

PostgreSQL

Déploiement de l'opérateur PostgreSQL de Zalando

Simon ELBAZ (selbaz@linagora.com)

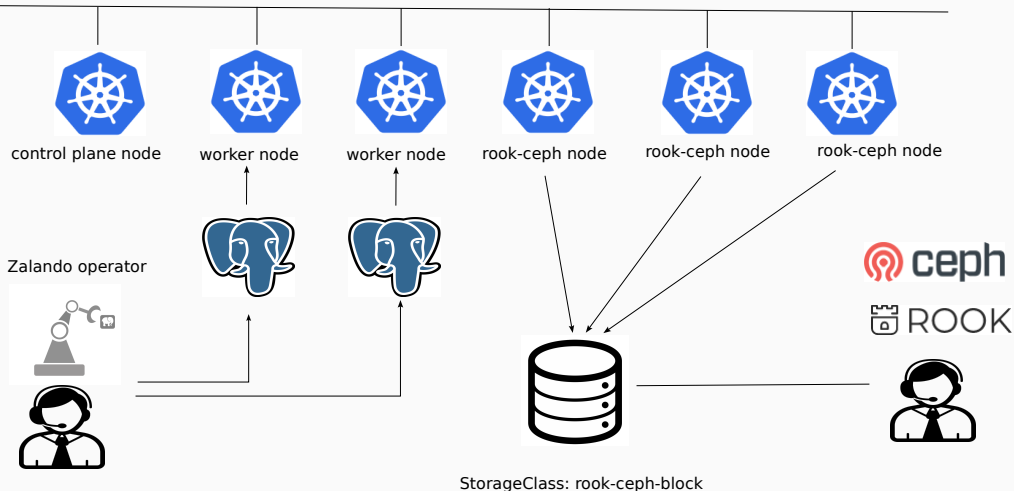
27 février 2023

Installation

Architecture



Kubernetes v1.26.2



- OS de déploiement : Debian 11 - Bullseye
- Versions de Kubernetes : 1.26.x

Dimensionnement du control plane :

- 8 CPU
- 8 Go RAM

Dimensionnement des workers :

- 2 CPU
- 2 Go RAM

- etcd est la base de données clé-valeurs centrale utilisée par Kubernetes
- etcd utilise de manière intensive les disques à disposition
- Pour une stabilité accrue du cluster, il est préférable d'utiliser des disques de type **SSD**

- Kubernetes s'appuie sur un élément essentiel qui est le *container runtime*.
- La méthode de déploiement du container runtime s'appuie la méthode décrite dans le lien : <https://docs.docker.com/engine/install/debian/>

Désactivation permanente de la mémoire swap

Le process kubelet ne démarre pas en cas de mémoire swap activée.
Pour désactiver l'utilisation de la swap, merci d'utiliser la commande suivante :

```
swapoff -a
```

Pour persister cet état et faire en sorte que la mémoire swap ne soit pas activée au prochain reboot, supprimer ou mettre en commentaires la ligne suivante dans */etc/fstab* :

```
$ sudo cat /etc/fstab
/dev/mapper/dnumworker1--vg-root / ext4 errors=remount-ro 0 1
# /boot was on /dev/sda1 during installation
UUID=ddd6fd9d-6ac3-4510-9156-22984bc82b67 /boot ext2 defaults 0 2
#/dev/mapper/dnumworker1--vg-swap_1 none swap sw 0 0
/dev/sr0 /media/cdrom0 udf,iso9660 user,noauto 0 0
```


Mise à jour de l'index du paquet *apt* et installation des paquets nécessaires à l'utilisation des dépôts avec le protocole HTTPS :

```
sudo apt-get update
```

```
sudo apt-get install \  
    ca-certificates \  
    curl \  
    gnupg
```

Ajout de la clef GPG officielle de Docker

```
sudo install -m 0755 -d /etc/apt/keyrings  
curl -fsSL https://download.docker.com/linux/debian/gpg | sudo gpg --dearmor -o /etc/apt/keyrings/docker.gpg  
sudo chmod a+r /etc/apt/keyrings/docker.gpg
```

Ajout du dépôt de Docker

```
echo \  
"deb [arch="$(dpkg --print-architecture)" signed-by=/etc/apt/keyrings/docker.gpg] https://download.docker.com/linux/debian \  
"${(. /etc/os-release & echo "$VERSION_CODENAME")}" stable" | \  
sudo tee /etc/apt/sources.list.d/docker.list > /dev/null
```

Installation de Docker Engine

```
sudo apt-get update  
sudo apt-get install docker-ce docker-ce-cli containerd.io docker-buildx-plugin docker-compose-plugin
```

Installation de kubectl, kubeadm et kubelet

```
sudo apt-get install -y ca-certificates curl
sudo apt-get install -y apt-transport-https
sudo apt-get update
curl -fsSL https://packages.cloud.google.com/apt/doc/apt-key.gpg | sudo gpg --dearmor -o /etc/apt/keyrings/kubernetes-apt-keyring.gpg
echo "deb [signed-by=/etc/apt/keyrings/kubernetes-apt-keyring.gpg] \
https://apt.kubernetes.io/ kubernetes-xenial main" | \
sudo tee /etc/apt/sources.list.d/kubernetes.list

sudo apt-get update
sudo apt-get install -y kubectl
sudo apt-get install -y kubeadm
sudo apt-get install -y kubelet
```

Activation des modules kernel *overlay* et *br_netfilter*

```
linagora@debian-cp:/etc/modules-load.d$ cat k8s.conf
overlay
br_netfilter
linagora@debian-cp:/etc/modules-load.d$ pwd
/etc/modules-load.d
```

Activation des fonctions *bridge/iptables* et *forward* du kernel

```
linagora@debian-cp:/etc/sysctl.d$ cat k8s.conf
inet.bridge.bridge-nf-call-iptables = 1
net.bridge.bridge-nf-call-ip6tables = 1
net.ipv4.ip_forward = 1
linagora@debian-cp:/etc/sysctl.d$ pwd
/etc/sysctl.d
```

Génération du paramétrage par défaut de containerd :

```
root@debian-cp:~# containerd config default dump > /etc/containerd/config.toml.dmp
```

Modifier la valeur à **true** pour le paramètre **SystemdCgroup** :

```
[plugins."io.containerd.grpc.v1.cri".containerd.runtimes.runc.options]
  BinaryName = ""
  CriuImagePath = ""
  CriuPath = ""
  CriuWorkPath = ""
  IoGid = 0
  IoUid = 0
  NoNewKeyring = false
  NoPivotRoot = false
  Root = ""
  ShimCgroup = ""
  SystemdCgroup = true
```


Remplacer le paramétrage actuel par le paramétrage modifié :

```
root@debian-cp:~# cp /etc/containerd/config.toml /etc/containerd/config.toml.bak
root@debian-cp:~# cat /etc/containerd/config.toml.dmp > /etc/containerd/config.toml
root@debian-cp:~# systemctl restart containerd
```

Initialisation du cluster Kubernetes

En tant que root, lancer la commande suivante :

```
# kubeadm init --control-plane-endpoint 10.10.10.30 \  
--skip-phases=addon/coredns,addon/kube-proxy \  
--v=5 \  
--pod-network-cidr="10.244.0.0/16"
```

Si les phases *addon/coredns* et *addon/kube-proxy* ne sont pas évitées au 1^{er} lancement de kubeadm, l'erreur suivante est générée :

```
[kubelet-finalize]Updating "/etc/kubernetes/kubelet.conf" to point to a rotatable kubelet client certificate and key error execution phase  
addon/coredns : unable to fetch CoreDNS current installed version and ConfigMap. : rpc error : code = Unknown desc = malformed  
header : missing HTTP content-type To see the stack trace of this error execute with -v=5 or higher
```

Initialisation du cluster Kubernetes

Le résultat de la commande d'init est le suivant :

```
I0315 01 :06 :38.342010 34405 kubeletfinalize.go :134][kubelet-finalize]Restarting the
kubelet to enable client certificate rotation
```

Your Kubernetes control-plane has initialized successfully !

To start using your cluster, you need to run the following as a regular user :

```
mkdir -p $HOME/.kube
sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config
sudo chown $(id -u):$(id -g) $HOME/.kube/config
```

Alternatively, if you are the root user, you can run :

```
export KUBECONFIG=/etc/kubernetes/admin.conf
```

You should now deploy a pod network to the cluster.

Run "kubectl apply -f [podnetwork].yaml" with one of the options listed at :

<https://kubernetes.io/docs/concepts/cluster-administration/addons/>

You can now join any number of control-plane nodes by copying certificate authorities and service account keys on each node and then running the following as root :

```
kubeadm join 10.10.10.30:6443 --token 6pia7c.n6u8pbm7yjl6nnr8 \
--discovery-token-ca-cert-hash sha256:f6d45602ea75c7659dc91f661d19e97e6817e2847e4e5d0047880b871317a145 \
--control-plane
```

Then you can join any number of worker nodes by running the following on each as root :

```
kubeadm join 10.10.10.30:6443 --token 6pia7c.n6u8pbm7yjl6nnr8 \
--discovery-token-ca-cert-hash sha256:f6d45602ea75c7659dc91f661d19e97e6817e2847e4e5d0047880b871317a145
```

L'utilisation de *kubect* nécessite l'action suivante :

```
mkdir -p $HOME/.kube  
sudo cp -i /etc/kubernetes/admin.conf $HOME/.kube/config  
sudo chown $(id -u):$(id -g) $HOME/.kube/config
```

Déploiement de l'addon CoreDNS

Comme indiqué précédemment, les addons CoreDNS et Kube-Proxy n'ont pas été déployés au 1^{er} lancement de kubeadm.

CoreDNS peut maintenant être déployé sans erreur :

```
linagora@debian-cp:~$ sudo kubeadm init phase addon coredns  
[addons] Applied essential addon: CoreDNS
```

Déploiement de l'addon Kube-Proxy

```
linagora@debian-cp:~$ sudo kubeadm init phase addon kube-proxy  
[addons] Applied essential addon: kube-proxy
```

Il existe différentes add-ons Kubernetes implémentant l'interface CNI.

Ces add-ons sont listés dans l'URL suivante :

<https://kubernetes.io/docs/concepts/cluster-administration/addons>

Pour le POC, l'add-on sélectionné est Flannel car il semble être le plus simple et le plus basique des add-ons CNI.

L'addon Flannel s'installe de plusieurs manières

(<https://github.com/flannel-io/flannel#deploying-flannel-manually>)

La méthode utilisée pour le POC est kubectl :

```
kubectl apply -f https://github.com/flannel-io/flannel/releases/latest/download/kube-flannel.yml
```


Un outil pratique de visualisation d'un cluster kubernetes est : **k9s**

(<https://k9scli.io/>)

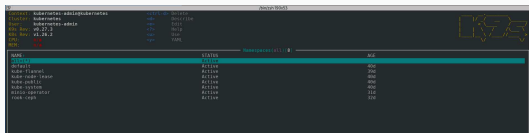
Le lien suivant permet de télécharger l'archive incluant le binaire :

https://github.com/derailed/k9s/releases/download/v0.27.3/k9s_Lin

Liste des namespaces

```
linagora@debian-cp:~$ kubectl get namespaces
```

NAME	STATUS	AGE
default	Active	40d
kube-flannel	Active	39d
kube-node-lease	Active	40d
kube-public	Active	40d
kube-system	Active	40d
minio-operator	Active	32d
rook-ceph	Active	32d



The screenshot shows a terminal window with the command 'kubectl get namespaces' executed. The output is a table with three columns: NAME, STATUS, and AGE. The namespaces listed are default, kube-flannel, kube-node-lease, kube-public, kube-system, minio-operator, and rook-ceph, all with a status of 'Active' and ages ranging from 32d to 40d. A red horizontal bar highlights the 'NAME' column. In the top right corner of the terminal, there is a small logo that says 'K8S'.

```
linagora@debian-cp:~$ kubectl get namespaces
```

NAME	STATUS	AGE
default	Active	40d
kube-flannel	Active	39d
kube-node-lease	Active	40d
kube-public	Active	40d
kube-system	Active	40d
minio-operator	Active	32d
rook-ceph	Active	32d

Pods du namespace default

```
linagora@debian-cp:~$ kubectl get pods
```

NAME	READY	STATUS	RESTARTS	AGE
acid-test-cluster-0	1/1	Running	0	27d
acid-test-cluster-1	1/1	Running	0	27d
postgres-operator-fcbd7cc96-ndpj8	1/1	Running	0	40d
postgres-operator-ui-5579cc7779-86rqk	1/1	Running	0	40d



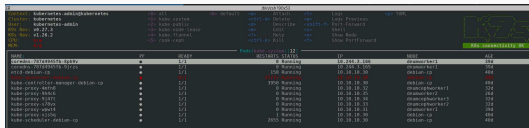
The screenshot shows a terminal window with the command `kubectl get pods` and its output. The output is a table with columns: NAME, READY, STATUS, RESTARTS, and AGE. The pods listed are acid-test-cluster-0, acid-test-cluster-1, postgres-operator-fcbd7cc96-ndpj8, and postgres-operator-ui-5579cc7779-86rqk. All are in a 'Running' state. To the right of the terminal output, there is a small diagram of a Kubernetes cluster architecture showing a control plane and worker nodes.

NAME	READY	STATUS	RESTARTS	AGE
acid-test-cluster-0	1/1	Running	0	27d
acid-test-cluster-1	1/1	Running	0	27d
postgres-operator-fcbd7cc96-ndpj8	1/1	Running	0	40d
postgres-operator-ui-5579cc7779-86rqk	1/1	Running	0	40d

Pods du namespace kube-system

```
linagora@debian-cp:~$ kubectl get pods -n kube-system
```

NAME	READY	STATUS	RESTARTS	AGE
coredns-787d4945fb-8ph9v	1/1	Running	0	40d
coredns-787d4945fb-9jrzs	1/1	Running	0	40d
etcd-debian-cp	1/1	Running	158	41d
kube-apiserver-debian-cp	0/1	Running	4968 (13m ago)	41d
kube-controller-manager-debian-cp	1/1	Running	4161 (8m26s ago)	41d
kube-proxy-4mfn8	1/1	Running	0	33d
kube-proxy-9h4c6	1/1	Running	0	27d
kube-proxy-9j47t	1/1	Running	0	33d
kube-proxy-s78vx	1/1	Running	0	33d
kube-proxy-wpwt4	1/1	Running	0	40d
kube-proxy-xjs5q	1/1	Running	1 (33d ago)	41d
kube-scheduler-debian-cp	1/1	Running	2848 (6m20s ago)	41d

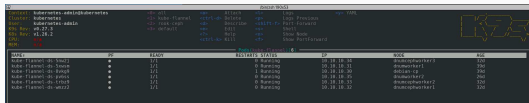


NAME	READY	STATUS	RESTARTS	IP	NODE	AGE
coredns-787d4945fb-8ph9v	1/1	Running	0	10.244.1.100	debian-cp	40d
coredns-787d4945fb-9jrzs	1/1	Running	0	10.244.1.101	debian-cp	40d
etcd-debian-cp	1/1	Running	158	10.244.1.102	debian-cp	41d
kube-apiserver-debian-cp	0/1	Running	4968	10.244.1.103	debian-cp	41d
kube-controller-manager-debian-cp	1/1	Running	4161	10.244.1.104	debian-cp	41d
kube-proxy-4mfn8	1/1	Running	0	10.244.1.105	debian-cp	33d
kube-proxy-9h4c6	1/1	Running	0	10.244.1.106	debian-cp	27d
kube-proxy-9j47t	1/1	Running	0	10.244.1.107	debian-cp	33d
kube-proxy-s78vx	1/1	Running	0	10.244.1.108	debian-cp	33d
kube-proxy-wpwt4	1/1	Running	0	10.244.1.109	debian-cp	40d
kube-proxy-xjs5q	1/1	Running	1	10.244.1.110	debian-cp	41d
kube-scheduler-debian-cp	1/1	Running	2848	10.244.1.111	debian-cp	41d

Pods du namespace kube-flannel

```
linagora@debian-cp:~$ kubectl get pods -n kube-flannel
```

NAME	READY	STATUS	RESTARTS	AGE
kube-flannel-ds-5nw2j	1/1	Running	0	33d
kube-flannel-ds-5xwsm	1/1	Running	0	40d
kube-flannel-ds-8vkg9	1/1	Running	1 (33d ago)	40d
kube-flannel-ds-pv6ss	1/1	Running	0	27d
kube-flannel-ds-trbz9	1/1	Running	0	33d
kube-flannel-ds-wmzz2	1/1	Running	0	33d



The screenshot shows a terminal window with the command `kubectl get pods -n kube-flannel` and its output. Below the command output, there is a detailed view of the pods, including their names, IP addresses, ready status, restarts, states, and the nodes they are running on.

NAME	IP	READY	RESTARTS	STATES	IP	NODE	AGE
kube-flannel-ds-5nw2j	10.18.18.10	1/1	0	Running	10.18.18.10	dnsmaster2	33d
kube-flannel-ds-5xwsm	10.18.18.11	1/1	0	Running	10.18.18.11	dnsmaster1	40d
kube-flannel-ds-8vkg9	10.18.18.12	1/1	1	Running	10.18.18.12	dnsmaster1	40d
kube-flannel-ds-pv6ss	10.18.18.13	1/1	0	Running	10.18.18.13	dnsmaster2	27d
kube-flannel-ds-trbz9	10.18.18.14	1/1	0	Running	10.18.18.14	dnsmaster2	33d
kube-flannel-ds-wmzz2	10.18.18.15	1/1	0	Running	10.18.18.15	dnsmaster1	33d

Pods du namespace rook-ceph

```
linagora@debian-cp:~$ kubectl get pods -n rook-ceph
```

NAME	READY	STATUS	RESTARTS	AGE
csi-cephfsplugin-9nbts	2/2	Running	1 (27d ago)	27d
csi-cephfsplugin-bpxlw	2/2	Running	0	33d
csi-cephfsplugin-jd5x8	2/2	Running	0	33d
csi-cephfsplugin-mdkfk	2/2	Running	0	33d
csi-cephfsplugin-nrmfz	2/2	Running	0	33d
csi-cephfsplugin-provisioner-84cc595b78-9mml4	5/5	Running	6008 (2m44s ago)	33d
csi-cephfsplugin-provisioner-84cc595b78-9twng	5/5	Running	2171	33d
csi-rbdplugin-92z1q	2/2	Running	0	33d
csi-rbdplugin-c95w7	2/2	Running	0	33d
csi-rbdplugin-pk57s	2/2	Running	1 (27d ago)	27d
csi-rbdplugin-provisioner-6f6b6b8cd6-4c8jd	1/5	CreateContainerError	1344	33d
csi-rbdplugin-provisioner-6f6b6b8cd6-gw6bm	1/5	CreateContainerError	4465	33d
csi-rbdplugin-srtfz	2/2	Running	0	33d
csi-rbdplugin-v6gqm	2/2	Running	0	33d
rook-ceph-crashcollector-dnumcephworker1-7845bb8ff-vs9fx	1/1	Running	0	32d
rook-ceph-crashcollector-dnumcephworker2-75cdf95dcd-n5xsx	1/1	Running	0	33d
rook-ceph-crashcollector-dnumcephworker3-6fddb6cd9-x45w5	1/1	Running	1 (8d ago)	32d
rook-ceph-mgr-a-c5db58dff-hvsp9	3/3	Running	1487 (6d6h ago)	33d
rook-ceph-mgr-b-7bbfd88c8b-wh4ww	2/3	CreateContainerError	944	22d
rook-ceph-mon-a-75cf9ccddc-b2jgc	2/2	Running	1163	33d
rook-ceph-mon-b-78d6586d5-qss4z	1/2	CreateContainerError	701 (19d ago)	19d
rook-ceph-mon-c-64dcb4c86c-ws8sg	2/2	Running	1755	33d
rook-ceph-operator-cf4f7dfd4-6tm6p	1/1	Running	0	32d
rook-ceph-osd-0-57d9b8dbd4d-d6dhr	1/2	CreateContainerError	484	32d
rook-ceph-osd-1-74698f77fd-6n2mh	1/2	Running	529	32d
rook-ceph-osd-2-5cc486467c-lhm47	1/2	Running	1116 (49m ago)	32d
rook-ceph-osd-prepare-dnumcephworker1-rnk78	0/1	Completed	0	21d
rook-ceph-osd-prepare-dnumcephworker3-42rxv	0/1	Completed	0	21d
rook-ceph-tools-7c4b8bb9b5-pxk67	1/1	Running	0	33d

```
linagora@debian-cp:~$ kubectl get pods -n rook-ceph
```

NAME	READY	STATUS	RESTARTS	AGE
csi-cephfsplugin-9nbts	2/2	Running	1 (27d ago)	27d
csi-cephfsplugin-bpxlw	2/2	Running	0	33d
csi-cephfsplugin-jd5x8	2/2	Running	0	33d
csi-cephfsplugin-mdkfk	2/2	Running	0	33d
csi-cephfsplugin-nrmfz	2/2	Running	0	33d
csi-cephfsplugin-provisioner-84cc595b78-9mml4	5/5	Running	6008 (2m44s ago)	33d
csi-cephfsplugin-provisioner-84cc595b78-9twng	5/5	Running	2171	33d
csi-rbdplugin-92z1q	2/2	Running	0	33d
csi-rbdplugin-c95w7	2/2	Running	0	33d
csi-rbdplugin-pk57s	2/2	Running	1 (27d ago)	27d
csi-rbdplugin-provisioner-6f6b6b8cd6-4c8jd	1/5	CreateContainerError	1344	33d
csi-rbdplugin-provisioner-6f6b6b8cd6-gw6bm	1/5	CreateContainerError	4465	33d
csi-rbdplugin-srtfz	2/2	Running	0	33d
csi-rbdplugin-v6gqm	2/2	Running	0	33d
rook-ceph-crashcollector-dnumcephworker1-7845bb8ff-vs9fx	1/1	Running	0	32d
rook-ceph-crashcollector-dnumcephworker2-75cdf95dcd-n5xsx	1/1	Running	0	33d
rook-ceph-crashcollector-dnumcephworker3-6fddb6cd9-x45w5	1/1	Running	1 (8d ago)	32d
rook-ceph-mgr-a-c5db58dff-hvsp9	3/3	Running	1487 (6d6h ago)	33d
rook-ceph-mgr-b-7bbfd88c8b-wh4ww	2/3	CreateContainerError	944	22d
rook-ceph-mon-a-75cf9ccddc-b2jgc	2/2	Running	1163	33d
rook-ceph-mon-b-78d6586d5-qss4z	1/2	CreateContainerError	701 (19d ago)	19d
rook-ceph-mon-c-64dcb4c86c-ws8sg	2/2	Running	1755	33d
rook-ceph-operator-cf4f7dfd4-6tm6p	1/1	Running	0	32d
rook-ceph-osd-0-57d9b8dbd4d-d6dhr	1/2	CreateContainerError	484	32d
rook-ceph-osd-1-74698f77fd-6n2mh	1/2	Running	529	32d
rook-ceph-osd-2-5cc486467c-lhm47	1/2	Running	1116 (49m ago)	32d
rook-ceph-osd-prepare-dnumcephworker1-rnk78	0/1	Completed	0	21d
rook-ceph-osd-prepare-dnumcephworker3-42rxv	0/1	Completed	0	21d
rook-ceph-tools-7c4b8bb9b5-pxk67	1/1	Running	0	33d

Sur chacun des 2 workers, il est nécessaire de déployer :

- le runtime containerd de Docker
- les commandes kubect!, kubeadm et kubelet
- l'activation des modules kernel overlay et br_netfilter
- l'activation des fonctions bridge/iptables et forward du kernel
- le paramétrage de containerd

Ajout du nœud worker dans le cluster k8s - join

L'opération qui permet au nœud worker de rejoindre le cluster s'appelle le join.

La syntaxe de cette commande est obtenue en lançant la commande suivante sur le control plane avec l'utilisateur root :

```
# kubeadm token create --print-join-command
kubeadm join 10.10.10.30:6443 \
--token ilfbgc.8xco4svm5pnxkfbj \
--discovery-token-ca-cert-hash sha256:73bf45619ae0051d4ff810328d1dad18e6a5966c95d3c4ec76275b89a934595
```


Lancement du join sur chacun des workers

Sur chacun des workers, le lancement de la commande join produit le résultat suivant :

```
# kubeadm join 10.10.10.30:6443 \
--token 6pia7c.n6u8pbm7yjl6nnr8 \
--discovery-token-ca-cert-hash sha256:f6d45602ea75c7659dc91f661d19e97e6817e2847e4e5d0047880b871317a145
[preflight] Running pre-flight checks
[preflight] Reading configuration from the cluster...
[preflight] FYI: You can look at this config file with 'kubectl -n kube-system \
get cm kubeadm-config -o yaml'
W0315 16:31:41.445771 6266 configset.go:78] Warning: No kubeproxy.config.k8s.io/v1alpha1 config is loaded.
Continuing without it: configmaps "kube-proxy" is forbidden: User "system:bootstrap:6pia7c"
cannot get resource "configmaps" in API group "" in the namespace "kube-system"
[kubelet-start] Writing kubelet configuration to file "/var/lib/kubelet/config.yaml"
[kubelet-start] Writing kubelet environment file with flags to file "/var/lib/kubelet/kubeadm-flags.env"
[kubelet-start] Starting the kubelet
[kubelet-start] Waiting for the kubelet to perform the TLS Bootstrap...
```

This node has joined the cluster:

- * Certificate signing request was sent to apiserver and a response was received.
- * The Kubelet was informed of the new secure connection details.

Run 'kubectl get nodes' on the control-plane to see this node join the cluster.

Lancement du join sur chacun des workers

La commande suivante permet de vérifier le résultat du join :

```
$ kubectl get nodes
```

NAME	STATUS	ROLES	AGE	VERSION
debian-cp	NotReady	control-plane	15h	v1.26.2
dnumworker1	NotReady	<none>	53s	v1.26.2

Terminologie du stockage dans k8s

- Le stockage permanent des données s'appuie les volumes persistants (PV)
(<https://kubernetes.io/docs/concepts/storage/persistent-volumes/>)
- Un PV est un espace de stockage mis à disposition par k8s.
- Il peut être alloué manuellement ou dynamiquement par l'intermédiaire des storage class
(<https://kubernetes.io/docs/concepts/storage/storage-classes/>)
- Les PV sont l'équivalent d'un node dans un cluster.
- Les persistentVolumeClaim (PVC) sont l'équivalent d'un pod.

- Le storage class sur lequel s'appuie l'opérateur PostgreSQL est Ceph
- L'opérateur k8s **Rook Ceph** facilite le déploiement de Ceph
- Le déploiement s'appuie sur le lien
`https://rook.io/docs/rook/v1.9/quickstart.html`
- La version de l'opérateur utilisée est la v1.9
- Elle supporte les versions k8s v1.17+

Prérequis au déploiement de l'opérateur - Rook Ceph

- Le déploiement de l'opérateur scanne l'ensemble des noeuds de stockage pour vérifier la présence de :
 - des devices bruts (sans partitions ou filesystems formatés)
 - des partitions brutes (sans filesystems formatés)
 - les volumes physiques initialisés par LVM

L'exemple ci-dessous indique comment vérifier la disponibilité d'espace pour l'opérateur Rook Ceph :

```
lsblk -f
```

NAME	FSTYPE	LABEL	UUID	MOUNTPOINT
vda				
-vda1	LVM2_member		>eS050t-GkUV-YKTH-WsGq-hNJY-eKNf-3i07IB	
-ubuntu--vg-root	ext4		c2366f76-6e21-4f10-a8f3-6776212e2fe4	/
-ubuntu--vg-swap_1	swap		9492a3dc-ad75-47cd-9596-678e8cf17ff9	[SWAP]
vdb				

- Dans l'exemple précédent, si la colonne *FSTYPE* est renseignée, cela indique la présence d'un filesystem
- La partition vdb n'est pas formatée avec un filesystem : elle est donc utilisable par l'opérateur Rook Ceph
- Le paquet **lvm2** est une dépendance importante de Rook Ceph

Sélection des nœuds sur lesquels Ceph sera déployé

L'opérateur Rook Ceph offre la possibilité de sélectionner les nœuds sur lesquels le stockage Ceph est déployé.

Pour cela, il s'appuie sur la notion de label.

Dans le cadre du POC, les 3 nœuds suivants sont sélectionnés pour porter le stockage :

- dnumcephworker1
- dnumcephworker2
- dnumcephworker3

Affectation des labels sur les nœuds de stockage

Depuis le control plane, lancer les commandes suivantes pour marquer les nœuds :

```
$ kubectl label nodes dnumcephworker1 role=storage-node
node/dnumcephworker1 labeled
$ kubectl label nodes dnumcephworker2 role=storage-node
node/dnumcephworker2 labeled
$ kubectl label nodes dnumcephworker3 role=storage-node
node/dnumcephworker3 labeled
```

Affichage du label des nœuds :

```
$ kubectl get nodes --show-labels
```

NAME	STATUS	ROLES	LABELS
dnumcephworker1	Ready	<none>	kubernetes.io/hostname=dnumcephworker1, kubernetes.io/os=linux, role=storage-node
dnumcephworker2	Ready	<none>	kubernetes.io/hostname=dnumcephworker2, kubernetes.io/os=linux, role=storage-node
dnumcephworker3	Ready	<none>	kubernetes.io/hostname=dnumcephworker3, kubernetes.io/os=linux, role=storage-node

Paramétrage pour la répartition du stockage Ceph sur les nœuds labelisés

```
~/rook$ git diff
diff --git a/deploy/examples/cluster.yaml b/deploy/examples/cluster.yaml
index 9bd50ec97..fef3f777f 100644
--- a/deploy/examples/cluster.yaml
+++ b/deploy/examples/cluster.yaml
@@ -154,22 +154,22 @@ spec:
   # To control where various services will be scheduled by kubernetes, use the placement configuration sections below.
   # The example under 'all' would have all services scheduled on kubernetes nodes labeled with 'role=storage-node' and
   # tolerate taints with a key of 'storage-node'.
-  # placement:
-  #   all:
-  #     nodeAffinity:
-  #       requiredDuringSchedulingIgnoredDuringExecution:
-  #         nodeSelectorTerms:
-  #           - matchExpressions:
-  #             - key: role
-  #               operator: In
-  #               values:
-  #                 - storage-node
-  #     podAffinity:
-  #     podAntiAffinity:
-  #     topologySpreadConstraints:
-  #     tolerations:
-  #       - key: storage-node
-  #         operator: Exists
+  placement:
+    all:
+      nodeAffinity:
+        requiredDuringSchedulingIgnoredDuringExecution:
+          nodeSelectorTerms:
+            - matchExpressions:
+              - key: role
+                operator: In
+                values:
+                  - storage-node
+      podAffinity:
+      podAntiAffinity:
+      topologySpreadConstraints:
+      tolerations:
+        - key: storage-node
+          operator: Exists
+  # The above placement information can also be specified for mon, osd, and mgr components
+  # mon:
+  # Monitor deployments may contain an anti-affinity rule for avoiding monitor
```

Paramétrage pour la répartition du stockage Ceph sur les nœuds labelisés

La directive *nodeSelectorTerms* permet de sélectionner les noeuds portant la storageclass Ceph

```
+         nodeSelectorTerms:
...
+         - storage-node
+     podAffinity:
+     podAntiAffinity:
```

Déploiement de l'opérateur Rook Ceph

Comme indiqué dans le lien

<https://rook.io/docs/rook/v1.9/quickstart.html>, l'application des commandes ci-dessous amorce le déploiement de l'opérateur :

```
$ git clone --single-branch --branch v1.9.2 https://github.com/rook/rook.git
cd rook/deploy/examples
kubectl create -f crds.yaml -f common.yaml -f operator.yaml
kubectl create -f cluster.yaml
```

- Une fois le cluster opérationnel, il devient possible de créer :
 - stockage bloc
 - stockage objet
 - stockage fichier

Vérification de l'opérateur Rook Ceph

```
# verify the rook-ceph-operator is in the 'Running' state before proceeding
```

```
kubectl -n rook-ceph get pod
```

NAME	READY	STATUS	RESTARTS	AGE
csi-cephfsplugin-9nbt5	2/2	Running	1 (63d ago)	63d
csi-cephfsplugin-bpxlw	2/2	Running	0	69d
csi-cephfsplugin-jd5x8	2/2	Running	0	69d
csi-cephfsplugin-mddkf	2/2	Running	0	69d
csi-cephfsplugin-nrmfz	2/2	Running	0	69d
csi-cephfsplugin-provisioner-84cc595b78-9mml4	5/5	Running	6523 (28d ago)	69d
csi-cephfsplugin-provisioner-84cc595b78-9twng	5/5	Running	3908 (30d ago)	69d
csi-rbdplugin-92zliq	2/2	Running	0	69d
csi-rbdplugin-c95w7	2/2	Running	0	69d
csi-rbdplugin-pk57s	2/2	Running	1 (63d ago)	63d
csi-rbdplugin-provisioner-6f6b6b8cd6-4c8jd	5/5	Terminating	2919 (29d ago)	69d
csi-rbdplugin-provisioner-6f6b6b8cd6-d4t56	0/5	Pending	0	4d10h
csi-rbdplugin-provisioner-6f6b6b8cd6-gw6bm	1/5	CreateContainerError	4465	69d
csi-rbdplugin-srtfz	2/2	Running	0	69d
csi-rbdplugin-v6gqm	2/2	Running	0	69d
rook-ceph-crashcollector-dnumcephworker1-7845bb8ff-vs9fx	1/1	Running	0	68d
rook-ceph-crashcollector-dnumcephworker2-75cdf95dcd-1jkqd	0/1	Pending	0	4d10h
rook-ceph-crashcollector-dnumcephworker2-75cdf95dcd-n5xsx	1/1	Terminating	0	69d
rook-ceph-crashcollector-dnumcephworker3-6fddb6cd9-x45w5	1/1	Running	2	68d
rook-ceph-mgr-a-c5db58dff-fpp7z	2/3	CrashLoopBackOff	146 (28d ago)	30d
rook-ceph-mgr-a-c5db58dff-hvsp9	2/3	Terminating	3115 (30d ago)	69d
rook-ceph-mgr-b-7bbfd88c8b-jdg4p	0/3	Pending	0	4d10h
rook-ceph-mgr-b-7bbfd88c8b-wh4ww	2/3	Terminating	2283 (28d ago)	58d
rook-ceph-mon-a-75cf9cdddc-b2jgc	2/2	Running	1500 (31d ago)	69d
rook-ceph-mon-c-64dcb4c86c-wz8sg	2/2	Running	1808 (28d ago)	69d
rook-ceph-operator-cf4f7dfd4-6tm6p	1/1	Running	0	68d
rook-ceph-osd-0-57d9b8db4d-d6dhr	1/2	Terminating	731 (28d ago)	68d
rook-ceph-osd-0-57d9b8db4d-vmtjp	0/2	Pending	0	4d10h
rook-ceph-osd-1-74698f77fd-6n2mh	1/2	Running	716 (30d ago)	68d
rook-ceph-osd-2-5cc486467c-lhm47	1/2	Running	1172 (28d ago)	68d
rook-ceph-osd-prepare-dnumcephworker1-rnk78	0/1	Completed	0	57d
rook-ceph-osd-prepare-dnumcephworker3-42rxv	0/1	Completed	0	57d
rook-ceph-tools-7c4b8bb9b5-8tf8r	0/1	Pending	0	4d10h
rook-ceph-tools-7c4b8bb9b5-pxk67	1/1	Terminating	0	68d

Le contrôleur d'admission (Admission Controller) - Rook Ceph

- Il est recommandé de déployer le contrôleur d'admission : il permet de vérifier que Rook est correctement paramétré grâce aux réglages des Customer Resources (CR)
- L'Admission Controller intercepte les requêtes à destination de l'API k8s avant l'objet persistant après les phases d'authentification et d'autorisation
- Pour installer l'Admission Controller, lancer les requêtes suivantes :

```
kubectl apply -f https://github.com/jetstack/cert-manager/releases/download/v1.7.1/cert-manager.yaml
```

Le storageclass déployé a pour nom **rook-ceph-block**.

```
linagora@debian-cp:~$ kubectl get storageclass
```

NAME	PROVISIONER	RECLAIMPOLICY	VOLUMEBINDINGMODE	ALLOWVOLUMEEXPANSION	AGE
local-storage	kubernetes.io/no-provisioner	Delete	WaitForFirstConsumer	false	12d
rook-ceph-block	rook-ceph.rbd.csi.ceph.com	Delete	Immediate	true	5d23h

De manière similaire à l'opérateur Rook Ceph, il est possible de sélectionner les nœuds portant le pod PostgreSQL en se basant sur les labels Kubernetes.

Marquage des nœuds PostgreSQL

Les commandes ci-dessous marquent les nœuds destinés à porter les pods PostgreSQL :

```
$ kubectl label nodes dnumworker1 postgres-operator=enabled
```

```
node/dnumworker1 labeled
```

```
$ kubectl label nodes dnumworker2 postgres-operator=enabled
```

```
node/dnumworker2 labeled
```

```
$ kubectl get nodes --show-labels
```

NAME	STATUS	ROLES	LABELS
dnumworker1	Ready	<none>	kubernetes.io/hostname=dnumworker1, kubernetes.io/os=linux, postgres-operator=enabled
dnumworker2	Ready	<none>	kubernetes.io/hostname=dnumworker2, kubernetes.io/os=linux, postgres-operator=enabled

Répartitions des pods PostgreSQL sur les nœuds worker et choix du storageClass

```
$ git diff
diff --git a/manifests/complete-postgres-manifest.yaml b/manifests/complete-postgres-manifest.yaml
index 8d197a75..56b32c34 100644
--- a/manifests/complete-postgres-manifest.yaml
+++ b/manifests/complete-postgres-manifest.yaml
@@ -57,7 +57,7 @@ spec:

    volume:
      size: 1Gi
-#    storageClass: my-sc
+  storageClass: rook-ceph-block
  #    iops: 1000 # for EBS gp3
  #    throughput: 250 # in MB/s for EBS gp3
  #    selector:
@@ -203,14 +203,14 @@ spec:

  # Add node affinity support by allowing postgres pods to schedule only on nodes that
  # have label: "postgres-operator:enabled" set.
-#  nodeAffinity:
-#    requiredDuringSchedulingIgnoredDuringExecution:
-#      nodeSelectorTerms:
-#        - matchExpressions:
-#          - key: postgres-operator
-#            operator: In
-#            values:
-#              - enabled
+  nodeAffinity:
+    requiredDuringSchedulingIgnoredDuringExecution:
+      nodeSelectorTerms:
+        - matchExpressions:
+          - key: postgres-operator
+            operator: In
+            values:
+              - enabled

  # Enables change data capture streams for defined database tables
  #  streams:
```

Déploiement de l'opérateur PostgreSQL de Zalando

Le storage class est maintenant déployé.

Il devient possible d'appliquer l'opérateur PostgreSQL.

Le lien suivant décrit les commandes à appliquer :

<https://github.com/zalando/postgres-operator/blob/master/docs/quickstart.md#deployment-options>

Clonage du dépôt de l'opérateur

```
git clone https://github.com/zalando/postgres-operator.git  
cd postgres-operator
```

Application des différents manifestes

```
kubectl create -f manifests/configmap.yaml # configuration
kubectl create -f manifests/operator-service-account-rbac.yaml # identity and permissions
kubectl create -f manifests/postgres-operator.yaml # deployment
kubectl create -f manifests/api-service.yaml # operator API to be used by UI
```

Pour information, il existe également des chart Helm pour faciliter le déploiement.

Pour activer l'accès à l'interface web de l'opérateur PostgreSQL, veuillez la commande suivante sur le nœud control plane :

```
$ kubectl port-forward svc/postgres-operator-ui 8081:80
Forwarding from 127.0.0.1:8081 -> 8081
Forwarding from [::1]:8081 -> 8081
```

Elle redirige le flux TCP du port 80 du control plane vers le port TCP 8081 du service postgres-operator-ui

Pour accéder à l'interface web de l'opérateur PostgreSQL depuis le PC de l'utilisateur, il est possible de passer par une redirection SSH :

```
ssh -L 9090:10.106.57.137:80 dgfip-k8s
```

Lancer le navigateur pour accéder à l'URL `http://localhost:9090/#new`

Interface web de l'opérateur PostgreSQL

← → ↺

localhost:9090/#new

☰ ☆ 🔍 Search

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PostgreSQL Operator UI PostgreSQL clusters Backups Status **New cluster** Documentation

New PostgreSQL cluster

Cluster YAML definition

```
kind: "postgresql"
apiVersion: "acid.zalan.do/v1"

metadata:
  name: ""
  namespace: "default"
  labels:
    team: acid

spec:
  teamId: "acid"
  postgresql:
    version: "15"
    numberOfInstances: 1
    volume:
      size: "10Gi"

allowedSourceRanges:
  # IP ranges to access your cluster go here

resources:
  requests:
    cpu: 100m
    memory: 100Mi
  limits:
    cpu: 500m
    memory: 500Mi
```

New cluster configuration

Validate Copy definition Create cluster

Name

new-cluster (can be 53 characters long)

Owning team

acid

PostgreSQL version

15

DNS name:

.default

Number of instances

1

Enable load balancer

☐ Master

Enable connection pooler

☐ Master

Enable connection pooler load balancer

☐ Master

Volume size

10 Gi

storageClass

Specify lops and Throughput only if you need more than the default 3000 lops and 125Mb/s EBS provides.

lops

54

Fonctionnalités proposées par l'interface web de l'opérateur PostgreSQL

L'UI permet de :

- choisir la version PostgreSQL (jusqu'à la version 15 actuellement)
- le nombre d'instances
- activation du load-balancer
- activation du pool de connexions à la base
- activation du load-balancer pour le pool de connexions à la base
- taille du volume persistant alloué à la base de données
- choix du storageClass
- performances IO
- choix des ressources (demandées et limites) CPU et RAM allouées

Utilisation de la commande en ligne pour la création d'un cluster PostgreSQL

- Les fonctionnalités proposées par l'UI sont également disponibles par la commande en ligne.
- Le manifeste *manifests/complete-postgresql-manifest.yaml* permet de préciser l'ensemble des paramètres proposés par l'UI.
- Pour appliquer ce manifeste *manifests/complete-postgresql-manifest.yaml*, la commande suivante est lancée sur le nœud :

```
kubectl create -f manifests/complete-postgresql-manifest.yaml
```

Vérification de l'état du cluster PostgreSQL

```
$ kubectl get pods -l application=spilo -L spilo-role
```

NAME	READY	STATUS	RESTARTS	AGE	SPILO-ROLE
acid-test-cluster-0	1/1	Running	0	12m	
acid-test-cluster-1	1/1	Running	0	10m	

```
$ kubectl get postgresql
```

NAME	TEAM	VERSION	PODS	VOLUME	CPU-REQUEST	MEMORY-REQUEST	AGE	STATUS
acid-test-cluster	acid	15	2	1Gi	10m	100Mi	68d	Running

```
$ kubectl get pods -l application=spilo -L spilo-role
```

NAME	READY	STATUS	RESTARTS	AGE	SPILO-ROLE
acid-test-cluster-0	1/1	Running	0	13m	
acid-test-cluster-1	1/1	Running	0	10m	

```
$ kubectl get svc -l application=spilo -L spilo-role
```

NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	AGE	SPILO-ROLE
acid-test-cluster	ClusterIP	10.103.247.68	<none>	5432/TCP	68d	master
acid-test-cluster-config	ClusterIP	None	<none>	<none>	68d	
acid-test-cluster-repl	ClusterIP	10.100.95.205	<none>	5432/TCP	68d	replica

Déploiement de krew

```
(  
  set -x; cd "$(mktemp -d)" &  
  OS="$(uname | tr '[:upper:]' '[:lower:]')" &  
  ARCH="$(uname -m | sed -e 's/x86_64/amd64/' -e 's/\(arm\)\(64\)\{0,1\}/\1\2/' -e 's/aarch64$/arm64/')" &  
  KREW="krew-${OS}_${ARCH}" &  
  curl -fsSLO "https://github.com/kubernetes-sigs/krew/releases/latest/download/${KREW}.tar.gz" &  
  tar zxvf "${KREW}.tar.gz" &  
  ./"${KREW}" install krew  
)
```

Ajout du répertoire des binaires du paquet krew dans **.bashrc** ou **.zshrc** :

```
export PATH="${KREW_ROOT:-$HOME/.krew}/bin:$PATH"
```

Redémarrer le shell.

Pour vérifier le déploiement correct de krew, lancer la commande suivante :

```
kubect1 krew
```

Le déploiement de Minio s'appuie sur l'opérateur Minio.

Son déploiement est décrit dans le lien suivant

<https://operator.min.io/#architecture>.

```
kubect1 krew update  
kubect1 krew install minio
```

Vérification de l'état de l'opérateur Minio

```
$ kubectl get pods -n minio-operator
```

NAME	READY	STATUS	RESTARTS	AGE
console-56f9795d5c-59fsx	1/1	Running	1 (33d ago)	82d
minio-operator-7cd6784f59-5c52w	1/1	Running	5 (23h ago)	17d
minio-operator-7cd6784f59-m7h8x	1/1	Running	2320 (3d16h ago)	82d

La commande suivante ouvre un accès de type proxy à la console Minio :

```
$ kubectl minio proxy -n minio-operator  
Starting port forward of the Console UI.
```

To connect open a browser and go to `http://localhost:9090`

Current JWT to login: *****

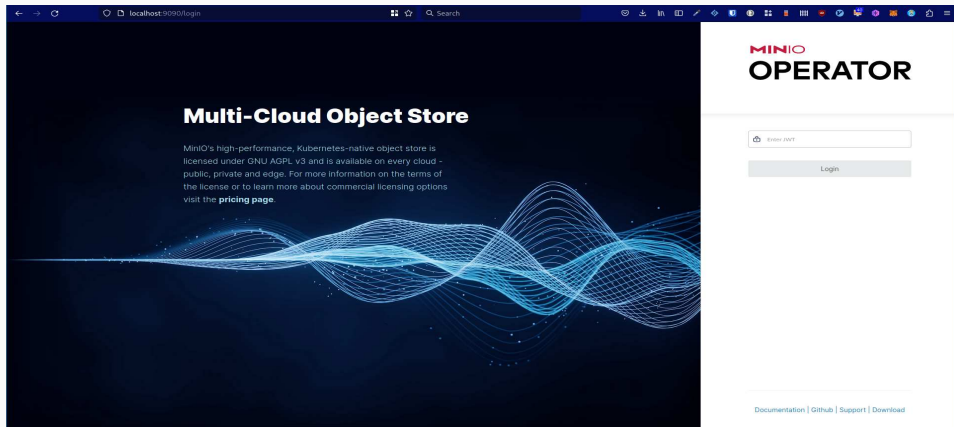
```
Forwarding from 0.0.0.0:9090 -> 9090  
Handling connection for 9090
```

Depuis le terminal de l'utilisateur, lancer la commande suivante :

```
$ ssh -L 9090:localhost:9090 dgfip-k8s
```

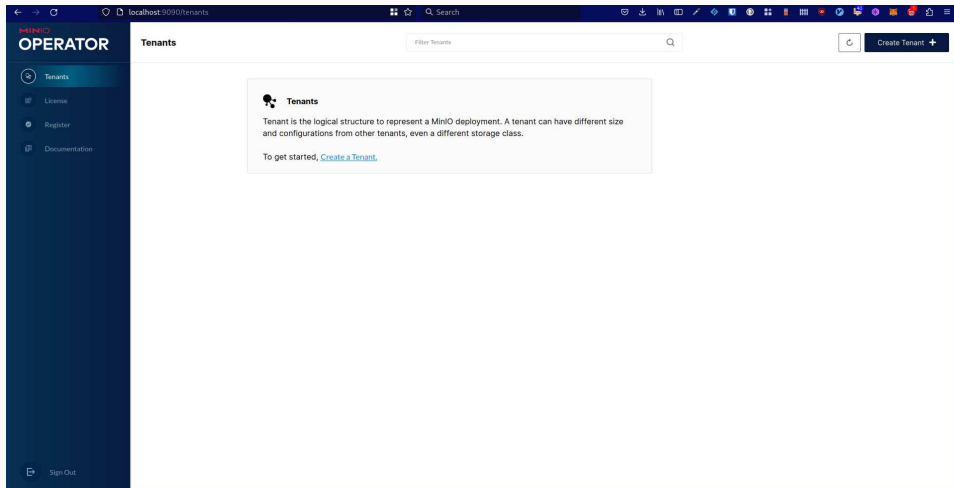
Accès à la console Minio

Dans le champ *Enter JWT*, renseigner la valeur du token JWT renvoyé par la commande précédente :



Dashboard Minio

Le tableau de bord de Minio ressemble à ceci :



Création d'un tenant - Setup - Minio

MINIO

OPERATOR

Tenants

License

Register

Documentation

Sign Out

localhost:9090/tenants/add

Tenants

Setup

Configure

Images

Pod Placement

Identity Provider

Security

Encryption

Audit Log

Monitoring

Name
How would you like to name this new tenant?

Name*

Namespace*

Storage Class

Capacity
Please select the desired capacity

Number of Servers*

Drives per Server*

Total Size*

Gi

Erasure Code Parity
EC-4 (Default)

Please select the desired parity. This setting will change the max usable capacity in the cluster

Resources
You may specify the amount of CPU and Memory that MinIO servers should reserve on each node.

CPU Request

Memory Request

Gi

Specify Limit

OFF ON

Resource Allocation

Number of Servers4

Drives per Server4

Drive Capacity64.0 GiB

Total Volumes16

Memory per Node2 Gi

CPU Selection1

Erasure Code Configuration

EC ParityEC-4

Raw Capacity1.0 TiB

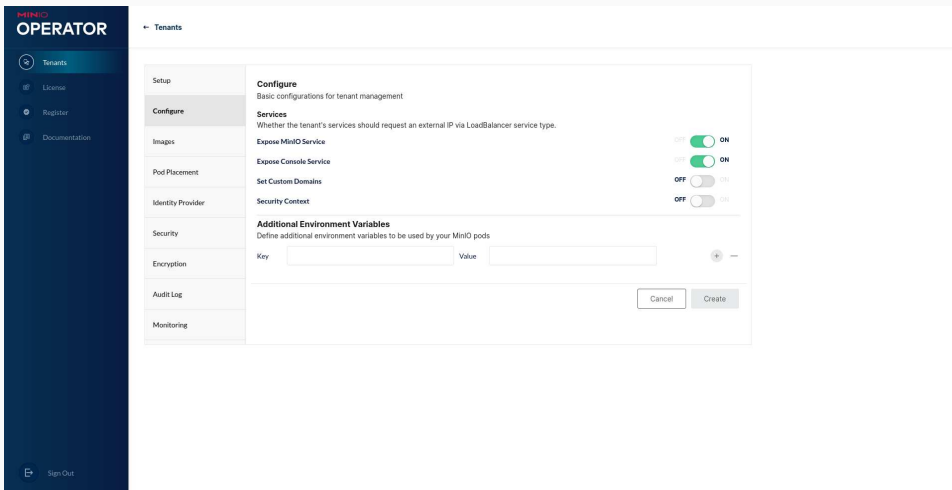
Usable Capacity768.0 GiB

Server Failures Tolerated1

Cancel

Create

Création d'un tenant - Configure - Minio



The screenshot shows the Minio Operator web interface. On the left is a dark blue sidebar with the 'MINIO OPERATOR' logo at the top. Below the logo are navigation links: 'Tenants' (active), 'License', 'Register', and 'Documentation'. At the bottom of the sidebar is a 'Sign Out' button. The main content area is titled '← Tenants'. It features a vertical list of configuration categories on the left: 'Setup', 'Configure' (highlighted), 'Images', 'Pod Placement', 'Identity Provider', 'Security', 'Encryption', 'Audit Log', and 'Monitoring'. The 'Configure' section is expanded, showing several sub-sections: 'Configure' (with a description: 'Basic configurations for tenant management'), 'Services' (with a description: 'Whether the tenant's services should request an external IP via LoadBalancer service type.'), 'Expose MinIO Service' (with a toggle switch set to 'ON'), 'Expose Console Service' (with a toggle switch set to 'ON'), 'Set Custom Domains' (with a toggle switch set to 'OFF'), and 'Security Context' (with a toggle switch set to 'OFF'). Below these is the 'Additional Environment Variables' section, which includes a description: 'Define additional environment variables to be used by your MinIO pods'. This section contains a table with two columns, 'Key' and 'Value', and a '+' button to add new variables. At the bottom right of the configuration area are 'Cancel' and 'Create' buttons.

MINIO OPERATOR

← Tenants

Setup

Configure

Images

Pod Placement

Identity Provider

Security

Encryption

Audit Log

Monitoring

Configure
Basic configurations for tenant management

Services
Whether the tenant's services should request an external IP via LoadBalancer service type.

Expose MinIO Service ☒ ON

Expose Console Service ☒ ON

Set Custom Domains ☐ OFF

Security Context ☐ OFF

Additional Environment Variables
Define additional environment variables to be used by your MinIO pods

Key	Value
-----	-------

Cancel Create

Marquage des nœuds Minio

Depuis le control plane, lancer les commandes suivantes pour marquer les nœuds :

```
$ kubectl label nodes dnumminioworker1 role=s3-node
node/dnumminioworker1 labeled
$ kubectl label nodes dnumminioworker2 role=s3-node
node/dnumminioworker2 labeled
$ kubectl label nodes dnumminioworker3 role=s3-node
node/dnumminioworker3 labeled
$ kubectl label nodes dnumminioworker4 role=s3-node
node/dnumminioworker4 labeled
```

Affichage du label des nœuds :

```
$ kubectl get nodes --show-labels
```

NAME	STATUS	ROLES	AGE	VERSION	LABELS
...					
dnumminioworker1	Ready	<none>	6h2m	v1.27.2	...,role=s3-node
dnumminioworker2	Ready	<none>	142m	v1.27.2	...,role=s3-node
dnumminioworker3	Ready	<none>	109m	v1.27.2	...,role=s3-node
dnumminioworker4	Ready	<none>	83m	v1.27.2	...,role=s3-node
...					

Création d'un tenant - Pod placement - Minio

The screenshot shows the Minio Operator web interface at the URL `localhost:9090/tenants/add`. The left sidebar contains navigation links: Tenants, License, Register, and Documentation. The main content area is titled "Tenants" and displays the configuration for a new tenant. The "Pod Placement" section is active, showing options for "Type" (None, Default (Pod Anti-Affinity), Node Selector) and "With Pod Anti-Affinity" (toggle ON). The "Labels" section is highlighted with a red oval, showing a table with one row: "role" and "s3-node". The "Tolerations" section shows a table with one row: "Toleration 1" with "Toleration Key" set to "role", "Is" set to "Equal", "to" set to "Toleration Value", "then" set to "NoSchedule", and "after" set to "0 seconds". The interface includes "Cancel" and "Create" buttons at the bottom right.

← Tenants

MINIO OPERATOR

Setup

Pod Placement

Configure how pods will be assigned to nodes

Type

MinIO supports multiple configurations for Pod Affinity

☐ None

☐ Default (Pod Anti-Affinity)

☒ Node Selector

With Pod Anti-Affinity ☐ OFF ☒ ON

Labels

Label	Value
role	s3-node

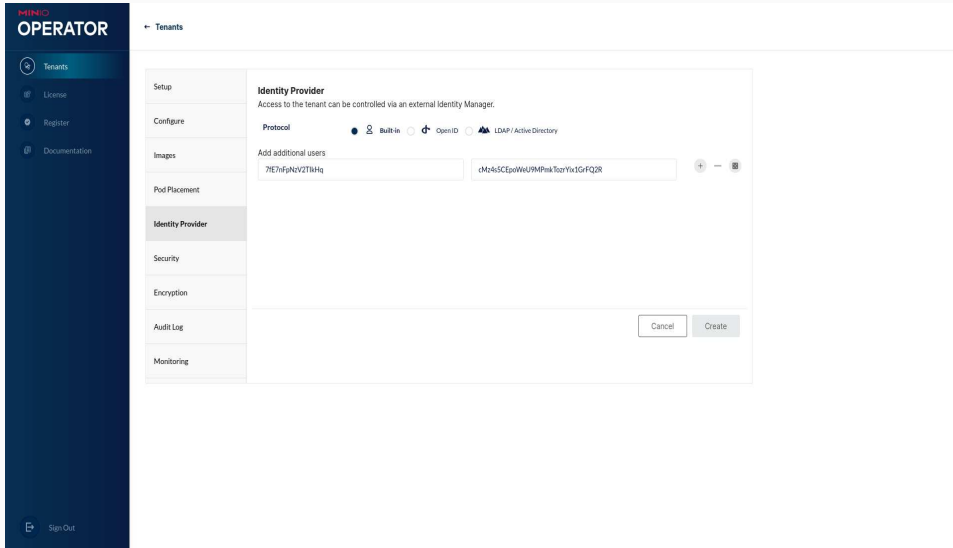
Tolerations

Toleration 1

If	Toleration Key	Is	Equal	to	Toleration Value
then	NoSchedule	after	0	seconds	

Cancel Create

Création d'un tenant - Choix d'un fournisseur d'identité - Minio



The screenshot displays the Minio Operator web interface. On the left is a dark blue sidebar with the 'MINIO OPERATOR' logo at the top. Below the logo are navigation links: 'Tenants' (active), 'License', 'Register', and 'Documentation'. At the bottom of the sidebar is a 'Sign Out' button. The main content area is titled 'Tenants' and shows a configuration form for a tenant's 'Identity Provider'. The form has a left-hand menu with options: 'Setup', 'Configure', 'Images', 'Pod Placement', 'Identity Provider' (selected), 'Security', 'Encryption', 'Audit Log', and 'Monitoring'. The 'Identity Provider' section contains the following elements:

- Identity Provider**: A heading followed by the text 'Access to the tenant can be controlled via an external Identity Manager.'
- Protocol**: A row of radio buttons for selecting the identity protocol. 'Built-in' is selected, while 'Open ID' and 'LDAP / Active Directory' are unselected.
- Add additional users**: A section with two text input fields. The first field contains '7fE7nFpNzV2TlHq' and the second contains 'cMz4s5CEp0WwU9MPmkT0orYix1GrFQ2R'. To the right of the fields are '+' and '-' buttons for adding or removing users, and a 'x' button to clear the list.
- Buttons**: At the bottom right of the form are 'Cancel' and 'Create' buttons.

Création d'un tenant - Sécurité - Minio

MINIO
OPERATOR

Tenants

License

Register

Documentation

Sign Out

Tenants

Setup	Security
Configure	TLS Securing all the traffic using TLS. This is required for Encryption Configuration
Images	AutoCert The internode certificates will be generated and managed by MinIO Operator
Pod Placement	Custom Certificates Certificates used to terminated TLS at MinIO
Identity Provider	
Security	
Encryption	
Audit Log	
Monitoring	

Cancel

Create

Création d'un tenant - Chiffrement - Minio

The screenshot displays the Minio Operator web interface. On the left is a dark blue sidebar with the 'MINIO OPERATOR' logo at the top. Below the logo are several menu items: 'Tenants' (with a plus icon), 'License', 'Register', 'Documentation', and 'Sign Out' at the bottom. The main content area is titled '← Tenants' and features a vertical sidebar with configuration options: 'Setup', 'Configure', 'Images', 'Pod Placement', 'Identity Provider', 'Security', 'Encryption' (which is highlighted), 'Audit Log', and 'Monitoring'. The 'Encryption' section is active, showing a toggle switch for 'Disabled' (selected) and 'Enabled'. Below the toggle, a text block explains: 'MinIO Server-Side Encryption (SSE) protects objects as part of write operations, allowing clients to take advantage of server processing power to secure objects at the storage layer (encryption-at-rest). SSE also provides key functionality to regulatory and compliance requirements around secure locking and erasure.' At the bottom right of this section are two buttons: 'Cancel' and 'Create'.

MINIO OPERATOR

← Tenants

Setup

Configure

Images

Pod Placement

Identity Provider

Security

Encryption

Audit Log

Monitoring

Encryption

Disabled Enabled

MinIO Server-Side Encryption (SSE) protects objects as part of write operations, allowing clients to take advantage of server processing power to secure objects at the storage layer (encryption-at-rest). SSE also provides key functionality to regulatory and compliance requirements around secure locking and erasure.

Cancel Create

Création d'un tenant - Log d'audit - Minio

MINIO

OPERATOR

Tenants

License

Register

Documentation

Sign Out

Tenants

Setup

Configure

Images

Pod Placement

Identity Provider

Security

Encryption

Audit Log

Monitoring

Tenants

Setup

Audit Log

Deploys a small PostgreSQL database and stores access logs of all calls into the tenant.

Disabled ☒ Enabled

Configure

Log Search Storage Class

Default

Storage Size*

\$

Gi

SecurityContext for LogSearch

Run As User*

1000

Run As Group*

1000

FsGroup*

1000

FsGroupChangePolicy

Always

Do not run as Root

OFF

☒ ON

SecurityContext for PostgreSQL

Run As User*

999

Run As Group*

999

FsGroup*

999

FsGroupChangePolicy

Always

Do not run as Root

OFF

☒ ON

Cancel

Create

72

Création d'un tenant - Supervision - Minio

MINIO

OPERATOR

Tenants

License

Register

Documentation

Sign Out

Tenants

Monitoring

Setup

Configure

Images

Pod Placement

Identity Provider

Security

Encryption

Audit Log

Monitoring

Monitoring

Disabled ☒ Enabled

A small Prometheus will be deployed to keep metrics about the tenant.

Storage Class

Default

Storage Size*

\$

Gi

SecurityContext

Run As User*

1000

Run As Group*

1000

FsGroup*

1000

FsGroupChangePolicy

Always

Do not run as Root

☒ ON

Cancel

Create

WIP

L'image déployée par l'opérateur PostgreSQL de Zalando s'appuie sur Spilo

`https://github.com/zalando/spilo`

Cette information se trouve dans le script

manifests/complete-postgres-manifest.yaml :

```
dockerImage: ghcr.io/zalando/spilo-15:3.0-p1
```

Utilisation de container en mode rootless dans OpenShift

L'URL suivante décrit la problématique d'utilisation de container dans un environnement rootless :

<https://docs.bitnami.com/tutorials/running-non-root-containers-on-openshift>

Cette page fournit également un lien intéressant sur la sécurisation d'un cluster Kubernetes en se basant sur les **Pod Security Policies**.

Le lien est le suivant :

<https://docs.bitnami.com/tutorials/secure-kubernetes-cluster-psp/>.

Comme indiqué dans

<https://kubernetes.io/docs/concepts/security/pod-security-policy/>
les PSP sont dépréciés.

Ils sont maintenant remplacés par **Pod Security Admission**

<https://kubernetes.io/docs/concepts/security/pod-security-admission/>

La norme

Pod Security Admission définit la notion de *Security Context* décrite dans le lien suivant :

<https://kubernetes.io/docs/tasks/configure-pod-container/security-context/>

C'est cette notion qui va permet d'approcher au plus près les conditions de run d'un cluster Openshift

Par défaut, l'opérateur PostgreSQL de Zalando applique les mesures de sécurité suivantes.

Extrait de manifests/postgres-operator.yaml :

```
securityContext:
  runAsUser: 1000
  runAsNonRoot: true
  readOnlyRootFilesystem: true
  allowPrivilegeEscalation: false
```

- Il ne tourne pas avec un identifiant privilégié ni le compte root
- Il s'appuie sur des filesystems en lecture seule

Il est possible d'affecter :

- un utilisateur non privilégié
- un groupe non privilégié au pod.
- un groupe de filesystem défini

Extrait de manifests/complete-postgres-manifest.yaml :

```
spiloRunAsUser: 101  
spiloRunAsGroup: 103  
spiloFSGroup: 103
```


Le lien suivant décrit l'installation d'ArgoCD :

<https://argo-cd.readthedocs.io/en/stable/#quick-start>

```
kubectl create namespace argocd
```

```
kubectl apply -n argocd -f https://raw.githubusercontent.com/argoproj/argo-cd/stable/manifests/install.yaml
```

Le lien suivant décrit l'installation de la CLI ArgoCD :

https://argo-cd.readthedocs.io/en/stable/cli_installation/#download

```
curl -sSL -o argocd-linux-amd64 https://github.com/argoproj/argo-cd/releases/latest/download/argocd-linux-amd64  
sudo install -m 555 argocd-linux-amd64 /usr/local/bin/argocd  
rm argocd-linux-amd64
```

Activation de l'accès au serveur d'API d'ArgoCD

Le lien suivant décrit les différentes méthodes d'accès au serveur d'API d'ArgoCD :

https://argo-cd.readthedocs.io/en/stable/getting_started/#3-access

```
$ kubectl patch svc argocd-server -n argocd -p '{"spec": {"type": "LoadBalancer"}}'  
service/argocd-server patched
```

Build de l'image Docker Spilo

Le Dockerfile définissant l'image Spilo est disponible à l'URL suivante :

<https://github.com/zalando/spilo>

La méthode de génération de l'image est décrite dans :

<https://github.com/zalando/spilo#how-to-build-this-docker-image>

```
$:~/spilo/postgres-appliance$ docker build --tag dnum-test .  
[+] Building 9762.1s (33/33) FINISHED  
=> [internal] load build definition from Dockerfile  
=> => transferring dockerfile: 3.01kB  
=> [internal] load .dockerignore  
=> => transferring context: 2B  
...  
=> => exporting layers  
=> => writing image sha256:52afd69aff9414333220ec408283a8ff20e2162e703c6ab5afd5090d9d62e4e0  
=> => naming to docker.io/library/dnum-test
```

Le build dure un peu moins de **2h43min**.

La commande suivante permet de récupérer le mot de passe initial de l'admin d'ArgoCD :

```
linagora@debian-cp:~$ argocd admin initial-password -n argocd
*****
```

This password must be only used for first time login. We strongly recommend you update the password using 'argocd acco

Login avec la CLI d'ArgoCD

```
$ kubectl get svc -n argocd
```

NAME	TYPE	CLUSTER-IP	EXTERNAL-IP	PORT(S)	ADDRESS
argocd-applicationset-controller	ClusterIP	10.109.27.242	<none>	7000/TCP, 8080/TCP	60
argocd-dex-server	ClusterIP	10.100.63.110	<none>	5556/TCP, 5557/TCP, 5558/TCP	60
argocd-metrics	ClusterIP	10.102.19.237	<none>	8082/TCP	60
argocd-notifications-controller-metrics	ClusterIP	10.102.70.229	<none>	9001/TCP	60
argocd-redis	ClusterIP	10.104.253.209	<none>	6379/TCP	60
argocd-repo-server	ClusterIP	10.111.28.234	<none>	8081/TCP, 8084/TCP	60
argocd-server	LoadBalancer	10.109.47.144	<pending>	80:30235/TCP, 443:30885/TCP	60
argocd-server-metrics	ClusterIP	10.98.167.31	<none>	8083/TCP	60

```
linagora@debian-cp:~$ argocd login 10.109.47.144
```

```
WARNING: server certificate had error: x509: cannot validate certificate for 10.109.47.144 because it doesn't contain a
```

```
Username: admin
```

```
Password:
```

```
'admin:login' logged in successfully
```

```
Context '10.109.47.144' updated
```

Ajout de l'application postgres-operator dans ArgoCD

- ArgoCD se met à l'écoute des changements d'un projet de déploiement dans un dépôt.
- L'étape suivante "abonne" ArgoCD au dépôt Github sur lequel est enregistré le déploiement de l'opérateur postgres
- La commande qui lie ArgoCD au dépôt de l'opérateur est la suivante :

```
argocd app create postgres-operator \  
--repo https://github.com/simoneibaz/postgres-operator.git \  
--path manifests \  
--dest-server https://kubernetes.default.svc \  
--revision poc-argocd \  
--dest-namespace default
```

- Cette commande est décrite en détail dans la documentation officielle :
<https://argo-cd.readthedocs.io/en/stable/user-guide/commands/>
- Pour information, le dépôt ci-dessus est un fork du dépôt officiel
- L'ensemble des modifications réalisées pour le POC sont tracées dans la branche *poc-argocd*

Ajout de l'application postgres-operator dans ArgoCD

- Pour vérifier que l'application a correctement été ajoutée dans ArgoCD :

```
$ argocd app list
```

NAME	CLUSTER	NAMESPACE	PROJECT	STATUS	HEALTH	SYNCPOLICY	CONDITION
argocd/postgres-operator	https://kubernetes.default.svc	default	default	Unknown	Healthy	<none>	Completed

- Selon le lien suivant

https://argo-cd.readthedocs.io/en/stable/user-guide/tool_detection/

le script kustomization.yaml est automatiquement détecté par ArgoCD

- ArgoCD est capable de s'interfacer avec Kustomize <https://kustomize.io/>.
- Zalando met à disposition un script Yaml **manifests/kustomization.yaml**

```
$ cat kustomization.yaml
apiVersion: kustomize.config.k8s.io/v1beta1
kind: Kustomization
resources:
- configmap.yaml
- operator-service-account-rbac.yaml
- postgres-operator.yaml
- api-service.yaml
```

- Ce dernier facilite le déploiement de l'opérateur dans l'environnement k8s
- Une page synthétisant l'utilisation de Kustomize est disponible à l'URL suivante :
<https://kubect1.docs.kubernetes.io/guides/introduction/kustomi>

- Le lien suivant décrit l'intégration d'un outil de CI/CD et ArgoCD.

`https://argo-cd.readthedocs.io/en/stable/user-guide/ci_automat`

- Globalement la mise à jour d'un cluster k8s par l'intermédiaire d'ArgoCD se déroule en 2 phases :
 - récupération du dépôt git
 - la phase de patch
 - la phase de sync

- La 1^{re} étape de la phase de patch est de récupérer le dépôt du projet :

```
git clone https://github.com/simonelbaz/postgres-operator.git  
cd postgres-operator
```

- Il devient possible de patcher avec la commande **kustomize** ou la commande **kubectl**
 - Patch avec kustomize (nécessite l'installation de kustomize) :

- L'URL suivante décrit l'installation de kustomize :

`https://kubectldocs.kubernetes.io/installation/kustomize/bin`

- Pour installer kustomize, merci de lancer la commande suivante :

```
curl -s "https://raw.githubusercontent.com/kubernetes-sigs/kustomize/master/hack/install_kustomize.sh" | bash
```

- kustomize peut servir à l'édition de kustomization.yaml.
- Dans le cadre du POC, cela n'a pas été nécessaire

Phase de patch avec kubectl

- On liste dans un 1^{er} temps l'ensemble des ConfigMaps :

```
$ kubectl get configmaps
NAME                DATA   AGE
kube-root-ca.crt    1       98d
postgres-operator   59      97d
```

- Pour lister la ConfigMap qui définit l'image **spilo** déployée :

```
$ kubectl get configmap postgres-operator -o yaml
apiVersion: v1
data:
  api_port: "8080"
...
  docker_image: ghcr.io/zalando/spilo-15:2.1-p9
...
kind: ConfigMap
metadata:
  creationTimestamp: "2023-03-16T22:20:28Z"
  name: postgres-operator
  namespace: default
...
```

La version de l'image spilo est modifiée :

```
kubectl patch --local -f configmap.yaml -p '"data":{"docker_image":"ghcr.io/zalando/spilo-15:3.0-p1"}' -o yaml > configmap.yaml.new  
mv configmap.yaml.new configmap.yaml
```

- Une fois la modification réalisée, il est nécessaire de la pusher vers le dépôt sur lequel se synchronise ArgoCD

```
git add . -m "Mise à jour de l'image"  
git push
```

- Lancer ensuite les commandes suivantes dans le pipeline de la CI :

```
export ARGOCD_SERVER=argocd.mycompany.com  
export ARGOCD_AUTH_TOKEN=<JWT token generated from project>  
curl -sSL -o /usr/local/bin/argocd https://$ARGOCD_SERVER/download/argocd-linux-amd64  
argocd app sync nom application  
argocd app wait nom application
```

ArgoCD - Etat du cluster avant le lancement du sync

```
$ git log | head -1
commit 90ad8c7aed92c6430bcb36ab23228a2d57c2715d
$ argocd app get argocd/postgres-operator
Name:          argocd/postgres-operator
Project:       default
Server:        https://kubernetes.default.svc
Namespace:     default
URL:           https://10.109.47.144/applications/postgres-operator
Repo:          https://github.com/simonelbaz/postgres-operator.git
Target:        poc-argocd
Path:          manifests
SyncWindow:    Sync Allowed
Sync Policy:   <none>
Sync Status:   OutOfSync from poc-argocd (90ad8c7)
Health Status: Healthy
```

GROUP	KIND	NAMESPACE	NAME	STATUS	HEALTH	HOOK	MESSAGE
	ConfigMap	default	postgres-operator	OutOfSync			
	Service	default	postgres-operator	OutOfSync	Healthy		
	ServiceAccount	default	postgres-operator	OutOfSync			
acid.zalan.do	postgresql	default	acid-test-cluster	OutOfSync			
apps	Deployment	default	postgres-operator	OutOfSync	Healthy		
rbac.authorization.k8s.io	ClusterRole		postgres-operator	OutOfSync			
rbac.authorization.k8s.io	ClusterRole		postgres-pod	OutOfSync			
rbac.authorization.k8s.io	ClusterRoleBinding		postgres-operator	OutOfSync			

- L'information renvoyée par la commande **argocd get** est cohérente.
- Il y a bien un décalage entre l'état du cluster et le dernier commit de la branche poc-argocd
- Vérification de la version de l'image spilo déployée :

```
$ kubectl describe pod acid-test-cluster-1 | grep spilo
Labels:          application=spilo
Image:           ghcr.io/zalando/spilo-15:2.1-p9
KUBERNETES_ROLE_LABEL:    spilo-role
KUBERNETES_LABELS:        "application":"spilo"
```

ArgoCD - Lancement de la synchronisation

```
$ argocd app sync postgres-operator
TIMESTAMP      GROUP              KIND              NAMESPACE      NAME              STATUS      HEALTH      HOOK  MESSAGE
2023-06-23T16:49:22+02:00  rbac.authorization.k8s.io  ClusterRoleBinding  default         postgres-operator  OutOfSync
2023-06-23T16:49:22+02:00  ConfigMap           default         postgres-operator  OutOfSync
2023-06-23T16:49:22+02:00  Service             default         postgres-operator  OutOfSync  Healthy
2023-06-23T16:49:22+02:00  ServiceAccount      default         postgres-operator  OutOfSync
2023-06-23T16:49:22+02:00  postgresql          default         acid-test-cluster  OutOfSync
2023-06-23T16:49:22+02:00  apps                deployment        default           postgres-operator  OutOfSync  Healthy
2023-06-23T16:49:22+02:00  rbac.authorization.k8s.io  ClusterRole      postgres-operator  OutOfSync
2023-06-23T16:49:22+02:00  rbac.authorization.k8s.io  ClusterRole      postgres-operator  OutOfSync
2023-06-23T16:49:22+02:00  ServiceAccount      default         postgres-operator  Synced
2023-06-23T16:49:22+02:00  ConfigMap           default         postgres-operator  Synced
2023-06-23T16:49:22+02:00  rbac.authorization.k8s.io  ClusterRole      postgres-operator  Synced
2023-06-23T16:49:22+02:00  rbac.authorization.k8s.io  ClusterRole      postgres-operator  Synced
2023-06-23T16:49:22+02:00  rbac.authorization.k8s.io  ClusterRoleBinding  postgres-operator  Synced
2023-06-23T16:49:22+02:00  Service             default         postgres-operator  Synced  Healthy
2023-06-23T16:49:22+02:00  apps                deployment        default           postgres-operator  Synced  Progressing
2023-06-23T16:50:00+02:00  acid.zalan.do        postgresql        default         acid-test-cluster  OutOfSync
figured. Warning: resource postgresql/acid-test-cluster is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on
resources created declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
2023-06-23T16:50:01+02:00  ConfigMap           default         postgres-operator  Synced
g: resource configmaps/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources creat
ed declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
2023-06-23T16:50:01+02:00  rbac.authorization.k8s.io  ClusterRole      default         postgres-operator  Running  Synced
-rpod reconciled. reconciliation required update. clusterrole.rbac.authorization.k8s.io/postgres-operator configured. Warning: resource clusterroles/postgres-operator is missing the kube
.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively by either create --save-config or apply. The missing ann
otation will be patched automatically.
2023-06-23T16:50:01+02:00  rbac.authorization.k8s.io  ClusterRole      default         postgres-operator  Running  Synced
-operator reconciled. reconciliation required update. clusterrole.rbac.authorization.k8s.io/postgres-operator configured. Warning: resource clusterroles/postgres-operator is missing the kube
ctl.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively by either create --save-config or apply.
The missing annotation will be patched automatically.
2023-06-23T16:50:01+02:00  rbac.authorization.k8s.io  ClusterRoleBinding  default         postgres-operator  Running  Synced
ostgres-operator reconciled. reconciliation required update. clusterrolebinding.rbac.authorization.k8s.io/postgres-operator configured. Warning: resource clusterrolebindings/postgres-operato
r is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively by either create --sa
ve-config or apply. The missing annotation will be patched automatically.
2023-06-23T16:50:01+02:00  ServiceAccount      default         postgres-operator  Synced
arning: resource serviceaccounts/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resou
rces created declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
2023-06-23T16:50:01+02:00  Service             default         postgres-operator  Synced  Healthy
resource services/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created d
eclaratively by either create --save-config or apply. The missing annotation will be patched automatically.
2023-06-23T16:50:01+02:00  apps                deployment        default         postgres-operator  Synced  Progressing
Warning: resource deployments/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resource
s created declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
2023-06-23T16:50:02+02:00  apps                deployment        default         postgres-operator  Synced  Healthy
ents/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively b
y either create --save-config or apply. The missing annotation will be patched automatically.
2023-06-23T16:50:02+02:00  acid.zalan.do        postgresql        default         acid-test-cluster  Synced
e postgresql/acid-test-cluster is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declar
atively by either create --save-config or apply. The missing annotation will be patched automatically.
...
```

ArgoCD - Lancement de la synchronisation

```
Name: argocd/postgres-operator
Project: default
Server: https://kubernetes.default.svc
Namespace: default
URL: https://10.109.47.144/applications/postgres-operator
Repo: https://github.com/simonelbaz/postgres-operator.git
Target: poc-argocd
Path: manifests
SyncWindow: Sync Allowed
Sync Policy: <none>
Sync Status: Synced to poc-argocd (90ad8c7)
Health Status: Healthy
```

```
Operation: Sync
Sync Revision: 90ad8c7aed92c6430bcb36ab23228a2d57c2715d
Phase: Succeeded
Start: 2023-06-23 16:49:21 +0200 CEST
Finished: 2023-06-23 16:50:00 +0200 CEST
Duration: 39s
Message: successfully synced (all tasks run)
```

GROUP	KIND	MESSAGE	NAME	STATUS	HEALTH	BOOK	MESSAGE
operator	ServiceAccount	default	postgres-operator	Synched			serviceaccount/postgres-operator configured. Warning: resource serviceaccounts/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
	ConfigMap	default	postgres-operator	Synched			configmap/postgres-operator configured. Warning: resource configmaps/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
rbac.authorization.k8s.io	ClusterRole	default	postgres-pod	Running	Synched		clusterrole.rbac.authorization.k8s.io/postgres-pod reconciled. reconciliation required update. clusterrole.rbac.authorization.k8s.io/postgres-operator configured. Warning: resource clusterroles/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
rbac.authorization.k8s.io	ClusterRoleBinding	default	postgres-operator	Running	Synched		clusterrolebinding.rbac.authorization.k8s.io/postgres-operator reconciled. reconciliation required update. clusterrolebinding.rbac.authorization.k8s.io/postgres-operator configured. Warning: resource clusterrolebindings/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
	Service	default	postgres-operator	Synched	Healthy		service/postgres-operator configured. Warning: resource services/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
apps	Deployment	default	postgres-operator	Synched	Healthy		deployment.apps/postgres-operator configured. Warning: resource deployments/postgres-operator is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
acid.zalan.do	PostgreSQL	default	acid-test-cluster	Synched			postgresql.acid.zalan.do/acid-test-cluster configured. Warning: resource postgresqls/acid-test-cluster is missing the kubect1.kubernetes.io/last-applied-configuration annotation which is required by apply. apply should only be used on resources created declaratively by either create --save-config or apply. The missing annotation will be patched automatically.
rbac.authorization.k8s.io	ClusterRole		postgres-operator	Synched			
rbac.authorization.k8s.io	ClusterRole		postgres-pod	Synched			
rbac.authorization.k8s.io	ClusterRoleBinding		postgres-operator	Synched			

Installation d'argo-rollouts

```
$ kubectl create namespace argo-rollouts
namespace/argo-rollouts created
$ kubectl apply -n argo-rollouts -f https://github.com/argoproj/argo-rollouts/releases/latest/download/install.yaml
customresourcedefinition.apiextensions.k8s.io/analysisruns.argoproj.io created
customresourcedefinition.apiextensions.k8s.io/analysistemplates.argoproj.io created
customresourcedefinition.apiextensions.k8s.io/clusteranalysistemplates.argoproj.io created
customresourcedefinition.apiextensions.k8s.io/experiments.argoproj.io created
customresourcedefinition.apiextensions.k8s.io/rollouts.argoproj.io created
serviceaccount/argo-rollouts created
clusterrole.rbac.authorization.k8s.io/argo-rollouts created
clusterrole.rbac.authorization.k8s.io/argo-rollouts-aggregate-to-admin created
clusterrole.rbac.authorization.k8s.io/argo-rollouts-aggregate-to-edit created
clusterrole.rbac.authorization.k8s.io/argo-rollouts-aggregate-to-view created
clusterrolebinding.rbac.authorization.k8s.io/argo-rollouts created
configmap/argo-rollouts-config created
secret/argo-rollouts-notification-secret created
service/argo-rollouts-metrics created
deployment.apps/argo-rollouts created
```

L'opérateur PostgreSQL met en place des réplicats set :

```
$ kubectl get rs
```

NAME	DESIRED	CURRENT	READY	AGE
postgres-operator-fcbd7cc96	1	1	1	101d
postgres-operator-ui-5579cc7779	1	1	1	101d

Détail des réplicasets

La commande suivante permet d'obtenir plus d'informations sur le réplicatset **postgres-operator** :

```
$ kubectl describe rs/postgres-operator-fcbd7cc96
Name:                postgres-operator-fcbd7cc96
Namespace:           default
Selector:             name=postgres-operator,pod-template-hash=fcbd7cc96
Labels:              name=postgres-operator
                    pod-template-hash=fcbd7cc96
Annotations:         deployment.kubernetes.io/desired-replicas: 1
                    deployment.kubernetes.io/max-replicas: 1
                    deployment.kubernetes.io/revision: 1
Controlled By:       Deployment/postgres-operator
Replicas:            1 current / 1 desired
Pods Status:        1 Running / 0 Waiting / 0 Succeeded / 0 Failed
Pod Template:
  Labels:             name=postgres-operator
                    pod-template-hash=fcbd7cc96
  Service Account:    postgres-operator
  Containers:
    postgres-operator:
      Image:           registry.opensource.zalan.do/acid/postgres-operator:v1.9.0
      Port:            <none>
      Host Port:       <none>
      Limits:
        cpu:           500m
        memory:        500Mi
      Requests:
        cpu:           100m
        memory:        250Mi
      Environment:
        CONFIG_MAP_NAME: postgres-operator
      Mounts:          <none>
      Volumes:         <none>
  Events:             <none>
```

WIP

WIP

WIP

WIP

WIP

WIP (Prometheus)

Bibliographie

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