PostgreSQL

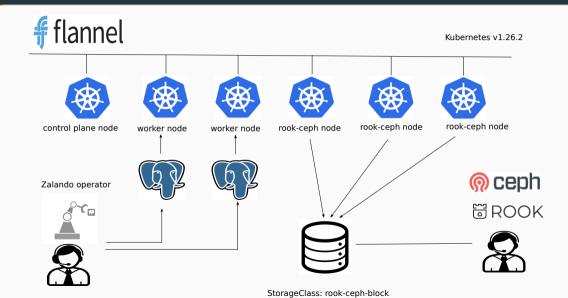
Déploiement de l'opérateur PostgreSQL

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Installation

Architecture



Versions utilisées

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

Dimensionnement des serveurs

Dimensionnement du control plane :

- 8 CPU
- 8 Go RAM

Dimensionnement des workers :

- 2 CPU
- 2 Go RAM

Prérequis matériels

- etcd est la base de données clé-valuers 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

Déploiement du nœud control plane

- 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/sdal 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
```

Installation du runtine container containerd

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

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

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

 $sudo \ curl \ -fsSLo \ /etc/apt/keyrings/kubernetes-archive-keyring.gpg \ https://packages.cloud.google.com/apt/doc/apt-key.gpg \\ echo \ "deb \ [signed-by=/etc/apt/keyrings/kubernetes-archive-keyring.gpg] \ https://apt.kubernetes.io/ kubernetes-xenial main" | \ sudo tee /etc/apt/sources.list.d/kubernetes.list$

```
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
```

Paramétrage de containerd

Génération du paramétrage par défaut de containerd :

 $\verb|root@debian-cp:~\#| containerd config| \textbf{default} | \texttt{dump}| > /\texttt{etc/containerd/config.toml.dmp}|$

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

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

Paramétrage de containerd

Remplacer le paramétrage actuel par le paramétrage modifié :

```
\label{lem:contined} $$\operatorname{rootdebian-cp:^\# cp /etc/containerd/config.toml /etc/containerd/config.toml.bak rootdebian-cp:^\# cat /etc/containerd/config.toml.dmp > /etc/containerd/config.toml rootdebian-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 :

```
10315-01:06:38.342010-34405 kubeletfinalize go:1341 [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 -a) $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].vaml" with one of the options listed at :
https://kubernetes.jo/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.n6u8pbm7vi16nnr8 \
         --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.n6u8pbm7vj16nnr8 \
         --discovery-token-ca-cert-hash sha256:f6d45602ea75c7659dc91f661d19e97e6817e2847e4e5d0047880b871317a145
```

Paramétrage de kubectl

L'utilisation de kubectl nécessite l'action suivante :

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

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

Choix de la couche réseau - Container Network Interface

Il existe différentes addons Kubernetes implémentant l'interface CNI.

Ces addons sont listés dans l'URL suivante :

https://kubernetes.io/docs/concepts/cluster-administration/addons/ Pour le POC, l'addon sélectionné est Flannel car il semble être le plus simple et le plus

basique des addons CNI.

Déploiement de l'addon Flannel

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

Installation de k9s

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 :

 $\verb|https://github.com/derailed/k9s/releases/download/v0.27.3/k9s_Linux_|$

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
```



Pods du namespace default

```
linagora@debian-cp:~$ kubectl get pods
NAME
                                        READY
                                                STATUS
                                                          RESTARTS
                                                                     AGE
acid-test-cluster-0
                                        1/1
                                                Running
                                                                     27d
acid-test-cluster-1
                                        1/1
                                                Running
                                                                      27d
postgres-operator-fcbd7cc96-ndpj8
                                        1/1
                                                Running
                                                                     40d
postgres-operator-ui-5579cc7779-86rgk
                                        1/1
                                                Running
                                                                      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



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
kube-flannel-ds-5xwsm
                        1/1
                                Running
                                                         40d
kube-flannel-ds-8vkg9
                        1/1
                                Running
                                          1 (33d ago)
                                                         40d
kube-flannel-ds-pv6ss
                        1/1
                                Running
                                                         27d
kube-flannel-ds-trbz9
                        1/1
                                Running
kube-flannel-ds-wmzz2
                        1/1
                                Running
```



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-mddkf	2/2	Running	0	33d
csi-cephfsplugin-nrmfz	2/2	Running	0	33d
csi-cephfsplugin-provisioner-84cc595b78-9mm14	5/5	Running	6008 (2m44s ago)	33d
csi-cephfsplugin-provisioner-84cc595b78-9twnq	5/5	Running	2171	33d
csi-rbdplugin-92zlq	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-n5xsz	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-wz8sq	2/2	Running	1755	33d
rook-ceph-operator-cf4f7dfd4-6tm6p	1/1	Running	0	32d
rook-ceph-osd-0-57d9b8db4d-d6dhr	1/2	CreateContainerError	484	32d
rook-ceph-osd-1-74698f77fd-6n2mh	1/2	Running	529	32d
rook-ceph-osd-2-5cc486467c-1hm47	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



Déploiement du nœud worker

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

- le runtime containerd de Docker
- les commandes kubectl, 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 10.10.10.301.6443 \
   --token ilfbgc.8xco4svm5pnxkfbj \
   --discovery-token-ca-cert-hash sha256:73bf45619ae0051d4ff810328d1dadc18e6a5966c95d3c4ec76275b89a934595
```

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/vlalphal config is loaded. Continuin
[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.

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.

Déploiement du stockage - Rook Ceph

- 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 formattés)
 - des partitions brutes (sans filesystems formattés)
 - 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
                          ESTYPE
                                       LABEL UUITD
                                                                                     MOUNTPOINT
    vda
    I-vda1
                          LVM2 member
                                             >eSO50t-GkUV-YKTH-WsGg-hNJY-eKNf-3i07IB
    |-ubuntu--vg-root
                         ext 4
                                            c2366f76-6e21-4f10-a8f3-6776212e2fe4
                                            9492a3dc-ad75-47cd-9596-678e8cf17ff9
    I-ubuntu--vg-swap 1 swap
                                                                                    [SWAP]
    vdb
```

Prérequis au déploiement de l'opérateur - Rook Ceph

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

Paramétrage pour la répartition du stockage Ceph sur les nœuds labelisés

```
diff --git a/deploy/examples/cluster.vaml b/deploy/examples/cluster.vaml
index 9bd50ec97..fef3f777f 100644
--- a/denlov/evamnles/cluster vaml
+++ h/denlow/evamples/cluster vaml
88 -154,22 +154,22 88 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'
- # nlacement:
- # all:
         nodeAffinity:
              - key: role
                operator: In
                - storage-node
         podAffinity:
         podAntiAffinity:
         topologySpreadConstraints:
         - kev: storage-node
+ placement;
           nodeSelectorTerms:
           - matchExpressions:
           - kev: role
              operator: In
               values:
              - storage-node
      nodaffinity:
      podAntiAffinity:
      topologySpreadConstraints:
      - key: storage-node
         operator: Exists
   # The above placement information can also be specified for mon. osd, and mor components
   # 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

cal - htdpluid-provisioner - 6f6b6b8cd-gw6bm 1/5 CreateContaineTErro 465 69d cal - htdpluid-nertfs 2/2 Running 0 69d cal - htdpluid-nertfg 2/2 Running 0 69d cook-ceph-crashcollector-dnumcephworker1-7845b8ff-wa9fx 1/1 Pending 0 4d10 rook-ceph-crashcollector-dnumcephworker2-75cdf95dcd-13cd 1/1 Terrainting 0 69d rook-ceph-arashcollector-dnumcephworker2-75cdf95dcd-n3cd 1/1 Terrainting 2 69d rook-ceph-arashcollector-dnumcephworker2-75cdf95dcd-n3cd 1/1 Running 1 69d rook-ceph-arashcollector-dnumcephworker2-75cdf95dcd-n4sb 1/1 Running 1 69d rook-ceph-aras-acd5b8dff-fpg7s 2/2 CrashcopBackoff 146 (28d apc) 3dd rook-ceph-aras-acd5b8dff-frups9 2/3 Terninating 150d (31d apc) 69d rook-ceph-aras-bc-5bdffedbe-bdyg 2/2 Running 1500 (31d apc) 69d rook-ceph-arc-6bdcodfc-b2jgc 2/2 Running 1500 (31d apc) 69d </th <th></th> <th></th> <th></th> <th></th> <th></th>					
cai-cephfaplugin-bpklw 2/2 Running 0 69d cai-cephfaplugin-indx8 2/2 Running 0 69d cai-cephfaplugin-mdx8 2/2 Running 0 69d ci-cephfaplugin-motors 2/2 Running 652 28d ago 69d ci-cephfaplugin-provisioner-84cc59b78-9ml4 5/5 Running 652 28d ago 69d ci-cephfaplugin-provisioner-84cc59b78-9ml4 5/5 Running 0 69d ci-chplugin-952ml 2/2 Running 1 63d ago 69d ci-chplugin-provisioner-6f6b88d6-4c8jd 5/5 Terminating 1 (3d ago) 69d ci-chplugin-provisioner-6f6b88d6-4c8jd 5/5 Terminating 1 (3d ago) 69d ci-chplugin-provisioner-6f6b88d6-4c8jd 5/5 Terminating 1 (3d ago) 69d ci-chplugin-provisioner-6f6b88d6-4c9bd 1/5 CreateContaineError 40c 64d ci-chplugin-provisioner-6f6b88d6-4c9bd 1/5 Running 0 60d 64d 64d 64d-1-chplugin	NAME	READY	STATUS	RESTARTS	AGE
cai-cephfaplugin-jdx8 2/2 Running 0 69d cai-cephfaplugin-mdxf 2/2 Running 0 69d cai-cephfaplugin-mcmfx 2/2 Running 0 69d ci-cephfaplugin-provisioner-84cc595b78-9ml4 5/5 Running 398 (30d ago) 69d ci-cephfaplugin-provisioner-84cc595b78-9twnq 2/2 Running 0 69d ci-rhdplugin-provisioner-8fc6b6b8cd 2/2 Running 0 69d ci-rhdplugin-provisioner-6fc6b6b8cd6-4ct3d 5/5 Terminating 2919 (29d ago) 60d ci-rhdplugin-provisioner-6fc6b6b8cd6-4ct5d 5/5 Terminating 2919 (29d ago) 60d ci-rhdplugin-provisioner-6fc6b6b8cd6-4ct5d 5/5 Terminating 2919 (29d ago) 60d ci-rhdplugin-provisioner-6fc6b6b8cd6-4ct5d 1/5 Pending 2919 (29d ago) 60d ci-rhdplugin-provisioner-6fc6b6b8cd6-4ct5d 1/5 Running 0 60d ci-rhdplugin-provisioner-6fc6b6b8cd6-4ct5d 1/7 Running 0 60d ci-rhdplugin-provisioner-6fc6b6b8			Running	1 (63d ago)	
cai-cephfaplugin-mdakf 2/2 Running 0 69d cai-cephfaplugin-mrmfa 2/2 Running 652 (28d ag) 69d cai-cephfaplugin-provisioner-84cc59b78-9ml 5/5 Running 652 (28d ag) 69d ci-cephfaplugin-provisioner-84cc59b78-9ml 5/5 Running 0 69d ci-cephfaplugin-provisioner-84cc59b78-9twq 2/2 Running 1 (3d ag) 69d ci-r-chplugin-pS78 2/2 Running 1 (3d ag) 63d ci-r-chplugin-pF0vfsioner-6f6b88cd6-de5jd 5/5 Ferninating 19 (3d ag) 60d ci-r-chplugin-provisioner-6f6b88cd6-de5jd 5/5 Ferninating 10 (3d ag) 60d ci-r-chplugin-provisioner-6f6b88cd6-de5jd 1/5 Ferninating 10 (3d ag) 60d ci-r-chplugin-provisioner-6f6b88cd6-de5jd 1/5 Running 60 60d ci-r-chplugin-provisioner-6f6b88cd6-de5jd 1/5 Running 60 60d ci-r-chplugin-provisioner-6f6b88cd6-de5jd 1/5 Running 60 60d ci-r-chplugin-provisioner-6f6b88cd	csi-cephfsplugin-bpxlw	2/2	Running	0	69d
cai-ephfaplugin-mrff 2/2 Running 0 69 cai-cephfaplugin-provisioner-84cc595b78-9ml4 5/5 Running 3908 (30d ago) 69d cai-cephfaplugin-provisioner-84cc595b78-9ml4 5/5 Running 3908 (30d ago) 69d cai-rhchglugin-povisioner-8fcb6b8cd 2/2 Running 0 69d cai-rhchglugin-p857s 2/2 Running 10 (30 ago) 69d cai-rhchglugin-provisioner-6f6b6b8cd-6de15d 5/5 Terninating 2919 (29d ago) 69d cai-rhchglugin-provisioner-6f6b6b8cd-6de15d 1/5 CreateContainerError 465 69d cai-rhchglugin-provisioner-6f6b6b8cd-4de15d 1/5 CreateContainerError 465 69d cai-rhchglugin-provisioner-6f6b6b8cd-4de5d 1/5 Runding 0 69d cai-rhchglugin-provisioner-6f6b6b8cd-4de5d 2/2 Runding 0 69d cai-rhchglugin-provisioner-6f6b6b8cd-4de5d 2/2 Runding 0 69d cai-rhchglugin-provisioner-6f6bb8cd-4de5de2 2/2 Runding 0 69d cai-	csi-cephfsplugin-jd5x8	2/2	Running	0	69d
cai-caphfaplugin-provisioner-84cc595b78-9mal4 5/5 Running 6523 (28d ago) 69d cai-caphfaplugin-provisioner-84cc595b78-9twnq 5/5 Running 308 (30d ago) 69d cai-caphfaplugin-provisioner-84cc595b78-9twnq 2/2 Running 0 69d cai-rhchplugin-pSy3 2/2 Running 1 (5d ago) 69d cai-rhchplugin-pFovisioner-6f6bb8ed6-4c8jd 5/5 Feminating 219 (29d ago) 60d cai-rhchplugin-provisioner-6f6bb8ed6-4c8jd 1/5 CreateContainerError 465 60d ci-rhchplugin-provisioner-6f6bb8ed6-4c96bm 1/5 CreateContainerError 465 60d ci-rhchplugin-provisioner-6f6bb8ed6-4c96bm 1/5 Running 0 60d ci-rhchplugin-provisioner-6f6bb8ed6-4c96bm 1/5 Running 0 60d ci-rhchplugin-provisioner-6f6bb8ed6-4c96bm 1/5 Running 0 60 ci-rhchplugin-browlead 2/2 Running 0 60 ci-rhchplugin-browlead 2/2 Running 0 60 ci-rhchplugin-browlea	csi-cephfsplugin-mddkf	2/2	Running	0	69d
cai-ephfaplugin-provisioner-84c595b78-9twnq 5/5 Running 390 (304 ag) 69d cai-rhdplugin-92tiq 2/2 Running 0 69d cai-rhdplugin-p857s 2/2 Running 0 60d cai-rhdplugin-p857s 2/2 Running 1 (3d ago) 69d cai-rhdplugin-provisioner-6f6b8b8cd6-4c9jd 5/5 Terninating 291 (29d ago) 69d cai-rhdplugin-provisioner-6f6b8b8cd6-4c9tbm 1/5 CreateContainerError 465 69d cai-rhdplugin-provisioner-6f6b8b8cd6-qwbm 1/5 Running 0 69d cai-rhdplugin-provisioner-6f6b8b8cd6-qwbm 1/5 Running 0 69d cai-rhdplugin-provisioner-6f6b8b8cd6-qwbm 1/2 Running 0 69d cai-rhdplugin-provisioner-6f6b8b8cd6-qwbm 1/2 Running 0 69d cai-rhdplugin-provisioner-6f6b8b8cd6-qwbm 1/2 Running 0 69d cai-rhdplugin-provisioner-6f6b8cd6-qwbm 1/2 Running 0 69d cai-rhdplugin-provisioner-6f6b8cd6-qwbm 1/2	csi-cephfsplugin-nrmfz	2/2	Running	0	69d
cai - hopluyin-921q 2/2 Running 0 69d cai - hopluyin-059W 2/2 Running 1 (5d ago) 69d cai - hopluyin-pK97s 2/2 Running 1 (5d ago) 69d cai - hopluyin-pF0v1sioner-6f6bb86d6-4c8jd 5/5 Foreiniating 2919 (29d ago) 60d cai - hopluyin-pF0v1sioner-6f6bb86d6-4c4b56 1/5 Pending 0 60d ci - hopluyin-pF0v1sioner-6f6bb86d6-4c4b66 1/5 CreateContainerErro 465 69d ci - hopluyin-ertris 2/2 Running 0 69d cob-ceph-erashoollector-d-muscephworker2-75cdf95dcd-1yd 1/1 Running 0 69d cob-ceph-erash	csi-cephfsplugin-provisioner-84cc595b78-9mm14	5/5	Running	6523 (28d ago)	69d
cal-hcplugin-098w 2/2 Running 0 69 cal-hcplugin-p68/Ts 2/2 Running 1 (3 dag) 64 cal-hcplugin-pcv4:ioner-6f6bb8cd6-409d 5/5 Terminating 2919 (29d ago) 69d cal-hcplugin-provisioner-6f6bb8cd6-q96bm 1/5 CreatContainerErro 465 69d cal-hcplugin-ertfs 2/2 Running 0 69d cal-hcplugin-ertfs 2/2 Running 0 69d cook-eaph-crashcollector-dunuscephworker1-7845b8ff-waffx 1/1 Running 0 68d rook-eaph-crashcollector-dunuscephworker2-75cdf95dcd-13vq 1/1 Pending 0 69d rook-eaph-crashcollector-dunuscephworker2-75cdf95dcd-13vq 1/1 Pending 0 69d rook-eaph-ara-acdo5b8dfr-fpg7s 2/3 CreathcoBackoff 146 (28d ago) 69d rook-eaph-aga-acdo5b8dfr-fyp9s 2/3 Terninating 146 (28d ago) 30d rook-eaph-aga-acdo5b8dfr-fyp9s 2/3 Terninating 146 (28d ago) 30d rook-eaph-aga-b-Tobfd8cb-Jdg6p 2	csi-cephfsplugin-provisioner-84cc595b78-9twnq	5/5	Running	3908 (30d ago)	69d
cai-r-bqluqin-pK57a 2/2 Running 1 (5d ago) 63 cai-r-bqluqin-provisioner-eff6bb8ede-det5d 5/5 Foreiniating 2919 (294 ago) 64 cai-r-bqluqin-provisioner-eff6bb8ede-q46ba 1/5 Pending 0 640 ci-r-bqluqin-provisioner-eff6bb8ede-q46ba 1/5 CreateContaineError 465 69d ci-r-bqluqin-ertfz 2/2 Running 0 69d ci-r-bqluqin-ertfz 2/2 Running 0 69d rook-eeph-crashcollector-d-muscephworkerl-78df9b6d-1ydg 1/1 Running 0 68d rook-eeph-crashcollector-d-muscephworkerl-78df9b6d-1ydg 1/1 Pending 0 69d rook-eeph-erashcollector-d-muscephworkerl-78df9b6d-1ydg 1/1 Terninating 0 69d rook-eeph-erashcollector-d-muscephworkerl-78df9b6d-1ydg 1/1 Terninating 0 69d rook-eeph-erashcollector-d-muscephworkerl-78df9b6d-4ydg 1/1 Terninating 0 69d rook-eeph-eras-a-dsb8dff-fypp?a 2/3 CrashcopBacoff 16 (28d ag) 30d	csi-rbdplugin-92zlq	2/2	Running	0	69d
cal - htdplujn-provisioner - offobbedde-debid 5/5 Terminating 291 (294 ago) 69d cal - htdplujn-provisioner - offobbedde-deb5 0/5 Pending 0 445 69d cal - htdplujn-provisioner - offobbedde-gw6bm 1/5 CreateContainerError 465 69d cal - htdplujn-retfx 2/2 Running 0 0 69d cal - htdplujn-retfx 2/2 Running 0 0 69d rob-teph-reashcollector-dnumeephworker1-7845bb8ffvw8fx 1/1 Running 0 0 69d rob-ceph-cashcollector-dnumeephworker2-75cdff55dd-11xq 1/1 Pending 0 0 69d rob-ceph-agn-a-do5b68ff-fygg 1/1 Running 2 0 69d rob-ceph-agn-a-do5b8ff-frybp3 2/3 CreathcoBackoff 146 (28d ago) 30d rob-ceph-agn-b-Tobfd8cb-Jdgfp 2/3 Terninating 146 (28d ago) 30d rob-ceph-agn-b-Tobfd8cb-Jdgfp 2/3 Running 150 (31d ago) 69d rob-ceph-agn-b-Tobfd8cb-Jdgfp 2/3 Running <td>csi-rbdplugin-c95w7</td> <td>2/2</td> <td>Running</td> <td>0</td> <td>69d</td>	csi-rbdplugin-c95w7	2/2	Running	0	69d
cal-rhqluqin-provisioner-ef6b6b8cd6-q4t56 0/5 Pending 0 4d10 cal-rhqluqin-provisioner-ef6b6b8cd6-q4t6bm 1/5 CreateContaineErro 465 69d cal-rhqluqin-artfa 2/2 Running 0 69d cal-rhqluqin-artfa 2/2 Running 0 69d cal-rhqluqin-artfa 2/2 Running 0 69d rook-ceph-crashcollector-d-muscephwocker2-75cdf95dcd-1xg 1/1 Running 0 69d rook-ceph-crashcollector-d-muscephwocker2-75cdf95dcd-nxsz 1/1 Terninating 0 69d rook-ceph-archaeloclector-d-muscephwocker2-75cdf95dcd-nxsz 1/1 Running 0 69d rook-ceph-arg-a-dxb65dff-tpp7z 2/3 CrashcopBackff 16 (28d ag) 30d rook-ceph-arg-a-dxb65dff-thvap9 2/3 Terninating 0 401 rook-ceph-arg-a-dxb65dff-thvap9 2/3 Terninating 10 40 rook-ceph-arg-b-b7bdfd8c8b-jdg9 2/3 Terninating 10 41 rook-ceph-arg-b-b7bdfd8c8b-jdg9 2/3 <td< td=""><td>csi-rbdplugin-pk57s</td><td>2/2</td><td>Running</td><td>1 (63d ago)</td><td>63d</td></td<>	csi-rbdplugin-pk57s	2/2	Running	1 (63d ago)	63d
cal - hqlujun-provisioner - 6f8b68dc6-qw6bm 1/5 CreateContaineTETro 4455 69d cal - hqlujun-artfa 2/2 Running 0 69d cal - hqlujun-wfqqm 1/2 Running 0 69d coh-ceph-crashcollector-duuscephworker2-75cdf55dcd-lykd 1/1 Running 0 64d rook-ceph-crashcollector-duuscephworker2-75cdf55dcd-lykd 1/1 Running 0 64d rook-ceph-crashcollector-duuscephworker2-75cdf55dcd-lykd 1/1 Running 2 68d rook-ceph-arahcollector-duuscephworker2-75cdf55dcd-nykd 1/1 Running 2 68d rook-ceph-arahcollector-duuscephworker2-75cdf55dcd-nykd 1/1 Running 2 68d rook-ceph-ara-a-du5b8dff-fpg7s 2/2 CrashcopBackoff 146 (28d apc) 30d rook-ceph-ag-a-a-du5b8dff-fuyap³ 2/3 Terslinating 315 (30d ago) 69d rook-ceph-ag-b-Drbfd8deb-hdsp 2/2 Running 150 (31d ago) 69d rook-ceph-ag-c-6fddcbd6dc-b23g 2/2 Running 150 (31d ago) 69d	csi-rbdplugin-provisioner-6f6b6b8cd6-4c8jd	5/5	Terminating	2919 (29d ago)	69d
caihcpluyin-artf 2/2 Running 0 69d caihcpluyin-v6gm 2/2 Running 0 69d caihcpluyin-v6gm 2/2 Running 0 68d cob-ceph-crashcollector-dnumcephworker2-75cdf95dcd-1xgd 1/1 Pending 0 68d rook-ceph-crashcollector-dnumcephworker2-75cdf95dcd-nxsz 1/1 Terninating 0 69d rook-ceph-archaelollector-dnumcephworker2-75cdf95dcd-nxsz 1/1 Terninating 0 69d rook-ceph-archaelollector-dnumcephworker2-75cdf95dcd-x45xz 1/1 Terninating 0 69d rook-ceph-archaelollector-dnumcephworker3-6fdddcd9-x45xz 1/1 Terninating 10 69d rook-ceph-arc-a-dsb8dff-f-vpp7z 2/3 CrashcopBackoff 16 (28d ag) 30d rook-ceph-arc-b-Tbdfd8c8b-Jdg5p 2/3 Terninating 0 4d10 rook-ceph-arc-b-Tbdfd8c8b-Jdg5p 2/3 Running 18 (28d ag) 58d rook-ceph-arc-e-fbcddddc-b2jgc 2/2 Running 150 (31d ag) 69d rook-ceph-arc-e-f4f7dfd4-6t	csi-rbdplugin-provisioner-6f6b6b8cd6-d4t56	0/5	Pending	0	4d10h
cal - help luglan-wiggm 2/2 Running 0 69d rook-eeph-crashcollector-dnumcephworker1-7845hb8ff-wa9fx 1/1 Running 0 68d rook-eeph-crashcollector-dnumcephworker2-75cdf95adcd-13cd 0/1 Pending 0 4d10 rook-eeph-crashcollector-dnumcephworker2-75cdf95adcd-n3cs 1/1 Terminating 0 69d rook-eeph-archaelollector-dnumcephworker2-75cdf95adcd-n3cs 1/1 Running 2 69d rook-eeph-archaelollector-dnumcephworker2-75cdf95adcd-n3cs 1/1 Running 2 69d rook-eeph-aga-a-cdb85adff-fpg7s 2/2 CrashLoopBackOff 146 (28d apc) 30d rook-eeph-aga-a-cdb85adff-frivaps 2/3 Terminating 3115 (30d agc) 69d rook-eeph-agh-b-Tobtd8deb-Jdgp 2/2 Running 1500 (31d agc) 69d rook-eeph-age	csi-rbdplugin-provisioner-6f6b6b8cd6-gw6bm	1/5	CreateContainerError	4465	69d
rook-ceph-crashcollector-dnumcephworker1-7845b8ff-vs9fx 1/1 Running 0 68d rook-ceph-crashcollector-dnumcephworker2-75cdf95dcd-1jkqd 0/1 Pending 0 4d10l rook-ceph-crashcollector-dnumcephworker2-75cdf95dcd-1jkqd 1/1 Terminating 0 69d rook-ceph-agr-a-cdsb65dff-ft-pgr3 2/3 CrashLoopBackOff 146 (28d ago) 30d rook-ceph-agr-a-cdsb65dff-ft-pgr3 2/3 Terminating 3115 (30d ago) 69d rook-ceph-agr-a-cdsb65dff-ft-pgr3 2/3 Pending 3115 (30d ago) 69d rook-ceph-agr-a-cdsb65dff-bdgfq 0/3 Pending 283 (28d ago) 80d rook-ceph-agr-a-b-Tobfd86e8b-wh4ww 2/3 Running 1500 (31d ago) 80d rook-ceph-agr-b-Tobfd8e8b-wh4ww 2/2 Running 1500 (31d ago) 80d rook-ceph-agr-b-Tobfd8e8b-wh4ww 2/2 Running 1800 (32d ago) 80d rook-ceph-agr-b-Tobfd8e8b-wh4ww 2/2 Running 1800 (32d ago) 69d rook-ceph-agr-b-Tobfd8e8b-wh4ww 2/2 Running 1800 (32d ago)	csi-rbdplugin-srtfz	2/2	Running	0	69d
rook-ceph-crashcol lector-deumcephvorker2-75cdf55dcd-1½cd 0/1 Pending 0 4410 rook-ceph-crashcol lector-deumcephvorker3-6fdb6cd9-x45bs 1/1 Running 2 68d rook-ceph-mgra-a-c5db58dff-lysp* 2/3 Terminating 3115 (30d ago) 69d rook-ceph-mgra-a-c5db58dff-lysp* 2/3 Terminating 3115 (30d ago) 69d rook-ceph-mgra-a-c5db58dff-lysp* 2/3 Terminating 3115 (30d ago) 69d rook-ceph-mgra-b-7bbfd8cBb-Jdqfp 2/3 Running 288 (28d ago) 58d rook-ceph-more-6d6cbed8cb-d2fgc 2/2 Running 1500 (31d ago) 69d rook-ceph-more-6d6cbed8cb-2fgc 2/2 Running 1500 (31d ago) 69d rook-ceph-more-6d6cbed8cb-2fgc 1/2 Running 1500 (31d ago) 69d rook-ceph-more-6d6cbed8cb-2fgc 1/2 Running 1 68d rook-ceph-more-6d7cbed8cb-4cdbr 1/2 Running 1 68d rook-ceph-more-6-57d9b8dbd-4-wtjp 1/2 Running 116 (30d ago) 68d rook-c	csi-rbdplugin-v6gqm	2/2	Running	0	69d
rook-eeph-crashoollector-dnumcephworker2-75cdf95dcd-n5xz 1/1 Terminating 0 69d rook-eeph-crashoollector-dnumcephworker3-6fddb6cd9-x45w3 1/1 Running 2 68d rook-eeph-mgr-a-c5db58dff-f-tpp7z 2/3 CrashicopBackoff 115 (30d ago) 69d rook-eeph-mgr-a-c5db58dff-thvap9 2/3 Pending 0 40t rook-eeph-mgr-b-Tbbfd8c8b-jdg5p 2/3 Pending 282 (38d ago) 58d rook-eeph-mgr-b-Tbbfd8c8b-jdg5p 2/2 Running 1500 (31d ago) 69d rook-eeph-more-64dbc46bc-b23g 2/2 Running 1500 (31d ago) 69d rook-eeph-more-64dbc46bc-w82g 2/2 Running 0 68d rook-eeph-od-05-7db8dbd4d-dsdhr 1/2 Terninating 31 (28d ago) 68d rook-eeph-od-05-7db8dbd4d-wstjp 1/2 Running 10 (30d ago) 68d rook-eeph-od-05-7db8dbd4d-wstjp 1/2 Running 117 (30d ago) 68d rook-eeph-od-05-7db8dbd4d-wstjp 1/2 Running 117 (30d ago) 68d rook-eeph-od-	rook-ceph-crashcollector-dnumcephworker1-7845bb8ff-vs9fx	1/1	Running	0	68d
rook-eeph-crashcollector-dnuncephworker3-6fdubécd9-x4595 1/1 Running 2 68 68 rook-eeph-mgr-a-c-dubbádff-fhvpp 2/3 CrashLoopBackOff 146 284 ago 90 rook-eeph-mgr-a-c-dubbádff-fhvpp 2/3 Terninating 3115 304 ago 90 rook-eeph-mgr-b-Thbfda8c8b-Jdgp 0/3 Preding 2283 (284 ago) 50 rook-eeph-mgr-b-Tbbfd8c8b-h4ww 2/3 Running 150 (314 ago) 69 rook-eeph-mgr-b-Tbbfd8c8b-h4ww 2/2 Running 150 (314 ago) 69 rook-eeph-mgr-b-Tbbfd8c8b-h4wing 2/2 Running 150 (314 ago) 69 rook-eeph-mgr-b-64dbc4b6cw-la5g 2/2 Running 0 68 68 rook-eeph-mgr-b-75dbbdd4d-dsfur 1/2 Fending 0 40 68 rook-eeph-mgr-b-74bbbd7d-65mh 1/2 Running 112 (304 ago) 68 rook-eeph-mgr-b-74bbbd7d-65mh 1/2 Running 112 (304 ago) 68 rook-eeph-mgr-p	rook-ceph-crashcollector-dnumcephworker2-75cdf95dcd-1jkqd	0/1	Pending	0	4d10h
rook-ceph-mgr-a-c5db58dfr-fpp7r 2/3 CrashLoopBackOff 146 (28d ago) 30d rook-ceph-mgr-a-c5db58dfr-lvap9 2/3 Terminating 3115 (30d ago) 69d rook-ceph-mgr-b-7bbfd8eBb-Jdgp 0/3 Pending 0 4d10 rook-ceph-mora-b-75df9cdb-b-12gc 2/2 Running 1500 (31d ago) 69d rook-ceph-mora-375df9cddb-b4g6c-w28ag 2/2 Running 1608 (28d ago) 69d rook-ceph-mora-ce-6fdcb4g6c-w28ag 1/1 Running 0 68d rook-ceph-od-0-57d9bdbd4-d-6dfnr 1/2 Pendinating 731 (28d ago) 68d rook-ceph-od-0-57d9bdbd4-d-ddhr 1/2 Pending 71 71 71 72	rook-ceph-crashcollector-dnumcephworker2-75cdf95dcd-n5xsz	1/1	Terminating	0	69d
rook-ceph-mgr-a-c-dub5ddf-fnVapp 2/3 Terminating 3115 (30d ago) 69d rook-ceph-mgr-b-Thbfd8cBb-hdaye 0/3 Pending 0 40t rook-ceph-mgr-b-Thbfd8cBb-hdaye 2/2 Terminating 2283 (28d ago) 58d rook-ceph-mon-a-75cf9ccddc-b2jc 2/2 Running 1500 (31 dago) 69d rook-ceph-mon-a-64dcbdc8c-wa8g 2/2 Running 100 (32d ago) 68d rook-ceph-os-0-57db9bddwd-d-didhr 1/2 Terminating 71 (28d ago) 68d rook-ceph-osd-0-57db9bddwd-wntjp 0/2 Pending 0 4d10 rook-ceph-osd-1-746982ff7-d-6zah 1/2 Running 116 (30d ago) 68d rook-ceph-osd-2-5ccd866f7c-lmsf 1/2 Running 117 (28d ago) 68d rook-ceph-osd-2-5ccd866f7c-lmsf 1/2 Running 117 (28d ago) 68d rook-ceph-osd-2-5ccd866f7c-lmsf 0/1 Completed 0 57d rook-ceph-osd-preparae-dnuncephvorker3-42rxv 0/1 Completed 0 57d rook-ceph-osd-1-7-408b9b578-berser	rook-ceph-crashcollector-dnumcephworker3-6fddb6cd9-x45w5	1/1	Running	2	68d
rook-ceph-mgr-b-Tbbfd88cBb-Jqdp 0/3 Pending 0 4d10* rook-ceph-mgr-b-Tbbfd88cBb-Jqdp 2/3 Treminating 228 (28d ago) 58d rook-ceph-mgr-b-Tbbfd88cBb-Hdww 2/2 Running 1500 (31d ago) 69d rook-ceph-mon-a-75cf9cddb-LdG6c-W28gg 2/2 Running 1800 (28d ago) 69d rook-ceph-more-64dbc466c-w28gg 1/1 Running 731 (28d ago) 68d rook-ceph-od-0-57d9bdbd4d-d-d6dhr 1/2 Pending 731 (28d ago) 68d rook-ceph-od-0-57d9bdbd4d-wttp 0/2 Pending 716 (30d ago) 68d rook-ceph-od-1-7469b3f77fd-6n2mh 1/2 Running 716 (30d ago) 68d rook-ceph-od-2-5ccd86467c-lhm47 1/2 Running 1172 (28d ago) 68d rook-ceph-od-prepare-dnuncephvorker1-rnk78 0/1 Completed 0 57d rook-ceph-od-prepare-dnuncephvorker3-42rxv 0/1 Completed 0 57d rook-ceph-od-1-7-40sbbb59-8-tfsr 0/1 Pending 0 400	rook-ceph-mgr-a-c5db58dff-fpp7z	2/3	CrashLoopBackOff	146 (28d ago)	30d
rook-ceph-megr-b-Tubtd8e8b-wh4ww 2/3 Terminating 2283 (28d ago) 8d rook-ceph-mon-a-75cfgcddch-bdjgc 2/2 Running 150 (31d ago) 6d rook-ceph-mon-c-64dcb4e86c-wz8sg 2/2 Running 1808 (28d ago) 69d rook-ceph-oc-0-57db8ddw4-dsdhr 1/2 Terminating 71 (28d ago) 68d rook-ceph-od-0-57db8ddw4-wntjp 0/2 Pending 71 (30d ago) 68d rook-ceph-od-1-746982f74-6nzhh 1/2 Running 716 (30d ago) 68d rook-ceph-od-2-5ccd866f7c-llm87 1/2 Running 117 (28d ago) 68d rook-ceph-od-2-5ccd866f7c-llm87 0/1 Completed 0 57d rook-ceph-od-preparae-dnuncephvorker3-42rw 0/1 Completed 0 57d rook-ceph-od-1-7-6d88bb58-bc.ffr 0/1 Pending 0 400	rook-ceph-mgr-a-c5db58dff-hvsp9	2/3	Terminating	3115 (30d ago)	69d
rook-ceph-mon-a-7st/9ccddc-b2/gc 2/2 Running 1500 (31d ago) 69d rook-ceph-mon-c-64dcb486c-w288g 2/2 Running 1808 (28d ago) 69d rook-ceph-oser-c-64f7df4d-61mfp 1/1 Running 731 (28d ago) 68d rook-ceph-od-0-57d9b8db4d-d6dhr 1/2 Pending 731 (28d ago) 68d rook-ceph-od-0-57d9b8db4d-wttp 0/2 Pending 716 (30d ago) 68d rook-ceph-od-2-57d9b8db4d-chefbr 1/2 Running 716 (30d ago) 68d rook-ceph-od-2-5cd8d6d7-lmaf 1/2 Running 1172 (28d ago) 68d rook-ceph-od-prepare-dnumcephworker1-rnk78 0/1 Completed 0 57d rook-ceph-od-prepare-dnumcephworker3-42xw 0/1 Completed 0 57d rook-ceph-od-10-7cd8b8b95-8-tfsr 0/1 Pending 0 400	rook-ceph-mgr-b-7bbfd88c8b-jdg4p	0/3	Pending	0	4d10h
rook-ceph-mon-o-64dabde6c-wz8sg 2/2 Running 1808 (28d ago) 69d rook-ceph-poerator-cftf7df3d4-6tmfp 1/1 Running 0 68d rook-ceph-osd-0-57db8db4d-4ddhr 1/2 Terminating 731 (28d ago) 68d rook-ceph-osd-0-57db8db4d-wmt.fp 0/2 Pending 0 4d10 rook-ceph-osd-0-57db8db4d-wmt.fp 1/2 Running 716 (30d ago) 68d rook-ceph-osd-2-5ccd86467c-lhms7 1/2 Running 1172 (28d ago) 68d rook-ceph-osd-2-5ccd86467c-lhms7 0/1 Completed 0 57d rook-ceph-osd-prepare-dnuncephvorker3-42rxv 0/1 Completed 0 57d rook-ceph-osd-prepare-dnuncephvorker3-42rxv 0/1 Cephected 0 57d rook-ceph-osd-prepare-dnuncephvorker3-42rxv 0/1 Pending 0 400	rook-ceph-mgr-b-7bbfd88c8b-wh4ww	2/3	Terminating	2283 (28d ago)	58d
rook-ceph-operator-cf47df44-6tm6p 1/1 Running 0 68d rook-ceph-oad-0-57d9b8db44-d6dhr 1/2 Terminating 731 (28d ago) 68d rook-ceph-oad-0-57d9b8db44-wttp 0/2 Pending 0 4d10 rook-ceph-oad-1-7469b8777d-6n2mh 1/2 Running 716 (30d ago) 68d rook-ceph-oad-2-5cc468647-1m47 1/2 Running 1172 (28d ago) 68d rook-ceph-oad-prepare-dnumcephvorkeri-rnk78 0/1 Completed 0 57d rook-ceph-oad-prepare-dnumcephvorker3-42xw 0/1 Completed 0 57d rook-ceph-oad-7-6ab8bb58-bc.ffr 0/1 Pending 0 4d10	rook-ceph-mon-a-75cf9ccddc-b2jgc	2/2	Running	1500 (31d ago)	69d
rook-ceph-osd-0-57db8db4d-4ddhr 1/2 Terminating 731 (28d ago) 68d rook-ceph-osd-0-57db8db4d-vmt.jp 0/2 Pending 0 4d10 rook-ceph-osd-1-746982T7f4-652mh 1/2 Running 716 (30d ago) 68d rook-ceph-osd-2-5ccd86467c-lhm47 1/2 Running 1172 (28d ago) 68d rook-ceph-osd-prepare-dnuncephworker1-rnk78 0/1 Completed 0 57d rook-ceph-osd-prepare-dnuncephworker3-42rxv 0/1 Completed 0 57d rook-ceph-osd-prepare-dnuncephworker3-42rxv 0/1 Pending 0 4d10	rook-ceph-mon-c-64dcb4c86c-wz8sg	2/2	Running	1808 (28d ago)	69d
rook-ceph-osd-0-57d9b8db4d-vmtjp 0/2 Pending 0 4d10t rook-ceph-osd-1-7469b8d77fd-6n2mh 1/2 Running 716 (30d ago) 68d rook-ceph-osd-2-5cc4846f7-lmaf7 1/2 Running 1172 (28d ago) 68d rook-ceph-osd-prepare-dnumcephvorkerl-rnk78 0/1 Completed 0 57d rook-ceph-osd-prepare-dnumcephvorker3-42rv 0/1 Completed 0 57d rook-ceph-colo-7-cobsbb95b-8-tfsr 0/1 Pending 0 4d10t	rook-ceph-operator-cf4f7dfd4-6tm6p	1/1	Running	0	68d
rook-ceph-oad-1-746987776-6a2mh 1/2 Running 716 (30d ago) 68d rook-ceph-oad-2-5cc486467c-lhm47 1/2 Running 1172 (28d ago) 68d rook-ceph-oad-prepare-dnumcephworker1-rnk78 0/1 Completed 0 57d rook-ceph-oad-prepare-dnumcephworker3-42xw 0/1 Completed 0 57d rook-ceph-to-01-7-C48bbb396-8-tfsr 0/1 Pending 0 4d10	rook-ceph-osd-0-57d9b8db4d-d6dhr	1/2	Terminating	731 (28d ago)	68d
rook-ceph-osd-2-5cc486467c-lnm47 1/2 Running 1172 (28d ago) 68d rook-ceph-osd-prepare-dnumcephworker1-rnk78 0/1 Completed 0 57d rook-ceph-osd-prepare-dnumcephworker3-42rv 0/1 Completed 0 57d rook-ceph-cools-7c4b8bb95-8tf8r 0/1 Pending 0 4dl0	rook-ceph-osd-0-57d9b8db4d-vmtjp	0/2	Pending	0	4d10h
rook-ceph-osd-prepare-dnumcephworkeri-rnk78 0/1 Completed 0 57d rook-ceph-osd-prepare-dnumcephworker3-42rwv 0/1 Completed 0 57d rook-ceph-tool-7-db8bbb5-8-ffr 0/1 Pending 0 4d100	rook-ceph-osd-1-74698f77fd-6n2mh	1/2	Running	716 (30d ago)	68d
rook-ceph-osd-prepare-dnumcephworker3-42rxv 0/1 Completed 0 57d rook-ceph-tools-7c4b8bb9b5-8tf8r 0/1 Pending 0 4d10h	rook-ceph-osd-2-5cc486467c-1hm47	1/2	Running	1172 (28d ago)	68d
rook-ceph-tools-7c4b8bb9b5-8tf8r	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-pxk67 1/1 Terminating 0 68d	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

Affichage des storage class déployés

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						

Sélection des nœuds PostgreSQL

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 :

```
$ kubect1 label nodes dnumworker1 postgres-operator=enabled
node/dnumworker1 labeled
$ kubect1 label nodes dnumworker2 postgres-operator=enabled
node/dnumworker2 labeled
$ kubect1 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

```
S git diff
diff --git a/manifests/complete-postgres-manifest.vaml b/manifests/complete-postgres-manifest.vaml
index 8d197a75..56b32c34 100644
--- a/manifests/complete-postgres-manifest.vaml
+++ b/manifests/complete-postgres-manifest.vaml
88 -57,7 +57,7 88 spec:
   volume:
     size: 1Gi
    storageClass: mv-sc
     storageClass: rook-ceph-block
     iops: 1000 # for EBS gp3
     throughput: 250 # in MB/s for EBS gp3
     selector.
00 -203,14 +203,14 00 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:
              - kev: postgres-operator
                operator: In
                values.
+ 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 :

Clonage du dépôt de l'opérateur

git clone $\label{local_postgres-operator} \begin{tabular}{ll} \tt git clone https://github.com/zalando/postgres-operator.git cd postgres-operator \end{tabular}$

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 facilier le déploiement.

Accès à l'interface web

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

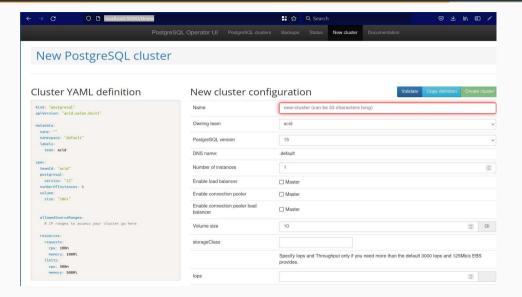
Accès à l'interface web

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



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

L'UI permet de :

- choisir la version PostgreSQL (jusquà la version 15 actuellement)
- le nombre d'instances
- activation du load-balancer
- activation du pool de connexions à la base
- activation du locad-balancer pour le pool de connexions à la base
- taille du volume persistent 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'Ul 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
                              Running
                                                   12m
acid-test-cluster-1 1/1
                              Running
                                                   10m
$ kubectl get postgresgl
NAME
                    TEAM
                           VERSION
                                     PODS
                                            VOLUME
                                                     CPU-REOUEST
                                                                   MEMORY-REQUEST
                                                                                           STATUS
                                                                                     AGE
acid-test-cluster
                    acid
                          15
                                                     10m
                                                                   100Mi
                                                                                     68d
                                                                                           Running
$ kubectl get pods -l application=spilo -L spilo-role
NAME
                      READY
                              STATUS
                                        RESTARTS
                                                   ACE
                                                         SPILO-ROLE
acid-test-cluster-0 1/1
                              Running
                                        Λ
                                                   1 3 m
acid-test-cluster-1 1/1
                              Running
                                                   1 0 m
$ kubectl get svc -l application=spilo -L spilo-role
NAME
                           TYPE
                                       CLUSTER-IP
                                                       EXTERNAL-IP
                                                                     PORT(S)
                                                                                       SPILO-ROLE
                                                                                 ACE
acid-test-cluster
                                       10.103.247.68
                           ClusterIP
                                                                     5432/TCP
                                                                                68d
                                                                                      master
                                                       <none>
acid-test-cluster-config
                           ClusterIP
                                                                                68d
                                       None
                                                       <none>
                                                                     <none>
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/\(arm\)\(64\)\?.*/\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
}
```

Déploiement de 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 :

kubectl krew

Déploiement de l'opérateur Minio

Le déploiement de Minio s'appuie sur l'opérateur Minio. Son déploiement est décrit dans le lien suivant https://operator.min.io/#architecture.

kubectl krew update
kubectl krew install minio

Accès client à la base de données

Point-in-time recovery PITR

Failover - Changement du nombre de pods

Mise à jour mineure de PostgreSQL

Mise à jour majeure de PostgreSQL

Bibliographie



Webographie

Sommaire

Sommaire

Installation

Conclusion