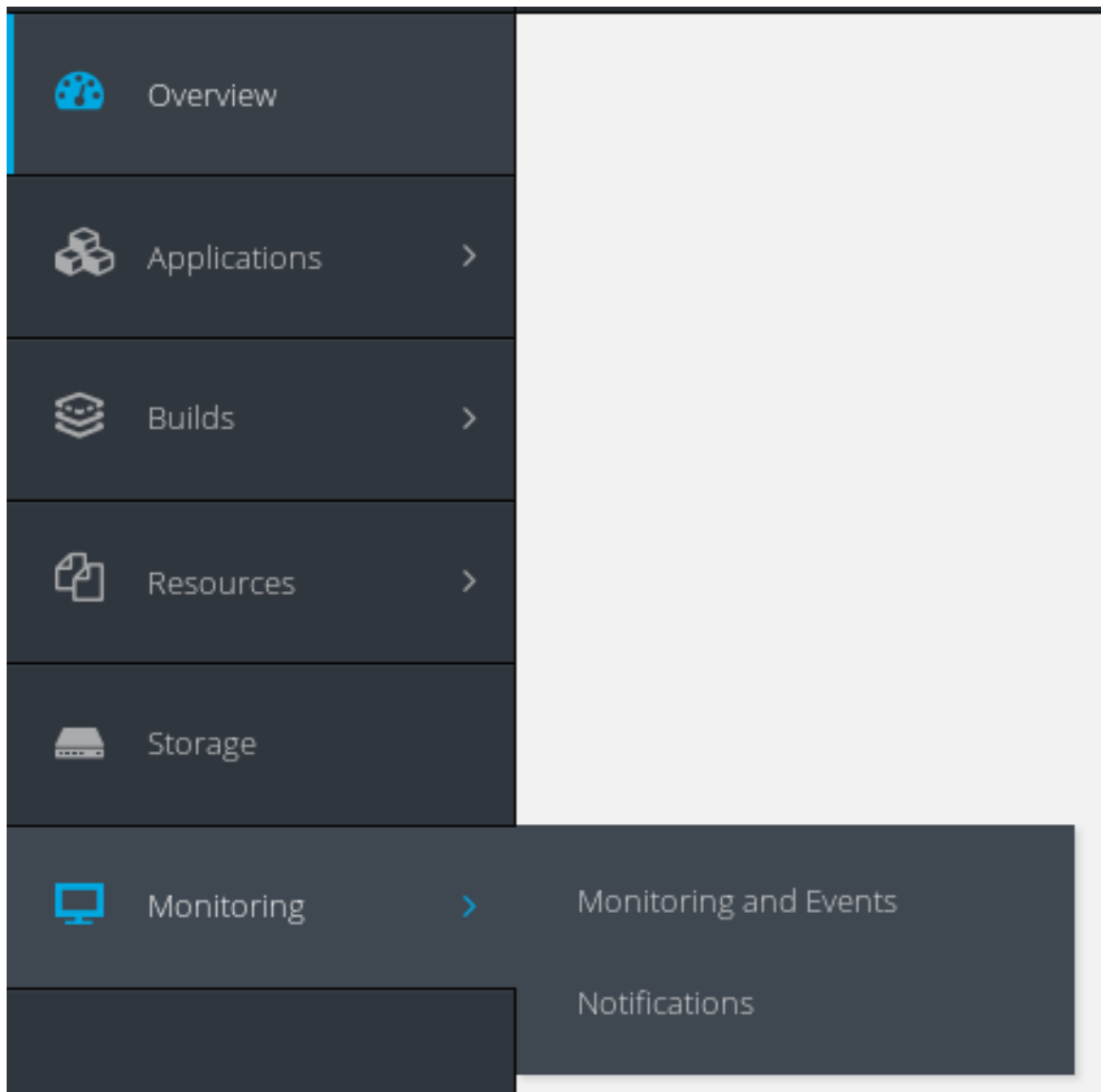
30.2. HOW IT WORKS

The Notifications feature continually monitors resources across the cluster. When problems are detected, notifications are sent to the email address of the project creator, designated in the **requester** field of the project. These notifications are throttled so that the recipient is not overwhelmed with email messages.

30.3. CONFIGURING NOTIFICATIONS VIA THE WEB CONSOLE

From the web console:

1. Select **Monitoring** from the left-hand navigation.
2. Select **Notifications** from the **Monitoring** dropdown menu.



3. Select your preferences on the **Notifications** page.

Notifications [Learn More](#) 

Control which critical event email notifications to receive from OpenShift Online.

Email notifications for project **example** will be sent to **developer**

Send notifications about critical events related to:

Application deployments

Example: Requesting more replicas than your quota allows.

Builds

Example: An automatically-triggered build fails, no notifications sent for repeat failures.

Storage and persistent volumes

Example: Unable to find a volume that satisfies the constraints defined in your persistent volume claim (PVC).

[Clear changes](#)

4. Click the **Save** button at the bottom of the page.
Once your options are successfully saved, this message will appear at the top of the page:



Successfully saved notification preferences.

30.4. STORING PREFERENCES

The Notifications feature uses a [ConfigMap](#) named **openshift-online-notifications** in each namespace to store preferences. The preferences allow users to specify which resources they would like to receive notifications for. An interface is provided in the web console to easily [modify these preferences](#).

Example ConfigMap for Notification Preferences

```
[source,yaml]
---
kind: ConfigMap
apiVersion: v1
metadata:
  name: openshift-online-notifications
  namespace: example
data:
  builds-enabled: 'true'
  deployments-enabled: 'true'
  storage-enabled: 'true'
```

If the ConfigMap is not present, it is assumed that notifications are disabled. The email address used is the email address of the project owner.

CHAPTER 31. MANAGING ENVIRONMENT VARIABLES

31.1. SETTING AND UNSETTING ENVIRONMENT VARIABLES

OpenShift Online provides the **oc set env** command to set or unset environment variables for objects that have a pod [template](#), such as replication controllers or deployment configurations. It can also list environment variables in pods or any object that has a pod template. This command can also be used on **BuildConfig** objects.

31.2. LIST ENVIRONMENT VARIABLES

To list environment variables in pods or pod templates:

```
$ oc set env <object-selection> --list [<common-options>]
```

This example lists all environment variables for pod **p1**:

```
$ oc set env pod/p1 --list
```

31.3. SET ENVIRONMENT VARIABLES

To set environment variables in the pod templates:

```
$ oc set env <object-selection> KEY_1=VAL_1 ... KEY_N=VAL_N [<set-env-options>] [<common-options>]
```

Set environment options:

Option	Description
-e, --env=<KEY>=<VAL>	Set given key value pairs of environment variables.
--overwrite	Confirm updating existing environment variables.

In the following example, both commands modify environment variable **STORAGE** in the deployment config **registry**. The first adds, with value **/data**. The second updates, with value **/opt**.

```
$ oc set env dc/registry STORAGE=/data
$ oc set env dc/registry --overwrite STORAGE=/opt
```

The following example finds environment variables in the current shell whose names begin with **RAILS_** and adds them to the replication controller **r1** on the server:

```
$ env | grep RAILS_ | oc set env rc/r1 -e -
```

The following example does not modify the replication controller defined in file **rc.json**. Instead, it writes a YAML object with updated environment **STORAGE=/local** to new file **rc.yaml**.

```
$ oc set env -f rc.json STORAGE=/opt -o yaml > rc.yaml
```


31.3.1. Automatically Added Environment Variables

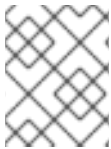
Table 31.1. Automatically Added Environment Variables

Variable Name
<SVCNAME>_SERVICE_HOST
<SVCNAME>_SERVICE_PORT

Example Usage

The service **KUBERNETES** which exposes TCP port 53 and has been allocated cluster IP address 10.0.0.11 produces the following environment variables:

```
KUBERNETES_SERVICE_PORT=53
MYSQL_DATABASE=root
KUBERNETES_PORT_53_TCP=tcp://10.0.0.11:53
KUBERNETES_SERVICE_HOST=10.0.0.11
```



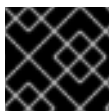
NOTE

Use the **oc rsh** command to SSH into your container and run **oc set env** to list all available variables.

31.4. UNSET ENVIRONMENT VARIABLES

To unset environment variables in the pod templates:

```
$ oc set env <object-selection> KEY_1- ... KEY_N- [<common-options>]
```



IMPORTANT

The trailing hyphen (-, U+2D) is required.

This example removes environment variables **ENV1** and **ENV2** from deployment config **d1**:

```
$ oc set env dc/d1 ENV1- ENV2-
```

This removes environment variable **ENV** from all replication controllers:

```
$ oc set env rc --all ENV-
```

This removes environment variable **ENV** from container **c1** for replication controller **r1**:

```
$ oc set env rc r1 --containers='c1' ENV-
```

CHAPTER 32. JOBS

32.1. OVERVIEW

A job, in contrast to a [replication controller](#), runs a pod with any number of replicas to completion. A job tracks the overall progress of a task and updates its status with information about active, succeeded, and failed pods. Deleting a job will clean up any pod replicas it created. Jobs are part of the Kubernetes API, which can be managed with **oc** commands like other [object types](#).

See the [Kubernetes documentation](#) for more information about jobs.

32.2. CREATING A JOB

A job configuration consists of the following key parts:

- A pod template, which describes the application the pod will create.
- An optional **parallelism** parameter, which specifies how many pod replicas running in parallel should execute a job. If not specified, this defaults to the value in the **completions** parameter.
- An optional **completions** parameter, specifying how many concurrently running pods should execute a job. If not specified, this value defaults to one.

The following is an example of a **job** resource:

```
apiVersion: batch/v1
kind: Job
metadata:
  name: pi
spec:
  parallelism: 1 1
  completions: 1 2
  template: 3
    metadata:
      name: pi
    spec:
      containers:
      - name: pi
        image: perl
        command: ["perl", "-Mbignum=bpi", "-wle", "print bpi(2000)"]
      restartPolicy: OnFailure 4
```

1. Optional value for how many pod replicas a job should run in parallel; defaults to **completions**.
2. Optional value for how many successful pod completions are needed to mark a job completed; defaults to one.
3. Template for the pod the controller creates.
4. The restart policy of the pod. This does not apply to the job controller. See [Section 32.2.1, "Known Limitations"](#) for details.

You can also create and launch a job from a single command using **oc run**. The following command creates and launches the same job as specified in the previous example:

```
$ oc run pi --image=perl --replicas=1 --restart=OnFailure \
  --command -- perl -Mbignum=bpi -wle 'print bpi(2000)'
```

32.2.1. Known Limitations

The job specification restart policy only applies to the *Pods*, and not the *job controller*. However, the job controller is hard-coded to keep retrying jobs to completion.

As such, **restartPolicy: Never** or **--restart=Never** results in the same behavior as **restartPolicy: OnFailure** or **--restart=OnFailure**. That is, when a job fails it is restarted automatically until it succeeds (or is manually discarded). The policy only sets which subsystem performs the restart.

With the **Never** policy, the *job controller* performs the restart. With each attempt, the job controller increments the number of failures in the job status and create new pods. This means that with each failed attempt, the number of pods increases.

With the **OnFailure** policy, *kubelet* performs the restart. Each attempt does not increment the number of failures in the job status. In addition, *kubelet* will retry failed jobs starting pods on the same nodes.

32.3. SCALING A JOB

A job can be scaled up or down by using the **oc scale** command with the **--replicas** option, which, in the case of jobs, modifies the **spec.parallelism** parameter. This will result in modifying the number of pod replicas running in parallel, executing a job.

The following command uses the example job above, and sets the **parallelism** parameter to three:

```
$ oc scale job pi --replicas=3
```



NOTE

Scaling replication controllers also uses the **oc scale** command with the **--replicas** option, but instead changes the **replicas** parameter of a replication controller configuration.

32.4. SETTING MAXIMUM DURATION

When defining a **Job**, you can define its maximum duration by setting the **activeDeadlineSeconds** field. It is specified in seconds and is not set by default. When not set, there is no maximum duration enforced.

The maximum duration is counted from the time when a first pod gets scheduled in the system, and defines how long a job can be active. It tracks overall time of an execution and is irrelevant to the number of completions (number of pod replicas needed to execute a task). After reaching the specified timeout, the job is terminated by OpenShift Online.

The following example shows the part of a **Job** specifying **activeDeadlineSeconds** field for 30 minutes:

```
spec:
  activeDeadlineSeconds: 1800
```

32.5. JOB BACKOFF FAILURE POLICY

A Job can be considered failed, after a set amount of retries due to a logical error in configuration or other similar reasons. To specify the number of retries for a job set the **.spec.backoffLimit** property. This field defaults to six. Failed Pods associated with the Job are recreated by the controller with an exponential backoff delay (**10s, 20s, 40s ...**) capped at six minutes. The limit is reset if no new failed pods appear between controller checks.

CHAPTER 33. OPENSIFT PIPELINE

33.1. OVERVIEW

OpenShift Pipelines give you control over building, deploying, and promoting your applications on OpenShift. Using a combination of the Jenkins Pipeline Build Strategy, Jenkinsfiles, and the OpenShift Domain Specific Language (DSL) (provided by the OpenShift Jenkins Client Plug-in), you can create advanced build, test, deploy, and promote pipelines for any scenario.

33.2. OPENSIFT JENKINS CLIENT PLUG-IN

The [OpenShift Jenkins Client Plug-in](#) must be installed on your Jenkins master so the OpenShift DSL will be available to use within the JenkinsFile for your application. This plug-in is installed and enabled by default when using the OpenShift Jenkins image.

33.2.1. OpenShift DSL

The OpenShift Jenkins Client Plug-in provides a fluent-styled DSL for communicating with the OpenShift API from within the Jenkins slaves. The OpenShift DSL is based on Groovy syntax and provides methods for controlling the lifecycle of your application such as create, build, deploy, and delete.

The full details of the API are embedded within the plug-in's online documentation within a running Jenkins instance. To find it:

- Create a new Pipeline Item.
- Click **Pipeline Syntax** below the DSL text area.
- From the left navigation menu, click **Global Variables Reference**.

33.3. JENKINS PIPELINE STRATEGY

In order to take advantage of the OpenShift Pipelines within your project, you will must use the [Jenkins Pipeline Build Strategy](#). This strategy defaults to using a **jenkinsfile** at the root of your source repository, but also provides the following configuration options:

- An inline **jenkinsfile** field within your BuildConfig.
- A **jenkinsfilePath** field within your BuildConfig that references the location of the **jenkinsfile** to use relative to the source **contextDir**.



NOTE

The optional **jenkinsfilePath** field specifies the name of the file to use, relative to the source **contextDir**. If **contextDir** is omitted, it defaults to the root of the repository. If **jenkinsfilePath** is omitted, it defaults to **jenkinsfile**.

For more detailed information about the Jenkins Pipeline Strategy, see [Pipeline Strategy Options](#).

33.4. JENKINSFILE

The **jenkinsfile** utilizes the standard groovy language syntax to allow fine grained control over the configuration, build, and deployment of your application.

The **jenkinsfile** can be supplied in one of the following ways:

- A file located within your source code repository.
- Embedded as part of your build configuration using the **jenkinsfile** field.

When using the first option, the **jenkinsfile** must be included in your applications source code repository at one of the following locations:

- A file named **jenkinsfile** at the root of your repository.
- A file named **jenkinsfile** at the root of the source **contextDir** of your repository.
- A file name specified via the **jenkinsfilePath** field of the **JenkinsPipelineStrategy** section of your BuildConfig, which is relative to the source **contextDir** if supplied, otherwise it defaults to the root of the repository.

The **jenkinsfile** is executed on the Jenkins slave pod, which must have the OpenShift Client binaries available if you intend to use the OpenShift DSL.

33.5. TUTORIAL

For a full walkthrough of building and deploying an application with Jenkins Pipeline, see [Jenkins Pipeline Tutorial](#).

33.6. ADVANCED TOPICS

33.6.1. Disabling Jenkins AutoProvisioning

When a Pipeline build configuration is created, OpenShift checks to see if there is currently a Jenkins master pod provisioned in the current project. If no Jenkins master is found, one is automatically created. If this behavior is not desirable, or if you would like to use a Jenkins server external to OpenShift, you can disable it.

33.6.2. Configuring Slave Pods

The [Kubernetes Plug-in](#) is also pre-installed in the official Jenkins image. This plug-in allows the Jenkins master to create slave pods on OpenShift and delegate running jobs to them to achieve scalability as well as providing pods with specific runtimes for specific jobs.

For more detailed information on configuring slave pods using the Kubernetes Plug-in, see [Kubernetes Plug-in](#).

CHAPTER 34. CRON JOBS

34.1. OVERVIEW

A *cron job* builds on a regular [job](#) by allowing you to specifically schedule how the job should be run. Cron jobs are part of the [Kubernetes API](#), which can be managed with `oc` commands like other [object types](#).



IMPORTANT

Cron Jobs are only available for *OpenShift Online Pro*. For more information about the differences between Starter and Pro tiers, visit the [pricing page](#).



WARNING

A cron job creates a job object approximately once per execution time of its schedule, but there are circumstances in which it fails to create a job or two jobs might be created. Therefore, jobs must be idempotent and you must [configure history limits](#).

34.2. CREATING A CRON JOB

A cron job configuration consists of the following key parts:

- A schedule specified in [cron format](#).
- A job template used when creating the next job.
- An optional deadline (in seconds) for starting the job if it misses its scheduled time for any reason. Missed jobs executions will be counted as failed ones. If not specified, there is no deadline.
- **ConcurrencyPolicy**: An optional concurrency policy, specifying how to treat concurrent jobs within a cron job. Only one of the following concurrent policies may be specified. If not specified, this defaults to allowing concurrent executions.
 - **Allow** allows Cron Jobs to run concurrently.
 - **Forbid** forbids concurrent runs, skipping the next run if the previous has not finished yet.
 - **Replace** cancels the currently running job and replaces it with a new one.
- An optional flag allowing the suspension of a cron job. If set to **true**, all subsequent executions will be suspended.

The following is an example of a **CronJob** resource:

```
apiVersion: batch/v1beta1
kind: CronJob
metadata:
  name: pi
```

```
spec:
  schedule: "*/1 * * * *" 1
  jobTemplate: 2
    spec:
      template:
        metadata:
          labels: 3
            parent: "cronjobpi"
        spec:
          containers:
            - name: pi
              image: perl
              command: ["perl", "-Mbignum=bpi", "-wle", "print bpi(2000)"]
          restartPolicy: OnFailure 4
```

1. Schedule for the job. In this example, the job will run every minute.
2. Job template. This is similar to the [job example](#).
3. Sets a label for jobs spawned by this cron job.
4. The restart policy of the pod. This does not apply to the job controller. See [Known Issues and Limitations](#) for details.



NOTE

All cron job **schedule** times are based on the timezone of the master where the job is initiated.

You can also create and launch a cron job from a single command using **oc run**. The following command creates and launches the same cron job as specified in the previous example:

```
$ oc run pi --image=perl --schedule='*/1 * * * *' \
  --restart=OnFailure --labels parent="cronjobpi" \
  --command -- perl -Mbignum=bpi -wle 'print bpi(2000)'
```

With **oc run**, the **--schedule** option accepts schedules in [cron format](#).



NOTE

When creating a cron job, **oc run** only supports the **Never** or **OnFailure** restart policies (**-restart**).

TIP

Delete cron jobs that you no longer need:

```
$ oc delete cronjob/<cron_job_name>
```

Doing this prevents them from generating unnecessary artifacts.

34.3. CLEANING UP AFTER A CRON JOB

The `.spec.successfulJobsHistoryLimit` and `.spec.failedJobsHistoryLimit` fields are optional. These fields specify how many completed and failed jobs should be kept. By default, they are set to **3** and **1** respectively. Setting a limit to **0** corresponds to keeping none of the corresponding kind of jobs after they finish.

Cron jobs can leave behind artifact resources such as jobs or pods. As a user it is important to configure history limits so that old jobs and their pods are properly cleaned. Currently, there are two fields within cron job's spec responsible for that:

```
apiVersion: batch/v1beta1
kind: CronJob
metadata:
  name: pi
spec:
  successfulJobsHistoryLimit: 3 1
  failedJobsHistoryLimit: 1 2
  schedule: "*/1 * * * *"
  jobTemplate:
    spec:
  ...
```

1 1 1 The number of successful finished jobs to retain (defaults to 3).

2 2 2 The number of failed finished jobs to retain (defaults to 1).

CHAPTER 35. CREATE FROM URL

35.1. OVERVIEW

Create From URL is a function that allows you to construct a URL from an image stream, image tag, or template.

Create from URL only works with image streams or templates from namespaces that have been explicitly whitelisted. The whitelist contains the **openshift** namespace by default.

You can define custom buttons.



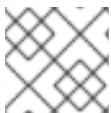
These buttons leverage a defined URL pattern with an appropriate query string. The user is prompted to select the project. Then, the Create from URL workflow continues.

35.2. USING AN IMAGE STREAM AND IMAGE TAG

35.2.1. Query String Parameters

Name	Description	Required	Schema	Default
imageStream	The value metadata.name as defined in the image stream to be used.	true	string	
imageTag	The value spec.tags.name as defined in the image stream to be used.	true	string	
namespace	The name of the namespace containing the image stream and image tag to use.	false	string	openshift
name	Identifies the resources created for this application.	false	string	

Name	Description	Required	Schema	Default
sourceURI	The Git repository URL containing the application source code.	false	string	
sourceRef	The branch, tag, or commit for the application source code specified in sourceURI .	false	string	
contextDir	The subdirectory for the application source code specified in sourceURI , used as the context directory for the build.	false	string	

**NOTE**

[Reserved characters](#) in parameter values should be URL encoded.

35.2.1.1. Example

```
create?
imageStream=nodejs&imageTag=4&name=nodejs&sourceURI=https%3A%2F%2Fgithub.com%2Fope
nshift%2Fnodejs-ex.git&sourceRef=master&contextDir=%2F
```

35.3. USING A TEMPLATE**35.3.1. Query String Parameters**

Name	Description	Required	Schema	Default
template	The value of metadata.name as defined in the template to be used.	true	string	

Name	Description	Required	Schema	Default
templateParamsMap	A JSON parameters map containing the template parameter name and corresponding value you wish to override.	false	JSON	
namespace	The name of the namespace containing the template to use.	false	string	openshift

**NOTE**

[Reserved characters](#) in parameter values should be URL encoded.

35.3.1.1. Example

```
create?template=nodejs-mongodb-example&templateParamsMap=
{"SOURCE_REPOSITORY_URL"%3A"https%3A%2F%2Fgithub.com%2Fopenshift%2Fnodejs-
ex.git"}
```

CHAPTER 36. APPLICATION MEMORY SIZING

36.1. OVERVIEW

This page is intended to provide guidance to application developers using OpenShift Online on:

1. Determining the memory and risk requirements of a containerized application component and configuring the container memory parameters to suit those requirements.
2. Configuring containerized application runtimes (for example, OpenJDK) to adhere optimally to the configured container memory parameters.
3. Diagnosing and resolving memory-related error conditions associated with running in a container.

36.2. BACKGROUND

It is recommended to read fully the overview of how OpenShift Online manages [Compute Resources](#) before proceeding.

For the purposes of sizing application memory, the key points are:

- For each kind of resource (memory, cpu, storage), OpenShift Online allows optional **request** and **limit** values to be placed on each container in a pod. For the purposes of this page, we are solely interested in memory requests and memory limits.
- **Memory request**
 - The memory request value, if specified, influences the OpenShift Online scheduler. The scheduler considers the memory request when scheduling a container to a node, then fences off the requested memory on the chosen node for the use of the container.
 - If a node's memory is exhausted, OpenShift Online prioritizes evicting its containers whose memory usage most exceeds their memory request. In serious cases of memory exhaustion, the node OOM killer may select and kill a process in a container based on a similar metric.
- **Memory limit**
 - The memory limit value, if specified, provides a hard limit on the memory that can be allocated across all the processes in a container.
 - If the memory allocated by all of the processes in a container exceeds the memory limit, the node OOM killer will immediately select and kill a process in the container.
 - If both memory request and limit are specified, the memory limit value must be greater than or equal to the memory request.
- **Administration**
 - The cluster administrator may assign quota against the memory request value, limit value, both, or neither.
 - The cluster administrator may assign default values for the memory request value, limit value, both, or neither.

- The cluster administrator may override the memory request values that a developer specifies, in order to manage cluster overcommit. This occurs on OpenShift Online, for example.

36.3. STRATEGY

The steps for sizing application memory on OpenShift Online are as follows:

1. **Determine expected container memory usage**

Determine expected mean and peak container memory usage, empirically if necessary (for example, by separate load testing). Remember to consider all the processes that may potentially run in parallel in the container: for example, does the main application spawn any ancillary scripts?

2. **Determine risk appetite**

Determine risk appetite for eviction. If the risk appetite is low, the container should request memory according to the expected peak usage plus a percentage safety margin. If the risk appetite is higher, it may be more appropriate to request memory according to the expected mean usage.

3. **Set container memory request**

Set container memory request based on the above. The more accurately the request represents the application memory usage, the better. If the request is too high, cluster and quota usage will be inefficient. If the request is too low, the chances of application eviction increase.

4. **Set container memory limit, if required**

Set container memory limit, if required. Setting a limit has the effect of immediately killing a container process if the combined memory usage of all processes in the container exceeds the limit, and is therefore a mixed blessing. On the one hand, it may make unanticipated excess memory usage obvious early ("fail fast"); on the other hand it also terminates processes abruptly.

Note that some OpenShift Online clusters may require a limit value to be set; some may override the request based on the limit; and some application images rely on a limit value being set as this is easier to detect than a request value.

If the memory limit is set, it should not be set to less than the expected peak container memory usage plus a percentage safety margin.

5. **Ensure application is tuned**

Ensure application is tuned with respect to configured request and limit values, if appropriate. This step is particularly relevant to applications which pool memory, such as the JVM. The rest of this page discusses this.

36.4. SIZING OPENJDK ON OPENSIFT ONLINE

The default OpenJDK settings unfortunately do not work well with containerized environments, with the result that as a rule, some additional Java memory settings must always be provided whenever running the OpenJDK in a container.

The JVM memory layout is complex, version dependent, and describing it in detail is beyond the scope of this documentation. However, as a starting point for running OpenJDK in a container, at least the following three memory-related tasks are key:

1. Overriding the JVM maximum heap size.

2. Encouraging the JVM to release unused memory to the operating system, if appropriate.
3. Ensuring all JVM processes within a container are appropriately configured.

Optimally tuning JVM workloads for running in a container is beyond the scope of this documentation, and may involve setting multiple additional JVM options.

36.4.1. Overriding the JVM Maximum Heap Size

For many Java workloads, the JVM heap is the largest single consumer of memory. Currently, the OpenJDK defaults to allowing up to 1/4 (1/**-XX:MaxRAMFraction**) of the compute node's memory to be used for the heap, regardless of whether the OpenJDK is running in a container or not. It is therefore **essential** to override this behaviour, especially if a container memory limit is also set.

There are at least two ways the above can be achieved:

1. If the container memory limit is set and the experimental options are supported by the JVM, set **-XX:+UnlockExperimentalVMOptions -XX:+UseCGroupMemoryLimitForHeap**. This sets **-XX:MaxRAM** to the container memory limit, and the maximum heap size (**-XX:MaxHeapSize** / **-Xmx**) to 1/ **-XX:MaxRAMFraction** (1/4 by default).
2. Directly override one of **-XX:MaxRAM**, **-XX:MaxHeapSize** or **-Xmx**. This option involves hard-coding a value, but has the advantage of allowing a safety margin to be calculated.

36.4.2. Encouraging the JVM to Release Unused Memory to the Operating System

By default, the OpenJDK does not aggressively return unused memory to the operating system. This may be appropriate for many containerized Java workloads, but notable exceptions include workloads where additional active processes co-exist with a JVM within a container, whether those additional processes are native, additional JVMs, or a combination of the two.

The [OpenShift Online Jenkins maven slave image](#) uses the following JVM arguments to encourage the JVM to release unused memory to the operating system: **-XX:+UseParallelGC -XX:MinHeapFreeRatio=5 -XX:MaxHeapFreeRatio=10 -XX:GCTimeRatio=4 -XX:AdaptiveSizePolicyWeight=90**. These arguments are intended to return heap memory to the operating system whenever allocated memory exceeds 110% of in-use memory (**-XX:MaxHeapFreeRatio**), spending up to 20% of CPU time in the garbage collector (**-XX:GCTimeRatio**). At no time will the application heap allocation be less than the initial heap allocation (overridden by **-XX:InitialHeapSize** / **-Xms**). Detailed additional information is available [Tuning Java's footprint in OpenShift \(Part 1\)](#), [Tuning Java's footprint in OpenShift \(Part 2\)](#), and at [OpenJDK and Containers](#).

36.4.3. Ensuring All JVM Processes Within a Container Are Appropriately Configured

In the case that multiple JVMs run in the same container, it is essential to ensure that they are all configured appropriately. For many workloads it will be necessary to grant each JVM a percentage memory budget, leaving a perhaps substantial additional safety margin.

Many Java tools use different environment variables (**JAVA_OPTS**, **GRADLE_OPTS**, **MAVEN_OPTS**, and so on) to configure their JVMs and it can be challenging to ensure that the right settings are being passed to the right JVM.

The **JAVA_TOOL_OPTIONS** environment variable is always respected by the OpenJDK, and values

specified in **JAVA_TOOL_OPTIONS** will be overridden by other options specified on the JVM command line. By default, the [OpenShift Online Jenkins maven slave image](#) sets **JAVA_TOOL_OPTIONS="-XX:+UnlockExperimentalVMOptions -XX:+UseCGroupMemoryLimitForHeap -Dsun.zip.disableMemoryMapping=true"** to ensure that these options are used by default for all JVM workloads run in the slave image. This does not guarantee that additional options are not required, but is intended to be a helpful starting point.

36.5. FINDING THE MEMORY REQUEST AND LIMIT FROM WITHIN A POD

An application wishing to dynamically discover its memory request and limit from within a pod should use the Downward API. The following snippet shows how this is done.

```
apiVersion: v1
kind: Pod
metadata:
  name: test
spec:
  containers:
  - name: test
    image: fedora:latest
    command:
    - sleep
    - "3600"
    env:
    - name: MEMORY_REQUEST
      valueFrom:
        resourceFieldRef:
          containerName: test
          resource: requests.memory
    - name: MEMORY_LIMIT
      valueFrom:
        resourceFieldRef:
          containerName: test
          resource: limits.memory
    resources:
      requests:
        memory: 384Mi
      limits:
        memory: 512Mi
```

```
# oc rsh test
$ env | grep MEMORY | sort
MEMORY_LIMIT=536870912
MEMORY_REQUEST=402653184
```

The memory limit value can also be read from inside the container by the `/sys/fs/cgroup/memory/memory.limit_in_bytes` file.

36.6. DIAGNOSING AN OOM KILL

OpenShift Online may kill a process in a container if the total memory usage of all the processes in the container exceeds the memory limit, or in serious cases of node memory exhaustion.

When a process is OOM killed, this may or may not result in the container exiting immediately. If the container PID 1 process receives the **SIGKILL**, the container will exit immediately. Otherwise, the container behavior is dependent on the behavior of the other processes.

If the container does not exit immediately, an OOM kill is detectable as follows:

1. A container process exited with code 137, indicating it received a SIGKILL signal
2. The `oom_kill` counter in `/sys/fs/cgroup/memory/memory.oom_control` is incremented

```
$ grep '^oom_kill ' /sys/fs/cgroup/memory/memory.oom_control
oom_kill 0
$ sed -e " </dev/zero # provoke an OOM kill
Killed
$ echo $?
137
$ grep '^oom_kill ' /sys/fs/cgroup/memory/memory.oom_control
oom_kill 1
```

If one or more processes in a pod are OOM killed, when the pod subsequently exits, whether immediately or not, it will have phase **Failed** and reason **OOMKilled**. An OOM killed pod may be restarted depending on the value of **restartPolicy**. If not restarted, controllers such as the ReplicationController will notice the pod's failed status and create a new pod to replace the old one.

If not restarted, the pod status is as follows:

```
$ oc get pod test
NAME    READY   STATUS    RESTARTS  AGE
test    0/1     OOMKilled 0          1m

$ oc get pod test -o yaml
...
status:
  containerStatuses:
  - name: test
    ready: false
    restartCount: 0
  state:
    terminated:
      exitCode: 137
      reason: OOMKilled
  phase: Failed
```

If restarted, its status is as follows:

```
$ oc get pod test
NAME    READY   STATUS    RESTARTS  AGE
test    1/1     Running   1          1m

$ oc get pod test -o yaml
...
status:
  containerStatuses:
  - name: test
    ready: true
```

```
restartCount: 1
lastState:
  terminated:
    exitCode: 137
    reason: OOMKilled
state:
  running:
phase: Running
```

36.7. DIAGNOSING AN EVICTED POD

OpenShift Online may evict a pod from its node when the node's memory is exhausted. Depending on the extent of memory exhaustion, the eviction may or may not be graceful. Graceful eviction implies the main process (PID 1) of each container receiving a SIGTERM signal, then some time later a SIGKILL signal if the process hasn't exited already. Non-graceful eviction implies the main process of each container immediately receiving a SIGKILL signal.

An evicted pod will have phase **Failed** and reason **Evicted**. It will not be restarted, regardless of the value of **restartPolicy**. However, controllers such as the ReplicationController will notice the pod's failed status and create a new pod to replace the old one.

```
$ oc get pod test
NAME    READY   STATUS    RESTARTS   AGE
test    0/1     Evicted   0           1m

$ oc get pod test -o yaml
...
status:
  message: 'Pod The node was low on resource: [MemoryPressure].'
```