Percona Distribution for PostgreSQL Operator

Release 1.1.0

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CONTENTS

Kubernetes have added a way to manage containerized systems, including database clusters. This management is achieved by controllers, declared in configuration files. These controllers provide automation with the ability to create objects, such as a container or a group of containers called pods, to listen for an specific event and then perform a task.

This automation adds a level of complexity to the container-based architecture and stateful applications, such as a database. A Kubernetes Operator is a special type of controller introduced to simplify complex deployments. The Operator extends the Kubernetes API with custom resources.

The Percona Distribution for PostgreSQL Operator is based on best practices for configuration and setup of a Percona Distribution for PostgreSQL cluster. The benefits of the Operator are many, but saving time and delivering a consistent and vetted environment is key.

Part I

Requirements

CHAPTER

ONE

SYSTEM REQUIREMENTS

The Operator is validated for deployment on Kubernetes, GKE and EKS clusters. The Operator is cloud native and storage agnostic, working with a wide variety of storage classes, hostPath, and NFS.

1.1 Officially supported platforms

The following platforms were tested and are officially supported by the Operator 1.1.0:

- Google Kubernetes Engine (GKE) 1.19 - 1.22
- Amazon Elastic Container Service for Kubernetes (EKS) 1.18 - 1.21
- OpenShift 4.7 - 4.9

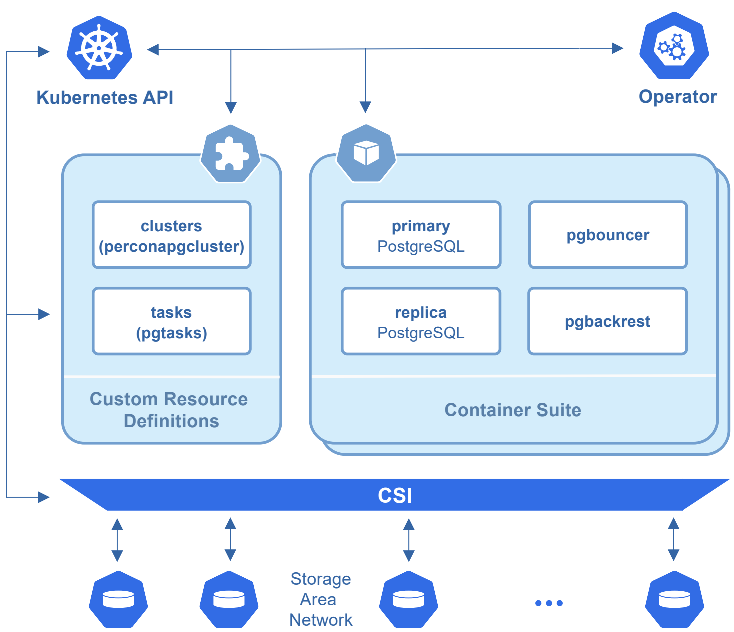
Other Kubernetes platforms may also work but have not been tested.

CHAPTER

TWO

DESIGN OVERVIEW

The Percona Distribution for PostgreSQL Operator automates and simplifies deploying and managing open source PostgreSQL clusters on Kubernetes. The Operator is based on CrunchyData's PostgreSQL Operator.

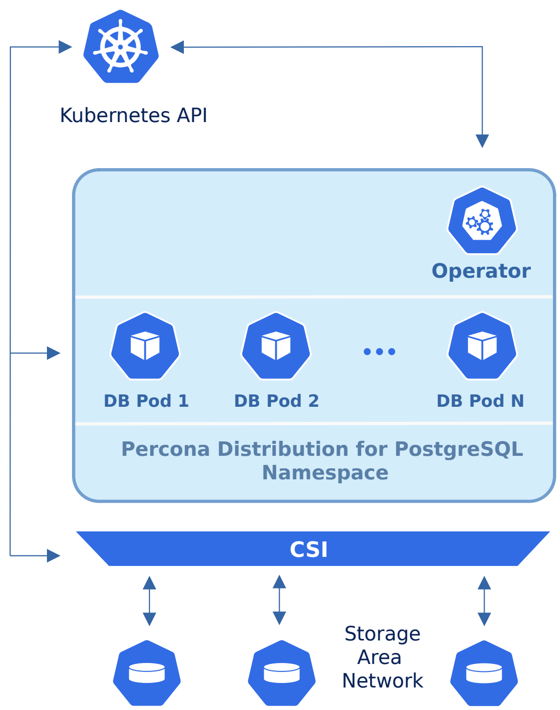


PostgreSQL containers deployed with the PostgreSQL Operator include the following components:

- The PostgreSQL database management system, including:
  - PostgreSQL Additional Supplied Modules,
  - pgAudit PostgreSQL auditing extension,
  - PostgreSQL set_user Extension Module,
  - wal2json output plugin,

- The pgBackRest Backup & Restore utility,
- The pgBouncer connection pooler for PostgreSQL,
- The PostgreSQL high-availability implementation based on the Patroni template,
- the pg_stat_monitor PostgreSQL Query Performance Monitoring utility,
- LLVM (for JIT compilation).

To provide high availability the Operator involves node affinity to run PostgreSQL Cluster instances on separate worker nodes if possible. If some node fails, the Pod with it is automatically re-created on another node.



To provide data storage for stateful applications, Kubernetes uses Persistent Volumes. A *PersistentVolumeClaim* (PVC) is used to implement the automatic storage provisioning to pods. If a failure occurs, the Container Storage Interface (CSI) should be able to re-mount storage on a different node.

The Operator functionality extends the Kubernetes API with Custom Resources Definitions. These CRDs provide extensions to the Kubernetes API, and, in the case of the Operator, allow you to perform actions such as creating a PostgreSQL Cluster, updating PostgreSQL Cluster resource allocations, adding additional utilities to a PostgreSQL cluster, e.g. pgBouncer for connection pooling and more.

When a new Custom Resource is created or an existing one undergoes some changes or deletion, the Operator automatically creates/changes/deletes all needed Kubernetes objects with the appropriate settings to provide a proper Percona PostgreSQL Cluster operation.

Following CRDs are created while the Operator installation:

- `pgclusters` stores information required to manage a PostgreSQL cluster. This includes things like the cluster name, what storage and resource classes to use, which version of PostgreSQL to run, information about how to maintain a high-availability cluster, etc.
- `pgreplicas` stores information required to manage the replicas within a PostgreSQL cluster. This includes things like the number of replicas, what storage and resource classes to use, special affinity rules, etc.

- `pgtasks` is a general purpose CRD that accepts a type of task that is needed to run against a cluster (e.g. take a backup) and tracks the state of said task through its workflow.

Part II

Installation guide

CHAPTER

THREE

INSTALL PERCONA DISTRIBUTION FOR POSTGRESQL ON KUBERNETES

Following steps will allow you to install the Operator and use it to manage Percona Distribution for PostgreSQL in a Kubernetes-based environment.

1. First of all, clone the percona-postgresql-operator repository:

```
git clone -b v1.1.0 https://github.com/percona/percona-postgresql-operator
cd percona-postgresql-operator
```

   Note: It is crucial to specify the right branch with `-b` option while cloning the code on this step. Please be careful.

2. The next thing to do is to add the `pgo` namespace to Kubernetes, not forgetting to set the correspondent context for further steps:

```
$ kubectl create namespace pgo
$ kubectl config set-context $(kubectl config current-context) --namespace=pgo
```

   Note: To use different namespace, you should edit *all occurrences* of the `namespace: pgo` line in both `deploy/cr.yaml` and `deploy/operator.yaml` configuration files.

3. Deploy the operator with the following command:

```
$ kubectl apply -f deploy/operator.yaml
```

4. After the operator is started Percona Distribution for PostgreSQL can be created at any time with the following command:

```
$ kubectl apply -f deploy/cr.yaml
```

   Creation process will take some time. The process is over when both operator and replica set pod have reached their Running status:

```
$ kubectl get pods
NAME                                              READY   STATUS      RESTARTS   AGE
backrest-backup-cluster1-j275w                    0/1     Completed   0          10m
cluster1-85486d645f-gpxzb                         1/1     Running     0          10m
cluster1-backrest-shared-repo-6495464548-c8wvl    1/1     Running     0          10m
```

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```
cluster1-pgbouncer-fc45869f7-s86rf                1/1     Running   0          10m
pgo-deploy-rhv6k                                  0/1     Completed 0          5m
postgres-operator-8646c68b57-z8m62                4/4     Running   1          5m
```

5. During previous steps, the Operator has generated several secrets, including the password for the `pguser` user, which you will need to access the cluster.

   Use `kubectl get secrets` command to see the list of Secrets objects (by default Secrets object you are interested in has `cluster1-pguser-secret` name). Then `kubectl get secret cluster1-pguser-secret -o yaml` will return the YAML file with generated secrets, including the password which should look as follows:

   ```
   ...
   data:
     ...
     password: cGd1c2VyX3Bhc3N3b3JkCg==
   ```

   Here the actual password is base64-encoded, and `echo 'cGd1c2VyX3Bhc3N3b3JkCg==' | base64 --decode` will bring it back to a human-readable form (in this example it will be a `pguser_password` string).

6. Check connectivity to newly created cluster

   ```
   $ kubectl run -i --rm --tty pg-client --image=perconalab/percona-distribution-
   ↪postgresql:13.2 --restart=Never -- bash -il
   [postgres@pg-client /]$ PGPASSWORD='pguser_password' psql -h cluster1-pgbouncer -p␣
   ↪5432 -U pguser pgdb
   ```

   This command will connect you to the PostgreSQL interactive terminal.

   ```
   psql (13.2)
   Type "help" for help.
   pgdb=>
   ```

CHAPTER

FOUR

INSTALL PERCONA DISTRIBUTION FOR POSTGRESQL ON OPENSHIFT

Following steps will allow you to install the Operator and use it to manage Percona Distribution for PostgreSQL on Red Hat OpenShift platform. For more information on the OpenShift, see its official documentation.

Following steps will allow you to install the Operator and use it to manage Percona Distribution for PostgreSQL on OpenShift.

1. First of all, clone the percona-postgresql-operator repository:

```
git clone -b v1.1.0 https://github.com/percona/percona-postgresql-operator
cd percona-postgresql-operator
```

Note: It is crucial to specify the right branch with `-b` option while cloning the code on this step. Please be careful.

2. The next thing to do is to add the `pgo` namespace to Kubernetes, not forgetting to set the correspondent context for further steps:

```
$ oc create namespace pgo
$ oc config set-context $(kubectl config current-context) --namespace=pgo
```

Note: To use different namespace, you should edit *all occurrences* of the `namespace: pgo` line in both `deploy/cr.yaml` and `deploy/operator.yaml` configuration files.

3. Deploy the operator with the following command:

```
$ oc apply -f deploy/operator.yaml
```

4. After the operator is started Percona Distribution for PostgreSQL can be created at any time with the following command:

```
$ oc apply -f deploy/cr.yaml
```

Creation process will take some time. The process is over when both operator and replica set pod have reached their Running status:

```
$ oc get pods
NAME                                              READY   STATUS     RESTARTS   AGE
backrest-backup-cluster1-j275w                    0/1     Completed 0           10m
```

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```
cluster1-85486d645f-gpxzb                        1/1     Running   0          10m
cluster1-backrest-shared-repo-6495464548-c8wvl   1/1     Running   0          10m
cluster1-pgbouncer-fc45869f7-s86rf               1/1     Running   0          10m
pgo-deploy-rhv6k                                 0/1     Completed 0          5m
postgres-operator-8646c68b57-z8m62               4/4     Running   1          5m
```

5. During previous steps, the Operator has generated several secrets, including the password for the `pguser` user, which you will need to access the cluster.

   Use `oc get secrets` command to see the list of Secrets objects (by default Secrets object you are interested in has `cluster1-pguser-secret` name). Then `kubectl get secret cluster1-pguser-secret -o yaml` will return the YAML file with generated secrets, including the password which should look as follows:

   ```
   ...
   data:
     ...
     password: cGd1c2VyX3Bhc3N3b3JkCg==
   ```

   Here the actual password is base64-encoded, and `echo 'cGd1c2VyX3Bhc3N3b3JkCg==' | base64 --decode` will bring it back to a human-readable form (in this example it will be a `pguser_password` string).

6. Check connectivity to newly created cluster

   ```
   $ oc run -i --rm --tty pg-client --image=perconalab/percona-distribution-
   ↪postgresql:13.2 --restart=Never -- bash -il
   [postgres@pg-client /]$ PGPASSWORD='pguser_password' psql -h cluster1-pgbouncer -p␣
   ↪5432 -U pguser pgdb
   ```

   This command will connect you to the PostgreSQL interactive terminal.

   ```
   psql (13.2)
   Type "help" for help.
   pgdb=>
   ```

CHAPTER

FIVE

INSTALL PERCONA DISTRIBUTION FOR POSTGRESQL ON MINIKUBE

Installing the Percona Distribution for PostgreSQL Operator on minikube is the easiest way to try it locally without a cloud provider. Minikube runs Kubernetes on GNU/Linux, Windows, or macOS system using a system-wide hypervisor, such as VirtualBox, KVM/QEMU, VMware Fusion or Hyper-V. Using it is a popular way to test the Kubernetes application locally prior to deploying it on a cloud.

The following steps are needed to run Percona Distribution for PostgreSQL Operator on minikube:

1. Install minikube, using a way recommended for your system. This includes the installation of the following three components:

    1. kubectl tool,
    2. a hypervisor, if it is not already installed,
    3. actual minikube package

    After the installation, run `minikube start` command. Being executed, this command will download needed virtualized images, then initialize and run the cluster. After minikube is successfully started, you can optionally run the Kubernetes dashboard, which visually represents the state of your cluster. Executing `minikube dashboard` will start the dashboard and open it in your default web browser.

2. Clone the percona-postgresql-operator repository:

    ```
    $ git clone -b v1.1.0 https://github.com/percona/percona-postgresql-operator
    $ cd percona-postgresql-operator
    ```

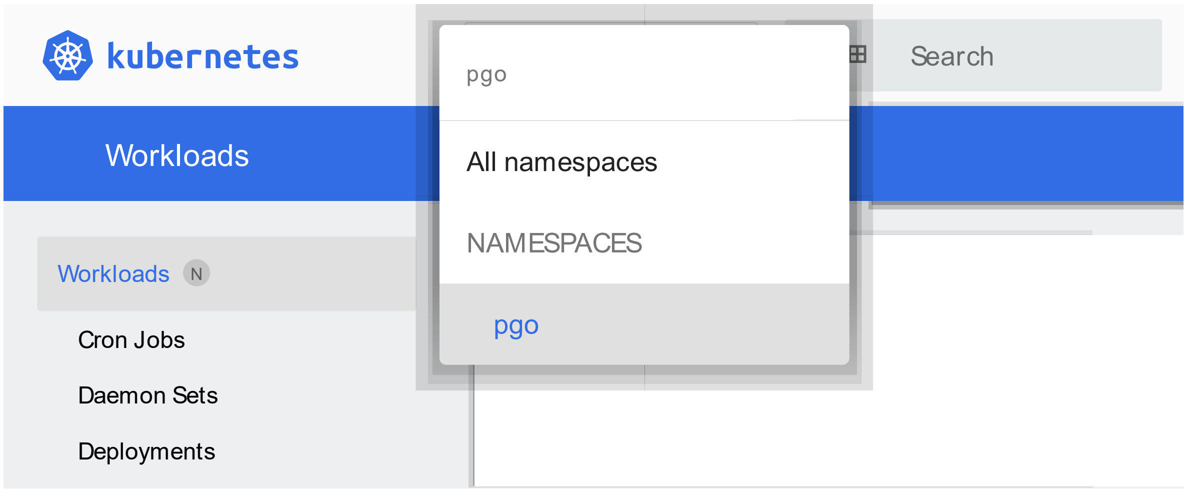
    Note: It is crucial to specify the right branch with `-b` option while cloning the code on this step. Please be careful.

3. The next thing to do is to add the `pgo` namespace to Kubernetes, not forgetting to set the correspondent context for further steps:

    ```
    $ kubectl create namespace pgo
    $ kubectl config set-context $(kubectl config current-context) --namespace=pgo
    ```

    Note: To use different namespace, you should edit *all occurrences* of the `namespace: pgo` line in both `deploy/cr.yaml` and `deploy/operator.yaml` configuration files.

    If you use Kubernetes dashboard, choose your newly created namespace to be shown instead of the default one:



4. Deploy the operator with the following command:

```
$ kubectl apply -f deploy/operator.yaml
```

5. Because minikube runs locally, the default `deploy/cr.yaml` file should be edited to adapt the Operator for the the local installation with limited resources. Comment **all occurrences** of the `resources.requests.memory` and `resources.requests.cpu` keys to fit the Operator in minikube default limitations.

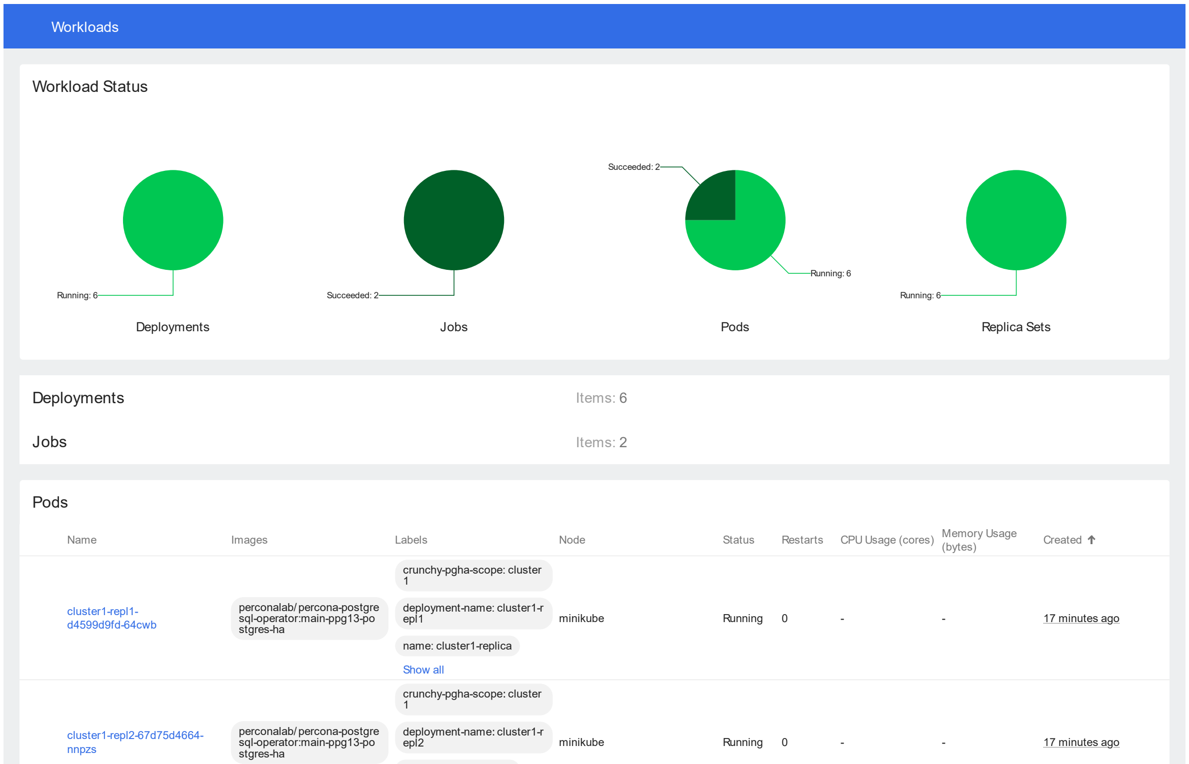
6. Now apply the `deploy/cr.yaml` file with the following command:

```
$ kubectl apply -f deploy/cr.yaml
```

Creation process will take some time. The process is over when both operator and replica set pod have reached their Running status:

```
$ kubectl get pods
NAME                                              READY   STATUS      RESTARTS       AGE
backrest-backup-cluster1--1-f29n8                 0/1     Completed   0              46s
cluster1-79bcc648c5-14mp6                         1/1     Running     0              2m13s
cluster1-backrest-shared-repo-76b888ff97-85bd9    1/1     Running     0              2m39s
cluster1-pgbouncer-74867b55f5-cxx74               1/1     Running     0              73s
cluster1-repl1-d4599d9fd-64cwb                    1/1     Running     0              32s
cluster1-repl2-67d75d4664-nnpzs                   1/1     Running     0              32s
pgo-deploy--1-2rxxt                               0/1     Completed   0              12m
postgres-operator-7df6999fbd-hfp9g                4/4     Running     1 (11m ago)    11m
```

You can also track the progress via the Kubernetes dashboard:



7. During previous steps, the Operator has generated several secrets, including the password for the `pguser` user, which you will need to access the cluster.

   Use `kubectl get secrets` command to see the list of Secrets objects(by default Secrets object you are interested in has `cluster1-pguser-secret` name). Then `kubectl get secret cluster1-pguser-secret -o yaml` will return the YAML file with generated secrets, including the password which should look as follows:

```
...
data:
  ...
  password: cGd1c2VyX3Bhc3N3b3JkCg==
```

   Here the actual password is base64-encoded, and `echo 'cGd1c2VyX3Bhc3N3b3JkCg==' | base64 --decode` will bring it back to a human-readable form (in this example it will be a `pguser_password` string).

8. Check connectivity to a newly created cluster.

   Run new Pod to use it as a client and connect its console output to your terminal (running it may require some time to deploy). When you see the command line prompt of the newly created Pod, run run `psql` tool using the password obtained from the secret:

```
$ kubectl run -i --rm --tty pg-client --image=perconalab/percona-distribution-postgresql:13.2 --restart=Never -- bash -il
[postgres@pg-client /]$ PGPASSWORD='pguser_password' psql -h cluster1-pgbouncer -p 5432 -U pguser pgdb
```

   This command will connect you to the PostgreSQL interactive terminal.

```
psql (13.2)
Type "help" for help.
pgdb=>
```

CHAPTER

SIX

INSTALL PERCONA DISTRIBUTION FOR POSTGRESQL ON GOOGLE KUBERNETES ENGINE (GKE)

Following steps will allow you to install the Operator and use it to manage Percona Distribution for PostgreSQL with the Google Kubernetes Engine. The document assumes some experience with Google Kubernetes Engine (GKE). For more information on the GKE, see the Kubernetes Engine Quickstart.

6.1 Prerequisites

All commands from this quickstart can be run either in the **Google Cloud shell** or in **your local shell**.

To use *Google Cloud shell*, you need nothing but a modern web browser.

If you would like to use *your local shell*, install the following:

1. gcloud. This tool is part of the Google Cloud SDK. To install it, select your operating system on the official Google Cloud SDK documentation page and then follow the instructions.
2. kubectl. It is the Kubernetes command-line tool you will use to manage and deploy applications. To install the tool, run the following command:

```
$ gcloud auth login
$ gcloud components install kubectl
```

6.2 Configuring default settings for the cluster

You can configure the settings using the `gcloud` tool. You can run it either in the Cloud Shell or in your local shell (if you have installed Google Cloud SDK locally on the previous step). The following command will create a cluster named `my-cluster-1`:

```
$ gcloud container clusters create cluster-1 --project <project name> --zone us-central1-
↪a --cluster-version {{{gkerecommended}}} --machine-type n1-standard-4 --num-nodes=3
```

Note: You must edit the following command and other command-line statements to replace the `<project name>` placeholder with your project name. You may also be required to edit the *zone location*, which is set to `us-central1` in the above example. Other parameters specify that we are creating a cluster with 3 nodes and with machine type of 4 vCPUs and 45 GB memory.

You may wait a few minutes for the cluster to be generated, and then you will see it listed in the Google Cloud console (select *Kubernetes Engine* → *Clusters* in the left menu panel):

Now you should configure the command-line access to your newly created cluster to make `kubectl` be able to use it.

In the Google Cloud Console, select your cluster and then click the *Connect* shown on the above image. You will see the connect statement configures command-line access. After you have edited the statement, you may run the command in your local shell:

```
$ gcloud container clusters get-credentials cluster-1 --zone us-central1-a --project <project name>
```

6.3 Installing the Operator

1. First of all, use your Cloud Identity and Access Management (Cloud IAM) to control access to the cluster. The following command will give you the ability to create Roles and RoleBindings:

   ```
   $ kubectl create clusterrolebinding cluster-admin-binding --clusterrole cluster-admin --user $(gcloud config get-value core/account)
   ```

   The return statement confirms the creation:

   ```
   clusterrolebinding.rbac.authorization.k8s.io/cluster-admin-binding created
   ```

2. Use the following `git clone` command to download the correct branch of the percona-postgresql-operator repository:

   ```
   git clone -b v1.1.0 https://github.com/percona/percona-postgresql-operator
   cd percona-postgresql-operator
   ```

3. The next thing to do is to add the `pgo` namespace to Kubernetes, not forgetting to set the correspondent context for further steps:

   ```
   $ kubectl create namespace pgo
   $ kubectl config set-context $(kubectl config current-context) --namespace=pgo
   ```

   Note: To use different namespace, you should edit *all occurrences* of the `namespace: pgo` line in both `deploy/cr.yaml` and `deploy/operator.yaml` configuration files.

4. Deploy the operator with the following command:

   ```
   $ kubectl apply -f deploy/operator.yaml
   ```

5. After the operator is started Percona Distribution for PostgreSQL can be created at any time with the following commands:

   ```
   $ kubectl apply -f deploy/cr.yaml
   ```

   Creation process will take some time. The process is over when the Operator and PostgreSQL Pods have reached their Running status:

```
$ kubectl get pods
NAME                                            READY   STATUS      RESTARTS   AGE
backrest-backup-cluster1-4nq2x                  0/1     Completed   0          10m
cluster1-6c9d4f9678-qdfx2                       1/1     Running     0          10m
cluster1-backrest-shared-repo-7cb4dd8f8f-sh5gg  1/1     Running     0          10m
cluster1-pgbouncer-6cd69d8966-vlxdt             1/1     Running     0          10m
pgo-deploy-bp2ts                                0/1     Completed   0          5m
postgres-operator-67f58bcb8c-9p4tl              4/4     Running     1          5m
```

Also, you can see the same information when browsing Pods of your cluster in Google Cloud console via the *Object Browser*:

Name	Status	Type	Namespace	Cluster	Location
core		API Group			
Pod		Kind			
backrest-backup-cluster1-t6s42	Succeeded	Pod	pgo	cluster1	europe-west3-b
cluster1-6c9d4f9678-qdfx2	Running	Pod	pgo	cluster1	europe-west3-b
cluster1-backrest-shared-repo-7cb4dd8f8f-sh5gg	Running	Pod	pgo	cluster1	europe-west3-b
cluster1-pgbouncer-6cd69d8966-vlxdt	Running	Pod	pgo	cluster1	europe-west3-b
pgo-deploy-bp2ts	Succeeded	Pod	pgo	cluster1	europe-west3-b
postgres-operator-67f58bcb8c-9p4tl	Running	Pod	pgo	cluster1	europe-west3-b

6. During previous steps, the Operator has generated several secrets, including the password for the `pguser` user, which you will need to access the cluster.

   Use `kubectl get secrets` command to see the list of Secrets objects (by default Secrets object you are interested in has `cluster1-pguser-secret` name). Then `kubectl get secret cluster1-pguser-secret -o yaml` will return the YAML file with generated secrets, including the password which should look as follows:

```
...
data:
  ...
  password: cGd1c2VyX3Bhc3N3b3JkCg==
```

   Here the actual password is base64-encoded, and `echo 'cGd1c2VyX3Bhc3N3b3JkCg==' | base64 --decode` will bring it back to a human-readable form (in this example it will be a `pguser_password` string).

7. Check connectivity to newly created cluster

```
$ kubectl run -i --rm --tty pg-client --image=perconalab/percona-distribution-
↪postgresql:13.2 --restart=Never -- bash -il
[postgres@pg-client /]$ PGPASSWORD='pguser_password' psql -h cluster1-pgbouncer -p␣
↪5432 -U pguser pgdb
```

   This command will connect you to the PostgreSQL interactive terminal.

```
psql (13.2)
Type "help" for help.
pgdb=>
```

CHAPTER

SEVEN

INSTALL PERCONA DISTRIBUTION FOR POSTGRESQL USING HELM

Helm is the package manager for Kubernetes. Percona Helm charts can be found in percona/percona-helm-charts repository in Github.

7.1 Pre-requisites

Install Helm following its official installation instructions.

Note: Helm v3 is needed to run the following steps.

7.2 Installation

1. Add the Percona's Helm charts repository and make your Helm client up to date with it:

```
$ helm repo add percona https://percona.github.io/percona-helm-charts/
$ helm repo update
```

2. Install the Percona Distribution for PostgreSQL Operator:

```
$ helm install my-operator percona/pg-operator --version 1.1.0
```

The `my-operator` parameter in the above example is the name of a new release object which is created for the Operator when you install its Helm chart (use any name you like).

Note: If nothing explicitly specified, `helm install` command will work with `default` namespace. To use different namespace, provide it with the following additional parameter: `--namespace my-namespace`.

3. Install PostgreSQL:

```
$ helm install my-db percona/pg-db --version 1.1.0 --namespace my-namespace
```

The `my-db` parameter in the above example is the name of a new release object which is created for the Percona Distribution for PostgreSQL when you install its Helm chart (use any name you like).

7.3 Installing Percona Distribution for PostgreSQL with customized parameters

The command above installs Percona Distribution for PostgreSQL with *default parameters*. Custom options can be passed to a `helm install` command as a `--set key=value[,key=value]` argument. The options passed with a chart can be any of the Operator's *Custom Resource options*.

The following example will deploy a Percona Distribution for PostgreSQL Cluster in the `pgdb` namespace, with enabled Percona Monitoring and Management (PMM) and 20 Gi storage for a Primary PostgreSQL node:

```
$ helm install my-db percona/pg-db --namespace pgdb \
  --set pgPrimary.volumeSpec.size=20Gi \
  --set pmm.enabled=true
```

Part III

Configuration and Management

CHAPTER

EIGHT

USERS

User accounts within the Cluster can be divided into two different groups:

- *application-level users*: the unprivileged user accounts,
- *system-level users*: the accounts needed to automate the cluster deployment and management tasks.

8.1 System Users

Credentials for system users are stored as a Kubernetes Secrets object. The Operator requires to be deployed before PostgreSQL Cluster is started. The name of the required secrets (`cluster1-users` by default) should be set in the `spec.secretsName` option of the `deploy/cr.yaml` configuration file.

The following table shows system users' names and purposes.

> **Warning:** These users should not be used to run an application.

The default PostgreSQL instance installation via the Percona Distribution for PostgreSQL Operator comes with the following users:

Role name	Attributes
`postgres`	Superuser, Create role, Create DB, Replication, Bypass RLS
`primaryuser`	Replication
`pguser`	Non-privileged user
`pgbouncer`	Administrative user for the pgBouncer connection pooler

The `postgres` user will be the admin user for the database instance. The `primaryuser` is used for replication between primary and replicas. The `pguser` is the default non-privileged user (you can configure different name of this user in the `spec.user` Custom Resource option).

8.1.1 YAML Object Format

The default name of the Secrets object for these users is `cluster1-users` and can be set in the CR for your cluster in `spec.secretName` to something different. When you create the object yourself, it should match the following simple format:

```yaml
apiVersion: v1
kind: Secret
metadata:
  name: cluster1-users
type: Opaque
stringData:
  pgbouncer: pgbouncer_password
  postgres: postgres_password
  primaryuser: primaryuser_password
  pguser: pguser_password
```

The example above matches what is shipped in the deploy/secrets.yaml file.

As you can see, we use the `stringData` type when creating the Secrets object, so all values for each key/value pair are stated in plain text format convenient from the user's point of view. But the resulting Secrets object contains passwords stored as `data` - i.e., base64-encoded strings. If you want to update any field, you'll need to encode the value into base64 format. To do this, you can run `echo -n "password" | base64` in your local shell to get valid values. For example, setting the PMM Server user's password to `new_password` in the `cluster1-users` object can be done with the following command:

```
kubectl patch secret/cluster1-users -p '{"data":{"pguser": '$(echo -n new_password |␣
↪base64)'}}'
```

CHAPTER

NINE

PROVIDING BACKUPS

The Operator allows doing backups in two ways. *Scheduled backups* are configured in the deploy/cr.yaml file to be executed automatically in proper time. *On-demand backups* can be done manually at any moment.

The Operator uses the open source pgBackRest backup and restore utility. A special *pgBackRest repository* is created by the Operator along with creating a new PostgreSQL cluster to facilitate the usage of the pgBackRest features in it.

The Operator can store PostgreSQL backups on Amazon S3, any S3-compatible storage and Google Cloud Storage outside the Kubernetes cluster. Storing backups on Persistent Volume attached to the pgBackRest Pod is also possible. At PostgreSQL cluster creation time, you can specify a specific Storage Class for the pgBackRest repository. Additionally, you can also specify the type of the pgBackRest repository that can be used for backups:

- `local`: Uses the storage that is provided by the Kubernetes cluster's Storage Class that you select,
- `s3`: Use Amazon S3 or an object storage system that uses the S3 protocol,
- `local,s3`: Use both the storage that is provided by the Kubernetes cluster's Storage Class that you select AND Amazon S3 (or equivalent object storage system that uses the S3 protocol).
- `gcs`: Use Google Cloud Storage,
- `local,gcs`: Use both the storage that is provided by the Kubernetes cluster's Storage Class that you select AND Google Cloud Storage.

The pgBackRest repository consists of the following Kubernetes objects:

- A Deployment,
- A Secret that contains information that is specific to the PostgreSQL cluster that it is deployed with (e.g. SSH keys, AWS S3 keys, etc.),
- A Pod with a number of supporting scripts,
- A Service.

The PostgreSQL primary is automatically configured to use the `pgbackrest archive-push` and push the write-ahead log (WAL) archives to the correct repository.

The PostgreSQL Operator supports three types of pgBackRest backups:

- Full (`full`): A full backup of all the contents of the PostgreSQL cluster,
- Differential (`diff`): A backup of only the files that have changed since the last full backup,
- Incremental (`incr`): A backup of only the files that have changed since the last full or differential backup. Incremental backup is the default choice.

The Operator also supports setting pgBackRest retention policies for backups. Backup retention can be controlled by the following pgBackRest options:

- `--repo1-retention-full` the number of full backups to retain,
- `--repo1-retention-diff` the number of differential backups to retain,
- `--repo1-retention-archive` how many sets of write-ahead log archives to retain alongside the full and differential backups that are retained.

You can set both backups type and retention policy when *Making on-demand backup*.

Also you should first configure the backup storage in the `deploy/cr.yaml` configuration file to have backups enabled.

9.1 Configuring the S3-compatible backup storage

In order to use S3-compatible storage for backups you need to provide some S3-related information, such as proper S3 bucket name, endpoint, etc. This information can be passed to pgBackRest via the following `deploy/cr.yaml` options in the `backup.storages` subsection:

- `bucket` specifies the AWS S3 bucket that should be utilized, for example `my-postgresql-backups-example`,
- `endpointUrl` specifies the S3 endpoint that should be utilized, for example `s3.amazonaws.com`,
- `region` specifies the AWS S3 region that should be utilized, for example `us-east-1`,
- `uriStyle` specifies whether `host` or `path` style URIs should be utilized,
- `verifyTLS` should be set to `true` to enable TLS verification or set to `false` to disable it,
- `type` should be set to `s3`.

You also need to supply pgBackRest with base64-encoded AWS S3 key and AWS S3 key secret stored along with other sensitive information in Kubernetes Secrets (e.g. encoding needed data with the `echo "string-to-encode" | base64` command). Edit the `deploy/backup/cluster1-backrest-repo-config-secret.yaml` configuration file: set there proper cluster name, AWS S3 key, and key secret:

```yaml
apiVersion: v1
kind: Secret
metadata:
  name: <cluster-name>-backrest-repo-config
type: Opaque
data:
  aws-s3-key: <base64-encoded-AWS-S3-key>
  aws-s3-key-secret: <base64-encoded-AWS-S3-key-secret>
```

When done, create the secret as follows:

```
$ kubectl apply -f deploy/backup/cluster1-backrest-repo-config-secret.yaml
```

Finally, create or update the cluster:

```
$ kubectl apply -f deploy/cr.yaml
```

9.2 Use Google Cloud Storage for backups

You can configure Google Cloud Storage as an object store for backups similarly to *S3 storage*.

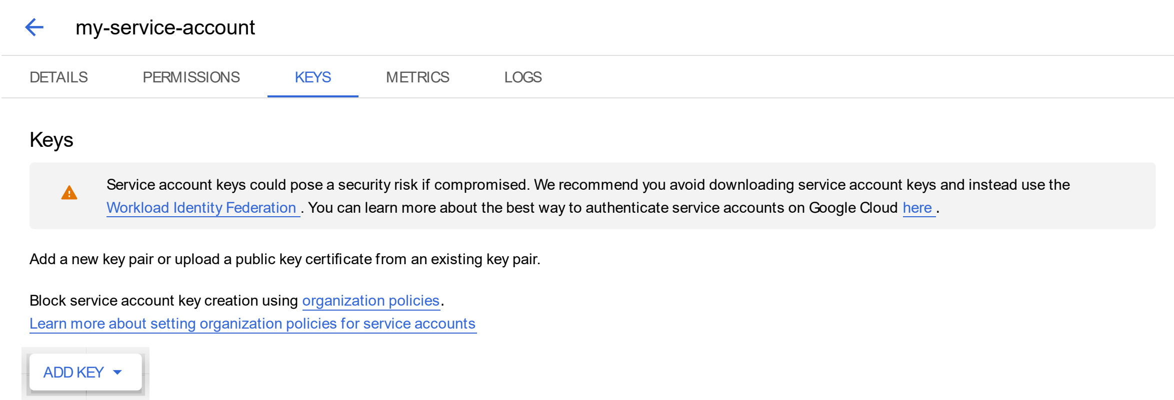
In order to use Google Cloud Storage (GCS) for backups you need to provide some GCS-related information, such as a proper GCS bucket name. This information can be passed to `pgBackRest` via the following options in the `backup.storages` subsection of the `deploy/cr.yaml` configuration file:

- `bucket` should contain the proper bucket name,
- `type` should be set to `gcs`.

The Operator will also need your service account key to access storage.

1. Create your service account key following the official Google Cloud instructions.
2. Export this key from your Google Cloud account.

   You can find your key in the Google Cloud console (select *IAM & Admin* → *Service Accounts* in the left menu panel, then click your account and open the *KEYS* tab):



   Click the *ADD KEY* button, chose *Create new key* and chose *JSON* as a key type. These actions will result in downloading a file in JSON format with your new private key and related information.

3. Now you should use a base64-encoded version of this file and to create the Kubernetes Secret. You can encode the file with the `base64 <filename>` command. When done, create the following yaml file with your cluster name and base64-encoded file contents:

```yaml
apiVersion: v1
kind: Secret
metadata:
  name: <cluster-name>-backrest-repo-config
type: Opaque
data:
  gcs-key: <base64-encoded-json-file-contents>
```

   When done, create the secret as follows:

```
$ kubectl apply -f ./my-gcs-account-secret.yaml
```

4. Finally, create or update the cluster:

```
$ kubectl apply -f deploy/cr.yaml
```

9.3 Scheduling backups

Backups schedule is defined in the `backup` section of the deploy/cr.yaml file. This section contains following subsections:

- `storages` subsection contains data needed to access the S3-compatible cloud to store backups.
- `schedule` subsection allows to actually schedule backups (the schedule is specified in crontab format).

Here is an example of deploy/cr.yaml which uses Amazon S3 storage for backups:

```
...
backup:
  ...
  schedule:
   - name: "sat-night-backup"
     schedule: "0 0 * * 6"
     keep: 3
     type: full
     storage: s3
  ...
```

The schedule is specified in crontab format as explained in *Custom Resource options*.

9.4 Making on-demand backup

To make an on-demand backup, the user should use a backup configuration file. The example of the backup configuration file is deploy/backup/backup.yaml.

The following keys are most important in the parameters section of this file:

- `parameters.backrest-opts` is the string with command line options which will be passed to pgBackRest, for example `--type=full --repo1-retention-full=5`,
- `parameters.pg-cluster` is the name of the PostgreSQL cluster to back up, for example `cluster1`.

When the backup options are configured, execute the actual backup command:

```
$ kubectl apply -f deploy/backup/backup.yaml
```

9.5 List existing backups

To get list of all existing backups in the pgBackrest repo, use the following command:

```
$ kubectl exec <name-of-backrest-shared-repo-pod>  -it -- pgbackrest info
```

9.6 Restore the cluster from a previously saved backup

The Operator supports the ability to perform a full restore on a PostgreSQL cluster as well as a point-in-time-recovery. There are two types of ways to restore a cluster:

- restore to a new cluster using the *pgDataSource.restoreFrom* option (and possibly, *pgDataSource.restoreOpts* for custom pgBackRest options),
- restore in-place, to an existing cluster (note that this is destructive).

Restoring to a new PostgreSQL cluster allows you to take a backup and create a new PostgreSQL cluster that can run alongside an existing one. There are several scenarios where using this technique is helpful:

- Creating a copy of a PostgreSQL cluster that can be used for other purposes. Another way of putting this is *creating a clone*.
- Restore to a point-in-time and inspect the state of the data without affecting the current cluster.

To restore the previously saved backup the user should use a *backup restore* configuration file. The example of the backup configuration file is deploy/backup/restore.yaml.

The following keys are the most important in the parameters section of this file:

- `parameters.backrest-restore-from-cluster` specifies the name of a PostgreSQL cluster which will be restored. This includes stopping the database and recreating a new primary with the restored data (for example, `cluster1`),
- `parameters.backrest-restore-opts` specifies additional options for pgBackRest (for example, `--type=time --target="2021-04-16 15:13:32"` to perform a point-in-time-recovery),
- `parameters.backrest-storage-type` the type of the pgBackRest repository, (for example, `local`).

The actual restoration process can be started as follows:

```
$ kubectl apply -f deploy/backup/restore.yaml
```

To create a new PostgreSQL cluster from either the active one, or a former cluster whose pgBackRest repository still exists, use the *pgDataSource.restoreFrom* option.

The following example will create a new cluster named `cluster2` from an existing one named``cluster1``.

1. First, create the `cluster2-config-secrets.yaml` configuration file with the following content:

```yaml
apiVersion: v1
data:
  password: <base64-encoded-password-for-pguser->
  username: <base64-encoded-pguser-user-name>
kind: Secret
metadata:
  labels:
    pg-cluster: cluster2
```

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```
    vendor: crunchydata
  name: cluster2-pguser-secret
type: Opaque
---
apiVersion: v1
data:
  password: <base64-encoded-password-for-primaryuser>
  username: <base64-encoded-primaryuser-user-name>
kind: Secret
metadata:
  labels:
    pg-cluster: cluster2
    vendor: crunchydata
  name: cluster2-primaryuser-secret
type: Opaque
---
apiVersion: v1
data:
  password: <base64-encoded-password-for-postgres-user>
  username: <base64-encoded-pguser-postgres-name>
kind: Secret
metadata:
  labels:
    pg-cluster: cluster2
    vendor: crunchydata
  name: cluster2-postgres-secret
type: Opaque
```

2. When done, create the secrets as follows:

```
$ kubectl apply -f ./cluster2-config-secrets.yaml
```

3. Edit the `deploy/cr.yaml` configuration file:
   - set a new cluster name (`cluster2`),
   - set the option *pgDataSource.restoreFrom* to `cluster1`.

Create the cluster as follows:

```
$ kubectl apply -f deploy/cr.yaml
```

9.7 Delete a previously saved backup

The maximum amount of stored backups is controlled by the *backup.schedule.keep* option (only successful backups are counted). Older backups are automatically deleted, so that amount of stored backups do not exceed this number.

If you want to delete some backup manually, you need to delete both the `pgtask` object and the corresponding job itself. Deletion of the backup object can be done using the same YAML file which was used for the on-demand backup:

```
$ kubectl delete -f deploy/backup/backup.yaml
```

Deletion of the job which corresponds to the backup can be done using `kubectl delete jobs` command with the backup name:

```
$ kubectl delete jobs cluster1-backrest-full-backup
```

CHAPTER

TEN

CHANGING POSTGRESQL OPTIONS

You may require a configuration change for your application. PostgreSQL allows customizing the database with configuration files. You can use a ConfigMap to provide the PostgreSQL configuration options specific to the following configuration files:

- PostgreSQL main configuration, postgresql.conf,
- client authentication configuration, pg_hba.conf,
- user name configuration, pg_ident.conf.

Configuration options may be applied in two ways:

- globally to all database servers in the cluster via Patroni Distributed Configuration Store (DCS),
- locally to each database server (Primary and Replica) within the cluster.

Note: PostgreSQL cluster is managed by the Operator, and so there is no need to set custom configuration options in common usage scenarios. Also, changing certain options may cause PostgreSQL cluster malfunction. Do not customize configuration unless you know what you are doing!

Use the `kubectl` command to create the ConfigMap from external resources, for more information, see Configure a Pod to use a ConfigMap.

You can either create a PostgreSQL Cluster With Custom Configuration, or use ConfigMap to set options for the already existing cluster.

To create a cluster with custom options, you should first place these options in a `postgres-ha.yaml` file under specific `bootstrap` section, then use `kubectl create configmap` command with this file to create a ConfigMap, and finally put the ConfigMap name to *pgPrimary.customconfig* key in the `deploy/cr.yaml` configuration file.

To change options for an existing cluster, you can do the same but put options in a `postgres-ha.yaml` file directly, without the `bootstrap` section.

In both cases, the `postgres-ha.yaml` file doesn't fully overwrite PostgreSQL configuration files: options present in `postgres-ha.yaml` will be overwritten, while non-present options will be left intact.

10.1 Creating a cluster with custom options

For example, you can create a cluster with a custom `max_connections` option in a `postgresql.conf` configuration file using the following `postgres-ha.yaml` contents:

```yaml
---
bootstrap:
  dcs:
    postgresql:
      parameters:
        max_connections: 30
```

..note:: `dsc.postgresql` subsection means that option will be applied globally to `postgresql.conf` of all database servers.

You can create a ConfigMap from this file. The syntax for `kubectl create configmap` command is:

```
kubectl -n <namespace> create configmap <configmap-name> --from-file=postgres-ha.yaml
```

ConfigMap name should include your cluster name and a dash as a prefix (`cluster1-` by default).

The following example defines `cluster1-custom-config` as the ConfigMap name:

```
$ kubectl create -n pgo configmap cluster1-custom-config --from-file=postgres-ha.yaml
```

To view the created ConfigMap, use the following command:

```
$ kubectl describe configmaps cluster1-custom-config
```

Don't forget to put the name of your ConfigMap to the `deploy/cr.yaml` configuration file:

```yaml
spec:
  ...
  pgPrimary:
    ...
      customconfig: "cluster1-custom-config"
```

Now you can create the cluster following the *regular installation instructions*.

10.2 Modifying options for the existing cluster

For example, you can change `max_connections` option in a `postgresql.conf` configuration file with the following `postgres-ha.yaml` contents:

```yaml
---
dcs:
  postgresql:
    parameters:
      max_connections: 50
```

..note:: `dsc.postgresql` subsection means that option will be applied globally to `postgresql.conf` of all database servers.

You can create a ConfigMap from this file. The syntax for `kubectl create configmap` command is:

```
kubectl -n <namespace> create configmap <configmap-name> --from-file=postgres-ha.yaml
```

ConfigMap name should include your cluster name and a dash as a prefix (`cluster1-` by default).

The following example defines `cluster1-custom-config` as the ConfigMap name:

```
$ kubectl create -n pgo configmap cluster1-custom-config --from-file=postgres-ha.yaml
```

To view the created ConfigMap, use the following command:

```
$ kubectl describe configmaps cluster1-custom-config
```

You can also use a similar `kubectl edit configmap` command to change the already existing ConfigMap with your default text editor:

```
$ kubectl edit -n pgo configmap cluster1-custom-config
```

Don't forget to put the name of your ConfigMap to the `deploy/cr.yaml` configuration file if it isn't already there:

```
spec:
  ...
  pgPrimary:
    ...
      customconfig: "cluster1-custom-config"
```

Now you should *restart the cluster* to ensure the update took effect.

CHAPTER

ELEVEN

PAUSE/RESUME POSTGRESQL CLUSTER

There may be external situations when it is needed to shutdown your PostgreSQL Cluster for a while and then start it back up (some works related to the maintenance of the enterprise infrastructure, etc.).

The `deploy/cr.yaml` file contains a special `spec.shutdown` key for this. Setting it to `true` gracefully stops the cluster:

```
spec:
  .......
  shutdown: true
```

To start the cluster after it was shut down just revert the `spec.shutdown` key to `false`.

There is an option also to put the cluster into a read-only mode instead of completely shutting it down. This is done by a special `spec.standby` key, which should be set to `true` for read-only state or should be set to `false` for normal cluster operation:

```
spec:
  .......
  standby: false
```

CHAPTER TWELVE

UPDATE PERCONA DISTRIBUTION FOR POSTGRESQL OPERATOR

Percona Distribution for PostgreSQL Operator allows upgrades to newer versions. This includes upgrades of the Operator itself, and upgrades of the Percona Distribution for PostgreSQL.

12.1 Upgrading the Operator

Note: Only the incremental update to a nearest minor version of the Operator is supported. To update to a newer version, which differs from the current version by more than one, make several incremental updates sequentially.

The following steps will allow you to update the Operator to current version (use the name of your cluster instead of the `<cluster-name>` placeholder).

1. Pause the cluster in order to stop all possible activities:

```
$ kubectl patch perconapgcluster/<cluster-name> --type json -p '[{"op": "replace",
↪"path": "/spec/pause", "value": true},{"op":"replace","path":"/spec/pgBouncer/size
↪","value":0}]'
```

2. If you upgrade the Operator **from a version earlier than 1.1.0**, the following additional step is needed for the 1.0.0 → 1.1.0 upgrade.

```
$ export CLUSTER=<cluster-name>
$ for user in postgres primaryuser $(kubectl get perconapgcluster/${CLUSTER} -o␣
↪yaml | yq r - 'spec.user'); do args+="--from-literal=$user=$(kubectl get secret/$
↪{CLUSTER}-${user}-o yaml | yq r - 'data.password' | base64 -d) "; done; eval␣
↪kubectl create secret generic ${CLUSTER}-users "${args}"
```

This command creates users' secrets with existing passwords. Otherwise, new secrets with autogenerated passwords will be created automatically, so existing passwords will be overwritten.

Note: The `pgbouncer` user password is stored in encrypted form, and therefore it is not included in the above command. If you know this password and/or would like to update it, please add it as `pgbouncer:`

base64encodednewpassword to the resulted Secret manually. Otherwise, this password needs no actions and will be overwritten by the Operator during upgrade.

3. Remove the old Operator and start the new Operator version:

```
$ kubectl delete \
    serviceaccounts/pgo-deployer-sa \
    clusterroles/pgo-deployer-cr \
    configmaps/pgo-deployer-cm \
    configmaps/pgo-config \
    clusterrolebindings/pgo-deployer-crb \
    jobs.batch/pgo-deploy \
    deployment/postgres-operator

$ kubectl create -f https://raw.githubusercontent.com/percona/percona-postgresql-
↪operator/v1.1.0/deploy/operator.yaml
$ kubectl wait --for=condition=Complete job/pgo-deploy --timeout=90s
```

12.2 Upgrading Percona Distribution for PostgreSQL

12.2.1 Automatic upgrade

Starting from version 1.1.0, the Operator does fully automatic upgrades to the newer versions of Percona PostgreSQL Cluster within the method named *Smart Updates*.

The Operator will carry on upgrades according to the following algorithm. It will query a special *Version Service* server at scheduled times to obtain fresh information about version numbers and valid image paths needed for the upgrade. If the current version should be upgraded, the Operator updates the CR to reflect the new image paths and carries on sequential Pods deletion in a safe order, allowing the cluster Pods to be re-deployed with the new image.

Note: Version Service is in technical preview status and is disabled by default for the Operator version 1.1.0. Disabling Version Service makes Smart Updates rely on the image keys in the *Operator's Custom Resource*.

The upgrade details are set in the upgradeOptions section of the deploy/cr.yaml configuration file. Make the following edits to configure updates:

1. Set the apply option to one of the following values:

   - recommended - automatic upgrades will choose the most recent version of software flagged as recommended,
   - latest - automatic upgrades will choose the most recent version of the software available,
   - *version number* - specify the desired version explicitly,
   - never or disabled - disable automatic upgrades

   Note: When automatic upgrades are disabled by the apply option, Smart Update functionality will continue working for changes triggered by other events, such as updating a ConfigMap, rotating a password, or changing resource values.

2. Make sure the `versionServiceEndpoint` key is set to a valid Version Server URL (otherwise Smart Updates will not occur).

   A. You can use the URL of the official Percona's Version Service (default). Set `versionServiceEndpoint` to `https://check.percona.com`.

   B. Alternatively, you can run Version Service inside your cluster. This can be done with the `kubectl` command as follows:

   ```
   $ kubectl run version-service --image=perconalab/version-service --env="SERVE_
   ↪HTTP=true" --port 11000 --expose
   ```

   Note: Version Service is never checked if automatic updates are disabled. If automatic updates are enabled, but Version Service URL can not be reached, upgrades will not occur.

3. Use the `schedule` option to specify the update checks time in CRON format.

The following example sets the midnight update checks with the official Percona's Version Service:

```
spec:
  upgradeOptions:
    apply: recommended
    versionServiceEndpoint: https://check.percona.com
    schedule: "0 4 * * *"
...
```

12.2.2 Semi-automatic upgrade

Semi-automatic update of Percona Distribution for PostgreSQL should be used with the Operator version 1.0.0 or earlier. For all newer versions, use *automatic update* instead.

The following steps will allow you to update the Operator to current version (use the name of your cluster instead of the `<cluster-name>` placeholder).

1. Pause the cluster in order to stop all possible activities:

   ```
   $ kubectl patch perconapgcluster/<cluster-name> --type json -p '[{"op": "replace",
   ↪"path": "/spec/pause", "value": true},{"op":"replace","path":"/spec/pgBouncer/size
   ↪","value":0}]'
   ```

2. Now you can switch the cluster to a new version:

   ```
   $ kubectl patch perconapgcluster/<cluster-name> --type json -p '[{"op": "replace",
   ↪"path": "/spec/backup/backrestRepoImage", "value": "percona/percona-postgresql-
   ↪operator:1.1.0-ppg13-pgbackrest-repo"},{"op":"replace","path":"/spec/backup/image
   ↪","value":"percona/percona-postgresql-operator:1.1.0-ppg13-pgbackrest"},{"op":
   ↪"replace","path":"/spec/pgBadger/image","value":"percona/percona-postgresql-
   ↪operator:1.1.0-ppg13-pgbadger"},{"op":"replace","path":"/spec/pgBouncer/image",
   ↪"value":"percona/percona-postgresql-operator:1.1.0-ppg13-pgbouncer"},{"op":
   ↪"replace","path":"/spec/pgPrimary/image","value":"percona/percona-postgresql-
   ↪operator:1.1.0-ppg13-postgres-ha"},{"op":"replace","path":"/spec/userLabels/pgo-
   ↪version","value":"v1.1.0"},{"op":"replace","path":"/metadata/labels/pgo-version",
   ↪"value":"v1.1.0"},{"op": "replace", "path": "/spec/pause", "value": false}]'
   ```

Note: The above example is composed in asumption of using PostgreSQL 13 as a database management system. For PostgreSQL 12 you should change all occurrences of the `ppg13` substring to `ppg12`.

This will carry on the image update, cluster version update and the pause status switch.

3. Now you can enable the `pgbouncer` again:

```
$ kubectl patch perconapgcluster/<cluster-name --type json -p \
    '[
        {"op":"replace","path":"/spec/pgBouncer/size","value":1}
    ]'
```

Wait until the cluster is ready.

CHAPTER

THIRTEEN

SCALE PERCONA DISTRIBUTION FOR POSTGRESQL ON KUBERNETES AND OPENSHIFT

One of the great advantages brought by Kubernetes and the OpenShift platform is the ease of an application scaling. Scaling an application results in adding or removing the Pods and scheduling them to available Kubernetes nodes.

Size of the cluster is dynamically controlled by a *pgReplicas.REPLICA-NAME.size key* in the *Custom Resource options* configuration. That's why scaling the cluster needs nothing more but changing this option and applying the updated configuration file. This may be done in a specifically saved config, or on the fly, using the following command:

```
$ kubectl scale --replicas=5 pgo/cluster1
```

In this example we have changed the number of PostgreSQL Replicas to 5 instances.

CHAPTER

FOURTEEN

TRANSPORT LAYER SECURITY (TLS)

The Percona Distribution for PostgreSQL Operator uses Transport Layer Security (TLS) cryptographic protocol for the following types of communication:

- Internal - communication between PostgreSQL instances in the cluster
- External - communication between the client application and the cluster

The internal certificate is also used as an authorization method for PostgreSQL Replica instances.

Currently, TLS security needs manual certificates generation.

You can also use pre-generated certificates available in the `deploy/ssl-secrets.yaml` file for test purposes, but we strongly recommend **avoiding their usage on any production system**!

The following subsections explain how to configure TLS security with the Operator yourself, as well as how to temporarily disable it if needed.

14.1 Generate certificates for the Operator

To generate certificates, follow these steps:

1. Provision a CA (Certificate authority) to generate TLS certificates,
2. Generate a CA key and certificate file with the server details,
3. Create the server TLS certificates using the CA keys, certs, and server details.

The set of commands generates certificates with the following attributes:

- `Server-pem` - Certificate
- `Server-key.pem` - the private key
- `ca.pem` - Certificate Authority

You should generate one set of certificates for external communications, and another set for internal ones.

Supposing that your cluster name is `cluster1`, you can use the following commands to generate certificates:

```
$ CLUSTER_NAME=cluster1
$ NAMESPACE=default
$ cat <<EOF | cfssl gencert -initca - | cfssljson -bare ca
{
  "CN": "*",
  "key": {
    "algo": "ecdsa",
    "size": 384
  }
}
EOF

$ cat <<EOF > ca-config.json
{
   "signing": {
     "default": {
        "expiry": "87600h",
        "usages": ["digital signature", "key encipherment", "content commitment"]
      }
   }
}
EOF

$ cat <<EOF | cfssl gencert -ca=ca.pem  -ca-key=ca-key.pem -config=./ca-config.json - |␣
↪cfssljson -bare server
{
   "hosts": [
     "localhost",
     "${CLUSTER_NAME}",
     "${CLUSTER_NAME}.${NAMESPACE}",
     "${CLUSTER_NAME}.${NAMESPACE}.svc.cluster.local",
     "${CLUSTER_NAME}-pgbouncer",
     "${CLUSTER_NAME}-pgbouncer.${NAMESPACE}",
     "${CLUSTER_NAME}-pgbouncer.${NAMESPACE}.svc.cluster.local",
     "*.${CLUSTER_NAME}",
     "*.${CLUSTER_NAME}.${NAMESPACE}",
     "*.${CLUSTER_NAME}.${NAMESPACE}.svc.cluster.local",
     "*.${CLUSTER_NAME}-pgbouncer",
     "*.${CLUSTER_NAME}-pgbouncer.${NAMESPACE}",
     "*.${CLUSTER_NAME}-pgbouncer.${NAMESPACE}.svc.cluster.local"
   ],
   "CN": "${CLUSTER_NAME}",
   "key": {
     "algo": "ecdsa",
     "size": 384
   }
}
EOF

$ kubectl create secret generic ${CLUSTER_NAME}-ssl-ca --from-file=ca.crt=ca.pem
$ kubectl create secret tls  ${CLUSTER_NAME}-ssl-keypair --cert=server.pem --key=server-
↪key.pem
```

If your PostgreSQL cluster includes replica instances (this feature is on by default), generate certificates for them in a similar way:

```
$ cat <<EOF | cfssl gencert -ca=ca.pem  -ca-key=ca-key.pem -config=./ca-config.json - |␣
↪cfssljson -bare replicas
{
   "CN": "primaryuser",
   "key": {
      "algo": "ecdsa",
      "size": 384
   }
}
EOF

$ kubectl create secret tls  ${CLUSTER_NAME}-ssl-replicas --cert=replicas.pem --
↪key=replicas-key.pem
```

When certificates are generated, set the following keys in the `deploy/cr.yaml` configuration file:

- `spec.sslCA` key should contain the name of the secret with TLS CA used for both connection encryption (external traffic), and replication (internal traffic),
- `spec.sslSecretName` key should contain the name of the secret created to encrypt **external** communications,
- `spec.secrets.sslReplicationSecretName` key should contain the name of the secret created to encrypt **internal** communications,
- `spec.tlsOnly` key should be set to `true` if you want to disable unencrypted communications.

Don't forget to apply changes as usual:

```
$ kubectl apply -f deploy/cr.yaml
```

14.1.1 Check connectivity to the cluster

You can check TLS communication with use of the `psql`, the standart interactive terminal-based front-end to PostgreSQL. The following command will spawn a new `pg-client` container, which includes needed command and can be used for the check (use your real cluster name instead of the `<cluster-name>` placeholder):

```
$ cat <<EOF | kubectl apply -f -
apiVersion: apps/v1
kind: Deployment
metadata:
  name: pg-client
spec:
  replicas: 1
  selector:
    matchLabels:
      name: pg-client
  template:
    metadata:
      labels:
        name: pg-client
    spec:
      containers:
```

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```
        - name: pg-client
          image: perconalab/percona-distribution-postgresql:13.2
          imagePullPolicy: Always
          command:
          - sleep
          args:
          - "100500"
          volumeMounts:
            - name: ca
              mountPath: "/tmp/tls"
      volumes:
      - name: ca
        secret:
          secretName: <cluster_name>-ssl-ca
          items:
          - key: ca.crt
            path: ca.crt
            mode: 0777
EOF
```

Now get shell access to the newly created container, and launch the PostgreSQL interactive terminal to check connectivity over the encrypted channel (please use real cluster-name, PostgreSQL user login and password):

```
$ kubectl exec -it deployment/pg-client -- bash -il
[postgres@pg-client /]$ PGSSLMODE=verify-ca PGSSLROOTCERT=/tmp/tls/ca.crt psql postgres:/
↪/<postgresql-user>:<postgresql-password>@<cluster-name>-pgbouncer.<namespace>.svc.
↪cluster.local
```

Now you should see the prompt of PostgreSQL interactive terminal:

```
psql (13.2)
Type "help" for help.
pgdb=>
```

14.2 Run Percona Distribution for PostgreSQL without TLS

Omitting TLS is also possible, but we recommend that you run your cluster with the TLS protocol enabled.

To disable TLS protocol (e.g. for demonstration purposes) set the `spec.tlsOnly` key to `` false`, and and make sure that there are no certificate secrets configured in the ``deploy/cr.yaml `` file.

CHAPTER

FIFTEEN

MONITORING

Percona Monitoring and Management (PMM) provides an excellent solution to monitor Percona Distribution for PostgreSQL.

Note: Only PMM 2.x versions are supported by the Operator.

PMM is a client/server application. PMM Client runs on each node with the database you wish to monitor: it collects needed metrics and sends gathered data to PMM Server. As a user, you connect to PMM Server to see database metrics on a number of dashboards.

That's why PMM Server and PMM Client need to be installed separately.

15.1 Installing the PMM Server

PMM Server runs as a *Docker image*, a *virtual appliance*, or on an *AWS instance*. Please refer to the official PMM documentation for the installation instructions.

15.2 Installing the PMM Client

The following steps are needed for the PMM client installation in your Kubernetes-based environment:

1. The PMM client installation is initiated by updating the `pmm` section in the deploy/cr.yaml file.
   - set `pmm.enabled=true`
   - set the `pmm.serverHost` key to your PMM Server hostname,
   - check that the `serverUser` key contains your PMM Server user name (`admin` by default),
   - make sure the `pmmserver` key in the deploy/pmm-secret.yaml secrets file contains the password specified for the PMM Server during its installation.

     Apply changes with the `kubectl apply -f deploy/pmm-secret.yaml` command.

   Note: You use `deploy/pmm-secret.yaml` file to *create* Secrets Object. The file contains all values for each key/value pair in a convenient plain text format. But the resulting Secrets contain passwords stored as base64-encoded strings. If you want to *update* password field, you'll need to encode the value into base64 format. To do this, you can run `echo -n "password" | base64` in your local shell to get valid values. For example, setting the PMM Server user's password to *new_password*` in the `cluster1-pmm-secret` object can be done with the following command:

```
kubectl patch secret/cluster1-pmm-secret -p '{"data":{"pmmserver": '$(echo -n␣
↪new_password | base64)'}}'
```

When done, apply the edited `deploy/cr.yaml` file:

```
$ kubectl apply -f deploy/cr.yaml
```

2. Check that corresponding Pods are not in a cycle of stopping and restarting. This cycle occurs if there are errors on the previous steps:

```
$ kubectl get pods
$ kubectl logs cluster1-7b7f7898d5-7f5pz -c pmm-client
```

3. Now you can access PMM via *https* in a web browser, with the login/password authentication, and the browser is configured to show Percona Distribution for PostgreSQL metrics.

Part IV

Reference

CHAPTER SIXTEEN

CUSTOM RESOURCE OPTIONS

The Cluster is configured via the deploy/cr.yaml file.

The metadata part of this file contains the following keys:

- `name` (`cluster1` by default) sets the name of your Percona Distribution for PostgreSQL Cluster; it should include only URL-compatible characters, not exceed 22 characters, start with an alphabetic character, and end with an alphanumeric character;

The spec part of the deploy/cr.yaml file contains the following sections:

Key	Value type	Default	Description
pause	boolean	`false`	Pause/resume: setting it to `true` gracefully stops the cluster, and setting it to `false` after shut down starts the cluster back.
walStorage	*subdoc*		Write-ahead Log Storage Section
pmm	*subdoc*		Percona Monitoring and Management section
backup	*subdoc*		Section to configure backups and pgBackRest
pgBouncer	*subdoc*		The pgBouncer connection pooler section
pgReplicas	*subdoc*		Section required to manage the replicas within a PostgreSQL cluster
pgBadger	*subdoc*		The pgBadger PostgreSQL log analyzer section

Key	database
Value	string
Example	`pgdb`
Description	The name of a database that the PostgreSQL user can log into after the PostgreSQL cluster is created
Key	disableAutofail
Value	boolean
Example	`false`
Description	Turns high availability on or off. By default, every cluster can have high availability if there is at least one replica
Key	tlsOnly
Value	boolean
Example	`false`
Description	Enforece Operator to use only Transport Layer Security (TLS) for both internal and external communications

continues on next page

Table 1 – continued from previous page

Key	sslCA
Value	string
Example	`cluster1-ssl-ca`
Description	The name of the secret with TLS CA used for both connection encryption (external traffic), and replication (internal traffic)
Key	sslSecretName
Value	string
Example	`cluster1-ssl-keypair`
Description	The name of the secret created to encrypt external communications
Key	sslReplicationSecretName
Value	string
Example	`cluster1-ssl-keypair"`
Description	The name of the secret created to encrypt internal communications
Key	keepData
Value	boolean
Example	`true`
Description	If `true`, PVCs will be kept after the cluster deletion
Key	keepBackups
Value	boolean
Example	`true`
Description	If `true`, local backups will be kept after the cluster deletion
Key	pgDataSource.restoreFrom
Value	string
Example	`""`
Description	The name of a data source PostgreSQL cluster, which is used to *restore backup to a a new cluster*
Key	pgDataSource.restoreOpts
Value	string
Example	`""`
Description	Custom pgBackRest options to *restore backup to a a new cluster*
Key	pgPrimary.image
Value	string
Example	`perconalab/percona-postgresql-operator:main-ppg13-postgres-ha`
Description	The Docker image of the PostgreSQL Primary instance
Key	pgPrimary.volumeSpec.size
Value	int
Example	`1G`
Description	The Kubernetes PersistentVolumeClaim size for the PostgreSQL Primary storage
Key	pgPrimary.volumeSpec.accessmode
Value	string
Example	`ReadWriteOnce`
Description	The Kubernetes PersistentVolumeClaim access modes for the PostgreSQL Primary storage

continues on next page

Table 1 – continued from previous page

Key	pgPrimary.volumeSpec.storagetype
Value	string
Example	`dynamic`
Description	Type of the PostgreSQL Primary storage provisioning: `create` (the default variant; used if storage is provisioned, e.g. using hostpath) or `dynamic` (for a dynamic storage provisioner, e.g. via a StorageClass)
Key	pgPrimary.volumeSpec.storageclass
Value	string
Example	`""`
Description	Optionally sets the Kubernetes storage class to use with the PostgreSQL Primary storage PersistentVolumeClaim
Key	pgPrimary.volumeSpec.matchLabels
Value	string
Example	`""`
Description	A PostgreSQL Primary storage label selector
Key	pgPrimary.customconfig
Value	string
Example	`""`
Description	Name of the *Custom configuration options ConfigMap* for PostgreSQL cluster

16.1 Write-ahead Log Storage Section

The `walStorage` section in the deploy/cr.yaml file contains configuration options for PostgreSQL write-ahead logging.

Key	walStorage.volumeSpec.size
Value	int
Example	`1G`
Description	The Kubernetes PersistentVolumeClaim size for the PostgreSQL Write-ahead Log storage
Key	walStorage.volumeSpec.accessmode
Value	string
Example	`ReadWriteOnce`
Description	The Kubernetes PersistentVolumeClaim access modes for the PostgreSQL Write-ahead Log storage
Key	walStorage.volumeSpec.storagetype
Value	string
Example	`dynamic`
Description	Type of the PostgreSQL Write-ahead Log storage provisioning: `create` (the default variant; used if storage is provisioned, e.g. using hostpath) or `dynamic` (for a dynamic storage provisioner, e.g. via a StorageClass)
Key	walStorage.volumeSpec.storageclass
Value	string
Example	`""`
Description	Optionally sets the Kubernetes storage class to use with the PostgreSQL Write-ahead Log storage PersistentVolumeClaim
Key	walStorage.volumeSpec.matchLabels
Value	string
Example	`""`
Description	A PostgreSQL Write-ahead Log storage label selector

16.2 Backup Section

The `backup` section in the deploy/cr.yaml file contains the following configuration options for the regular Percona Distribution for PostgreSQL backups.

Key	backup.image
Value	string
Example	`perconalab/percona-postgresql-operator:main-ppg13-pgbackrest`
Description	The Docker image for *pgBackRest*
Key	backup.backrestRepoImage
Value	string
Example	`perconalab/percona-postgresql-operator:main-ppg13-pgbackrest-repo`
Description	The Docker image for the *BackRest repository*
Key	backup.resources.requests.memory

continues on next page

Table 2 – continued from previous page

Value	int
Example	`48Mi`
Description	The Kubernetes memory requests for a pgBackRest container
Key	backup.resources.limits.cpu
Value	int
Example	`1`
Description	Kubernetes CPU limits for a pgBackRest container
Key	backup.resources.limits.memory
Value	int
Example	`64Mi`
Description	The Kubernetes memory limits for a pgBackRest container
Key	backup.volumeSpec.size
Value	int
Example	`1G`
Description	The Kubernetes PersistentVolumeClaim size for the pgBackRest Storage
Key	backup.volumeSpec.accessmode
Value	string
Example	`ReadWriteOnce`
Description	The Kubernetes PersistentVolumeClaim access modes for the pgBackRest Storage
Key	backup.volumeSpec.storagetype
Value	string
Example	`dynamic`
Description	Type of the pgBackRest storage provisioning: `create` (the default variant; used if storage is provisioned, e.g. using hostpath) or `dynamic` (for a dynamic storage provisioner, e.g. via a StorageClass)
Key	backup.volumeSpec.storageclass
Value	string
Example	`""`
Description	Optionally sets the Kubernetes storage class to use with the pgBackRest Storage PersistentVolumeClaim
Key	backup.volumeSpec.matchLabels
Value	string
Example	`""`
Description	A pgBackRest storage label selector
Key	backup.storages.<storage-name>.type
Value	string
Example	`s3`
Description	Type of the storage used for backups
Key	backup.storages.<storage-name>.endpointURL
Value	string
Example	`minio-gateway-svc:9000`

continues on next page

Table 2 – continued from previous page

Description	The endpoint URL of the S3-compatible storage to be used for backups (not needed for the original Amazon S3 cloud)
Key	backup.storages.<storage-name>.bucket
Value	string
Example	`""`
Description	The Amazon S3 bucket or Google Cloud Storage bucket name used for backups
Key	backup.storages.<storage-name>.region
Value	boolean
Example	`us-east-1`
Description	The AWS region to use for Amazon and all S3-compatible storages
Key	backup.storages.<storage-name>.uriStyle
Value	string
Example	`path`
Description	Optional parameter that specifies if pgBackRest should use the path or host S3 URI style
Key	backup.storages.<storage-name>.verifyTLS
Value	boolean
Example	`false`
Description	Enables or disables TLS verification for pgBackRest
Key	backup.storageTypes
Value	array
Example	`[ "s3" ]`
Description	The backup storage types for the pgBackRest repository
Key	backup.repoPath
Value	string
Example	`""`
Description	Custom path for pgBackRest repository backups
Key	backup.schedule.name
Value	string
Example	`sat-night-backup`
Description	The backup name
Key	backup.schedule.schedule
Value	string
Example	`0 0 * * 6`
Description	Scheduled time to make a backup specified in the crontab format
Key	backup.schedule.keep
Value	int
Example	`3`
Description	The amount of most recent backups to store. Older backups are automatically deleted. Set `keep` to zero or completely remove it to disable automatic deletion of backups
Key	backup.schedule.type

continues on next page

Table 2 – continued from previous page

Value	string
Example	`full`
Description	The *type* of the pgBackRest backup
Key	backup.schedule.storage
Value	string
Example	`local`
Description | The *type* of the pgBackRest repository	

16.3 PMM Section

The `pmm` section in the deploy/cr.yaml file contains configuration options for Percona Monitoring and Management.

Key	pmm.enabled
Value	boolean
Example	`false`
Description	Enables or disables monitoring Percona Distribution for PostgreSQL cluster with PMM
Key	pmm.image
Value	string
Example	`percona/pmm-client:2.24.0`
Description	Percona Monitoring and Management (PMM) Client Docker image
Key	pmm.serverHost
Value	string
Example	`monitoring-service`
Description	Address of the PMM Server to collect data from the cluster
Key	pmm.serverUser
Value	string
Example	`admin`
Description	The PMM Server User. The PMM Server password should be configured using Secrets
Key	pmm.pmmSecret
Value	string
Example	`cluster1-pmm-secret`
Description	Name of the Kubernetes Secret object for the PMM Server password
Key	pmm.resources.requests.memory
Value	string
Example	`200M`
Description	The Kubernetes memory requests for a PMM container
Key	pmm.resources.requests.cpu
Value	string
Example	`500m`
Description	Kubernetes CPU requests for a PMM container

continues on next page

Table 3 – continued from previous page

Key	pmm.resources.limits.cpu
Value	string
Example	`500m`
Description	Kubernetes CPU limits for a PMM container
Key	pmm.resources.limits.memory
Value	string
Example	`200M`
Description	The Kubernetes memory limits for a PMM container

16.4 pgBouncer Section

The `pgBouncer` section in the deploy/cr.yaml file contains configuration options for the pgBouncer connection pooler for PostgreSQL.

Key	pgBouncer.image
Value	string
Example	`perconalab/percona-postgresql-operator:main-ppg13-pgbouncer`
Description	Docker image for the pgBouncer connection pooler
Key	pgBouncer.size
Value	int
Example	`1G`
Description	The number of the pgBouncer Pods to provide connection pooling
Key	pgBouncer.resources.requests.cpu
Value	int
Example	`1`
Description	Kubernetes CPU requests for a pgBouncer container
Key	pgBouncer.resources.requests.memory
Value	int
Example	`128Mi`
Description	The Kubernetes memory requests for a pgBouncer container
Key	pgBouncer.resources.limits.cpu
Value	int
Example	`2`
Description	Kubernetes CPU limits for a pgBouncer container
Key	pgBouncer.resources.limits.memory
Value	int
Example	`512Mi`
Description	The Kubernetes memory limits for a pgBouncer container
Key	pgBouncer.expose.serviceType
Value	string

continues on next page

Table 4 – continued from previous page

Example	`ClusterIP`
Description	Specifies the type of Kubernetes Service for pgBouncer
Key	pgBouncer.expose.loadBalancerSourceRanges
Value	string
Example	`"10.0.0.0/8"`
Description	The range of client IP addresses from which the load balancer should be reachable (if not set, there is no limitations)
Key	pgBouncer.expose.annotations
Value	label
Example	`pg-cluster-annot: cluster1`
Description	The Kubernetes annotations metadata for pgBouncer
Key	pgBouncer.expose.labels
Value	label
Example	`pg-cluster-label: cluster1`
Description	Set labels for the pgBouncer Service

16.5 pgReplicas Section

The `pgReplicas` section in the deploy/cr.yaml file stores information required to manage the replicas within a PostgreSQL cluster.

Key	pgReplicas.<replica-name>.size
Value	int
Example	`1G`
Description	The number of the PostgreSQL Replica Pods
Key	pgReplicas.<replica-name>.resources.requests.cpu
Value	int
Example	`1`
Description	Kubernetes CPU requests for a PostgreSQL Replica container
Key	pgReplicas.<replica-name>.resources.requests.memory
Value	int
Example	`128Mi`
Description	The Kubernetes memory requests for a PostgreSQL Replica container
Key	pgReplicas.<replica-name>.resources.limits.cpu
Value	int
Example	`2`
Description	Kubernetes CPU limits for a PostgreSQL Replica container
Key	pgReplicas.<replica-name>.resources.limits.memory
Value	int
Example	`512Mi`
Description	The Kubernetes memory limits for a PostgreSQL Replica container

continues on next page

Table 5 – continued from previous page

Key	pgReplicas.<replica-name>.volumeSpec.accessmode
Value	string
Example	`ReadWriteOnce`
Description	The Kubernetes PersistentVolumeClaim access modes for the PostgreSQL Replica storage
Key	pgReplicas.<replica-name>.volumeSpec.size
Value	int
Example	`1G`
Description	The Kubernetes PersistentVolumeClaim size for the PostgreSQL Replica storage
Key	pgReplicas.<replica-name>.volumeSpec.storagetype
Value	string
Example	`dynamic`
Description	Type of the PostgreSQL Replica storage provisioning: `create` (the default variant; used if storage is provisioned, e.g. using hostpath) or `dynamic` (for a dynamic storage provisioner, e.g. via a StorageClass)
Key	pgReplicas.<replica-name>.volumeSpec.storageclass
Value	string
Example	`standard`
Description	Optionally sets the Kubernetes storage class to use with the PostgreSQL Replica storage PersistentVolumeClaim
Key	pgReplicas.<replica-name>.volumeSpec.matchLabels
Value	string
Example	`""`
Description	A PostgreSQL Replica storage label selector
Key	pgReplicas.<replica-name>.labels
Value	label
Example	`pg-cluster-label: cluster1`
Description	Set labels for PostgreSQL Replica Pods
Key	pgReplicas.<replica-name>.annotations
Value	label
Example	`pg-cluster-annot: cluster1-1`
Description	The Kubernetes annotations metadata for PostgreSQL Replica
Key	pgReplicas.<replica-name>.expose.serviceType
Value	string
Example	`ClusterIP`
Description	Specifies the type of Kubernetes Service for for PostgreSQL Replica
Key	pgReplicas.<replica-name>.expose.loadBalancerSourceRanges
Value	string
Example	`"10.0.0.0/8"`
Description	The range of client IP addresses from which the load balancer should be reachable (if not set, there is no limitations)

continues on next page

Table 5 – continued from previous page

Key	pgReplicas.<replica-name>.expose.annotations
Value	label
Example	`pg-cluster-annot: cluster1`
Description	The Kubernetes annotations metadata for PostgreSQL Replica
Key	pgReplicas.<replica-name>.expose.labels
Value	label
Example	`pg-cluster-label: cluster1`
Description	Set labels for the PostgreSQL Replica Service

16.6 pgBadger Section

The `pgBadger` section in the deploy/cr.yaml file contains configuration options for the pgBadger PostgreSQL log analyzer.

Key	pgBadger.enabled
Value	boolean
Example	`false`
Description	Enables or disables the pgBadger PostgreSQL log analyzer
Key	pgBadger.image
Value	string
Example	`perconalab/percona-postgresql-operator:main-ppg13-pgbadger`
Description	pgBadger PostgreSQL log analyzer Docker image
Key	pgBadger.port
Value	int
Example	`10000`
Description	The port number for pgBadger

CHAPTER

SEVENTEEN

PERCONA CERTIFIED IMAGES

Following table presents Percona's certified docker images to be used with the Percona Distribution for PostgreSQL Operator:

Image	Digest
percona/percona-postgresql-operator:1.1.0-pgo-deployer	sha256:caabb96e98c883e4809b5e21d5733403e67720c812fca81b79ad339341bf3708
percona/percona-postgresql-operator:1.1.0-postgres-operator	sha256:d7729cc714ec4db04fc9a6c4e29405875b5115b129b49d4f5dee6c85cf0731c6
percona/percona-postgresql-operator:1.1.0-pgo-scheduler	sha256:90432634f7414cc2f6c7e270e78af3adf92ce31e97d8dee16a2f7babe3e674c7
percona/percona-postgresql-operator:1.1.0-pgo-rmdata	sha256:ad3c14f6a8b1907b7d7f5fa3cdc8c2a494913c2255ec97a49927e13e5ea9579a
percona/percona-postgresql-operator:1.1.0-pgo-event	sha256:919d35795e206e6b83f7f624749615a3b07aabd42322d83494f9bf30fe618411
percona/percona-postgresql-operator:1.1.0-pgo-apiserver	sha256:b13ddb198eb248af14fc02f1170c0026274c1e88ad9dba54030e5089c910d01a
percona/percona-postgresql-operator:1.1.0-ppg12-pgbadger	sha256:5508ce5316014b498e07801472f23cb64947c0393b07dc7f664f2e246021f066
percona/percona-postgresql-operator:1.1.0-ppg13-pgbadger	sha256:2044d5e94f7862bc7ec4eceb94bee22d79d0f2f8c84a622790b9f530aba7cd9e
percona/percona-postgresql-operator:1.1.0-ppg14-pgbadger	sha256:fc6505b5c12b1ab1f948b37a7406f7694759a1b5ff2b695ba0b8f31c11da30af
percona/percona-postgresql-operator:1.1.0-ppg12-postgres-ha	sha256:f7ca98c2d3c325a87700fd5a3833e6a5e22c93b12b35fa0aef72373e40a2474a
percona/percona-postgresql-operator:1.1.0-ppg13-postgres-ha	sha256:83985cdd73d4531eebcd2a2bab11848036744caf4e4e31559a0c994ac49d88f0
percona/percona-postgresql-operator:1.1.0-ppg14-postgres-ha	sha256:9134f670e4fa785c41a12559598fa893107d62e6193af1eb7749ae87beec64e5
percona/percona-postgresql-operator:1.1.0-ppg12-pgbouncer	sha256:61ebf3623c9a8fad773d54bf3449b2bbf6663bb5e56a3cd02cf6747fa38da7f1
percona/percona-postgresql-operator:1.1.0-ppg13-pgbouncer	sha256:834af973b183674ae80656f746bd63b6f856038b0a8c28ef1977a0b65c1a5fca
percona/percona-postgresql-operator:1.1.0-ppg14-pgbouncer	sha256:0ad239b7a94bdad12d7b7cee78d91feda3735cc0c68939aab4901ca2970a4e7f
percona/percona-postgresql-operator:1.1.0-ppg12-pgbackrest	sha256:d2305c7f4f5c5b3dc32758c80ece9ec9b43871f5a582268613acf947dd0ac37a
percona/percona-postgresql-operator:1.1.0-ppg13-pgbackrest	sha256:43e34b4a4a58046fd7670771e05777ffd15779d7fd00c18224c6081ab185e9a8
percona/percona-postgresql-operator:1.1.0-ppg14-pgbackrest	sha256:def581e58384508316b355067fd5837e4b46565c9b917af959e0199b4150cf81
percona/percona-postgresql-operator:1.1.0-ppg12-pgbackrest-repo	sha256:8b954f29136ec7ea68143c126e311b6104e94b6524cc4234f87769a86edff8bb
percona/percona-postgresql-operator:1.1.0-ppg13-pgbackrest-repo	sha256:5bff3605833ef241281f28a76a877ef20583feed0fc1c95049f0dbc0af403129
percona/percona-postgresql-operator:1.1.0-ppg14-pgbackrest-repo	sha256:202d9751977119103b9720b8b78dbd8a5cf03f49fa1c71ac2876a298937f86b1

CHAPTER

EIGHTEEN

PERCONA DISTRIBUTION FOR POSTGRESQL OPERATOR 1.1.0 RELEASE NOTES

18.1 *Percona Distribution for PostgreSQL Operator* 1.1.0

Date December 7, 2021

Installation Installing Percona Distribution for PostgreSQL Operator

18.1.1 Release Highlights

- *A Kubernetes-native horizontal scaling* capability was added to the Custom Resource to unblock Horizontal Pod Autoscaler and Kubernetes Event-driven Autoscaling (KEDA) usage
- The *Smart Upgrade functionality* along with the technical preview of the Version Service allows users to automatically get the latest version of the software compatible with the Operator and apply it safely
- Percona Distribution for PostgreSQL Operator now supports PostgreSQL 14

18.1.2 New Features

- K8SPG-101: Add support for Kubernetes horizontal scaling to set the number of Replicas dynamically via the `kubectl scale` command or Horizontal Pod Autoscaler
- K8SPG-77: Add support for PostgreSQL 14 in the Operator
- K8SPG-75: *Manage Operator's system users* hrough a single Secret resource even after cluster creation
- K8SPG-71: Add Smart Upgrade functionality to automate Percona Distribution for PostgreSQL upgrades

18.1.3 Improvements

- K8SPG-96: PMM container does not cause the crash of the whole database Pod if pmm-agent is not working properly

18.1.4 Bugs Fixed

- K8SPG-120: The Operator default behavior is now to keep backups and PVCs when the cluster is deleted

Supported platforms

The following platforms were tested and are officially supported by the Operator 1.1.0:

- Google Kubernetes Engine (GKE) 1.19 - 1.22
- Amazon Elastic Container Service for Kubernetes (EKS) 1.18 - 1.21
- OpenShift 4.7 - 4.9

This list only includes the platforms that the Percona Operators are specifically tested on as part of the release process. Other Kubernetes flavors and versions depend on the backward compatibility offered by Kubernetes itself.

18.2 *Percona Distribution for PostgreSQL Operator* 1.0.0

Date October 7, 2021

Installation Installing Percona Distribution for PostgreSQL Operator

Percona announces the general availability of Percona Distribution for PostgreSQL Operator 1.0.0.

The Percona Distribution for PostgreSQL Operator automates the lifecycle, simplifies deploying and managing open source PostgreSQL clusters on Kubernetes.

The Operator follows best practices for configuration and setup of the Percona Distribution for PostgreSQL. The Operator provides a consistent way to package, deploy, manage, and perform a backup and a restore for a Kubernetes application. Operators deliver automation advantages in cloud-native applications.

The advantages are the following:

- Deploy a Percona Distribution for PostgreSQL with no single point of failure and environment which can span multiple availability zones
- Modify the Percona Distribution for PostgreSQL size parameter to add or remove PostgreSQL instances
- Use single Custom Resource as a universal entry point to configure the cluster, similar to other Percona Operators
- Carry on semi-automatic upgrades of the Operator and PostgreSQL to newer versions
- Integrate with Percona Monitoring and Management (PMM) to seamlessly monitor your Percona Distribution for PostgreSQL
- Automate backups or perform on-demand backups as needed with support for performing an automatic restore
- Use cloud storage with S3-compatible APIs or Google Cloud for backups
- Use Transport Layer Security (TLS) for the replication and client traffic
- Support advanced Kubernetes features such as pod disruption budgets, node selector, constraints, tolerations, priority classes, and affinity/anti-affinity

Percona Distribution for PostgreSQL Operator is based on Postgres Operator developed by Crunchy Data.

18.2.1 Release Highlights

- It is now possible to *configure scheduled backups* following the declarative approach in the `deploy/cr.yaml` file, similar to other Percona Kubernetes Operators
- OpenShift compatibility allows *running Percona Distribution for PostgreSQL on Red Hat OpenShift Container Platform*
- For the first time, the main functionality of the Operator is covered by functional tests, which ensure the overall quality and stability

18.2.2 New Features and Improvements

- K8SPG-96: PMM Client container does not cause the crash of the whole database Pod if `pmm-agent` is not working properly
- K8SPG-86: The Operator *is now compatible* with the OpenShift platform
- K8SPG-62: Configuring *scheduled backups* through the main Custom Resource is now supported
- K8SPG-99, K8SPG-131: The Operator documentation was substantially improved, and now it covers among other things the usage of Transport Layer Security (TLS) for internal and external communications, and cluster upgrades

18.2.3 Supported Platforms

The following platforms were tested and are officially supported by Operator 1.0.0:

- OpenShift 4.6 - 4.8
- Google Kubernetes Engine (GKE) 1.17 - 1.21
- Amazon Elastic Container Service for Kubernetes (EKS) 1.21

This list only includes the platforms that the Operator is specifically tested on as a part of the release process. Other Kubernetes flavors and versions depend on the backward compatibility offered by Kubernetes itself.

18.3 *Percona Distribution for PostgreSQL Operator* 0.2.0

Date August 12, 2021

Installation Installing Percona Distribution for PostgreSQL Operator

Version 0.2.0 of the Percona Distribution for PostgreSQL Operator is a Beta release, and it is not recommended for production environments.

18.3.1 New Features and Improvements

- K8SPG-80: The Custom Resource structure was reworked to provide the same look and feel as in other Percona Operators. Read more about Custom Resource options in the *documentation* and review the default `deploy/cr.yaml` configuration file on GitHub.
- K8SPG-53: Merged upstream CrunchyData Operator v4.7.0 made it possible to use *Google Cloud Storage as an object store for backups* without using third-party tools
- K8SPG-42: There is no need to specify the name of the pgBackrest Pod in the backup manifest anymore as it is detected automatically by the Operator
- K8SPG-30: Replicas management is now performed through a main Custom Resource manifest instead of creating separate Kubernetes resources. This also adds the possibility of scaling up/scaling down replicas via the 'deploy/cr.yaml' configuration file
- K8SPG-66: Helm chart is now *officially provided with the Operator*

18.4 *Percona Distribution for PostgreSQL Operator* 0.1.0

Date May 10, 2021

Installation Installing Percona Distribution for PostgreSQL Operator

The Percona Operator is based on best practices for configuration and setup of a Percona Distribution for PostgreSQL on Kubernetes. The benefits of the Operator are many, but saving time and delivering a consistent and vetted environment is key.

Kubernetes provides users with a distributed orchestration system that automates the deployment, management, and scaling of containerized applications. The Operator extends the Kubernetes API with a new custom resource for deploying, configuring, and managing the application through the whole life cycle. You can compare the Kubernetes Operator to a System Administrator who deploys the application and watches the Kubernetes events related to it, taking administrative/operational actions when needed.

Version 0.1.0 of the Percona Distribution for PostgreSQL Operator is a tech preview release and it is not recommended for production environments.

You can install *Percona Distribution for PostgreSQL Operator* on Kubernetes, Google Kubernetes Engine (GKE), and Amazon Elastic Kubernetes Service (EKS) clusters. The Operator is based on Postgres Operator developed by Crunchy Data.

Here are the main differences between v 0.1.0 and the original Operator:

- Percona Distribution for PostgreSQL is now used as the main container image.
- It is possible to specify custom images for all components separately. For example, users can easily build and use custom images for one or several components (e.g. pgBouncer) while all other images will be the official ones. Also, users can build and use all custom images.
- All container images are reworked and simplified. They are built on Red Hat Universal Base Image (UBI) 8.
- The Operator has built-in integration with Percona Monitoring and Management v2.
- A build/test infrastructure was created, and we have started adding e2e tests to be sure that all pieces of the cluster work together as expected.
- We have phased out the `pgo` CLI tool, and the Custom Resource UX will be completely aligned with other Percona Operators in the following release.

Once Percona Operator is promoted to GA, users would be able to get the full package of services from Percona teams.

While the Operator is in its very first release, instructions on how to install and configure it are already available along with the source code hosted in our Github repository.

Help us improve our software quality by reporting any bugs you encounter using our bug tracking system.