PostgreSQL

Déploiement de l'opérateur PostgreSQL

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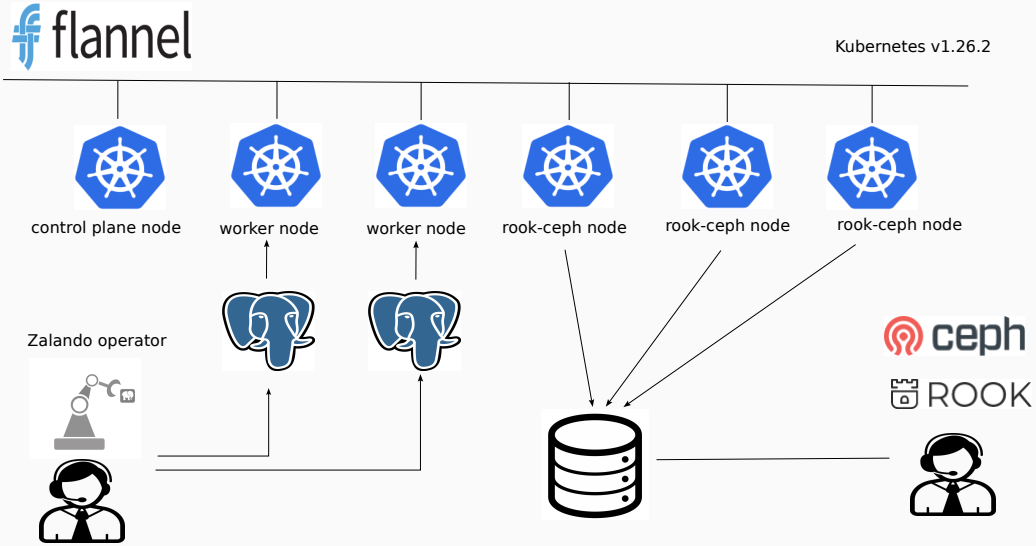
Installation

Architecture



Versions utilisées

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

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/`

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

```
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 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 :

```
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
```

Paramétrage de containerd

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 1er 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.n6u8pbm7yj16nnr8 \
      --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.n6u8pbm7yj16nnr8 \
      --discovery-token-ca-cert-hash sha256:f6d45602ea75c7659dc91f661d19e97e6817e2847e4e5d0047880b871317a145
```

Paramétrage de *kubectl*

L'utilisation de kubectl 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 1er 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 :

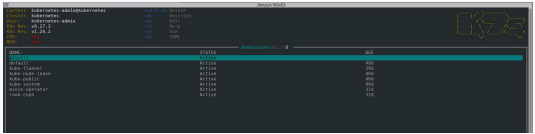
```
kubectl apply -f https://github.com/flannel-io/flannel/releases/latest/download/kube-flannel.yml
```

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 :
`https://github.com/derailed/k9s/releases/download/v0.27.3/k9s_Linux_`

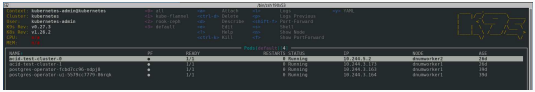
Liste des namespaces

```
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
```



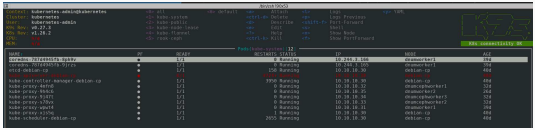
Pods du namespace default

```
linagora@debian-cp:~$ kubectl get pods
NAME                                    READY   STATUS    RESTARTS   AGE
acid-test-cluster-0                     1/1     Running   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
```



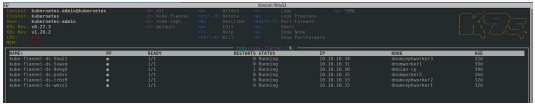
Pods du namespace kube-system

```
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
```



Pods du namespace kube-flannel

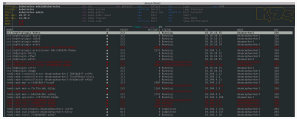
```
linagora@debian-cp:~$ kubectl get pods -n kube-flannel
NAME                     READY   STATUS    RESTARTS      AGE
kube-flannel-ds-5nw2j    1/1     Running   0             33d
kube-flannel-ds-5xwsm    1/1     Running   0             40d
kube-flannel-ds-8vkg9    1/1     Running   1 (33d ago)   40d
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
```



```
Context:  kubernetes-admin@kubernetes     <0> all            <a>       Attach     <l>         Logs              <y> YAML
Cluster:  kubernetes                      <1> kube-flannel   <ctrl-d>  Delete     <p>         Logs Previous
User:     kubernetes-admin                <2> rook-ceph      <d>       Describe   <shift-f>   Port-Forward
K9s Rev:  v0.27.3                         <3> default        <e>       Edit       <s>         Shell
K8s Rev:  v1.26.2                                            <?>       Help       <n>         Show Node
CPU:      n/a                                                <ctrl-k>  Kill       <f>         Show PortForward
MEM:      n/a
                                        Pods(kube-flannel)[6]
 NAME↑                    PF        READY              RESTARTS STATUS         IP              NODE                AGE
 kube-flannel-ds-5nw2j    ●         1/1                       0 Running        10.10.10.34     dnumcephworker3     32d
 kube-flannel-ds-5xwsm    ●         1/1                       0 Running        10.10.10.31     dnumworker1         39d
 kube-flannel-ds-8vkg9    ●         1/1                       1 Running        10.10.10.30     debian-cp           39d
 kube-flannel-ds-pv6ss    ●         1/1                       0 Running        10.10.10.35     dnumworker2         26d
 kube-flannel-ds-trbz9    ●         1/1                       0 Running        10.10.10.33     dnumcephworker2     32d
 kube-flannel-ds-wmzz2    ●         1/1                       0 Running        10.10.10.32     dnumcephworker1     32d
```

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-84cc595b78-9mml4             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-w4xvw                          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-wz8sg                          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-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
```



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 10.10.10.30:6443 \
--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/v1alpha1 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
```

Déploiement du stockage - Rook Ceph

WIP

```
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
```

Déploiement de l'opérateur PostgreSQL de Zalando

TODO

Répartitions des pods PostgreSQL sur les nœuds worker

TODO

Bibliographie

Webographie

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