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How to Stretch an OCP cluster from AWS to On-premise.

1.0 Introduction

We will be adding additional remote worker node @on-premise to an existing ocp@aws (release 4.7.19 ipi) cluster. The idea is to have a local worker node close to backend at premises as well as service consumers with low latency access.

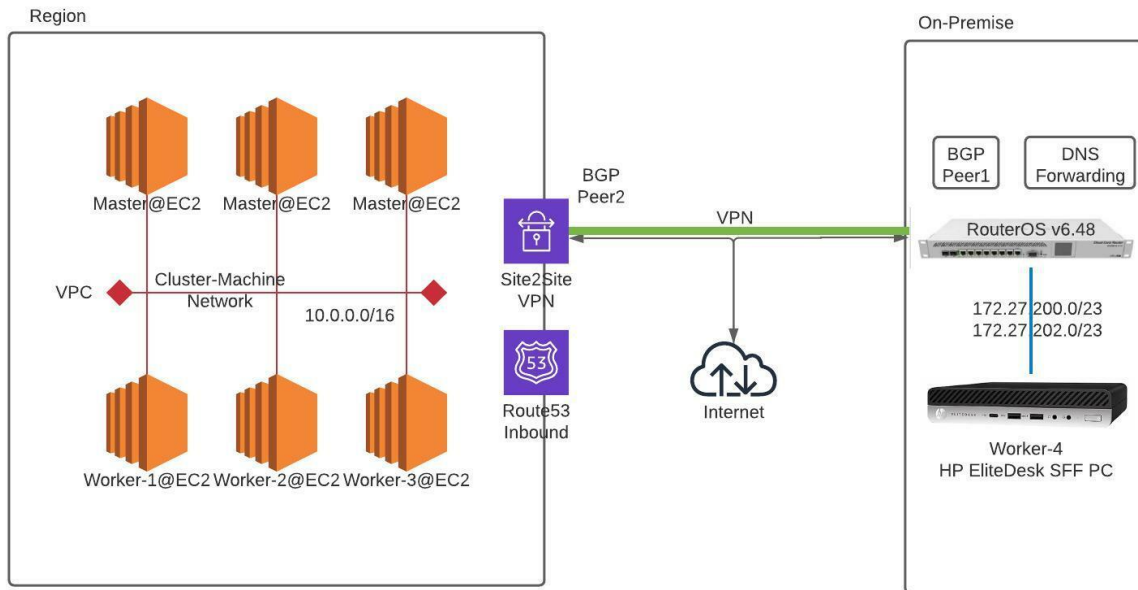
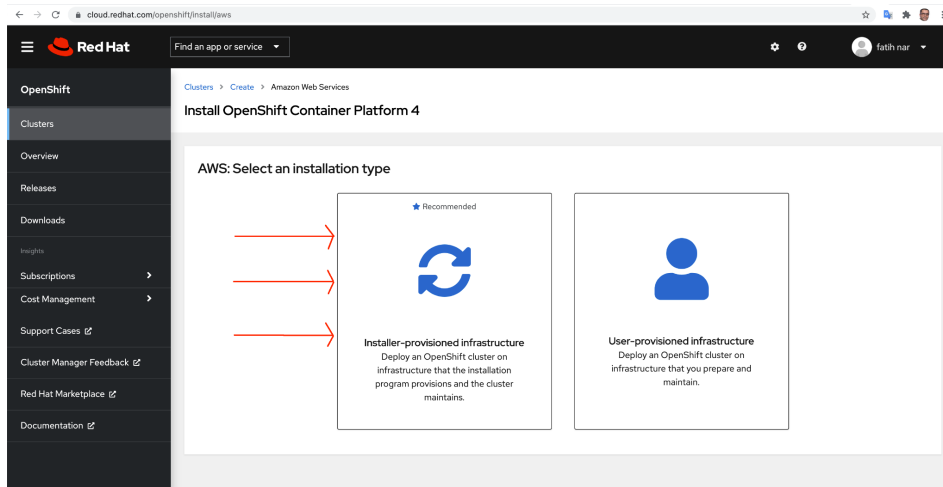


Figure-1 Solution TestBed Diagram

2.0 Prerequisites:

- I. OCP IPI deployed on AWS. Reference: [Link1](#), [Link2](#).



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- II. On-premise site route configurable (example vpn guidance reference: [Link2](#)) with;
- ❖ Dhcp server with host dns provisioning pointing aws route53 inbound

The screenshot shows the RouterOS v6.48.3 (stable) web interface. The left sidebar contains a menu with various configuration options, including CAPsMAN, Wireless, Interfaces, Bridge, Switch, PPP, Mesh, IP, ARP, Accounting, Addresses, Cloud, DHCP Client, DHCP Relay, DHCP Server (selected), DNS, Firewall, Hotspot, IPsec, Kid Control, Neighbors, Packing, Pool, Routes, SMB, SNMP, Services, Settings, Socks, TFTP, Traffic Flow, and UPnP. The main content area displays the DHCP Server configuration form. At the top, there are buttons for OK, Cancel, Apply, and Remove. The form fields are as follows:

- Address:** 172.27.200.0/23
- Gateway:** 172.27.201.254
- Netmask:** 0
- No DNS:** ☐
- DNS Servers:** Three entries: 10.0.20.53, 10.0.143.85, and 10.0.0.2. Three orange arrows point to these entries from the right, with the text "AWS Route53 Inbound Addresses" next to them.
- Domain:** (empty)
- WINS Servers:** (empty)
- NTP Servers:** (empty)
- CAPS Managers:** (empty)
- Next Server:** (empty)
- Boot File Name:** (empty)
- DHCP Options:** (empty)
- DHCP Option Set:** (empty)
- Comment:** (empty text area)

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3.0 Network Readiness on AWS and On-Premise:

- A. Create and attach VPN to a VPC where OCP Cluster deployed. Verify BP Peer connection established with on-premise router and route advertisement exchanged.

The screenshot displays the AWS VPN console and RouterOS configuration. The top section shows the 'Create VPN Connection' page with a table of VPN connections. Below this, the 'VPN Connection: vpn-09b388013af12f43f' details are shown, including the 'Tunnel State' table. The bottom section shows the RouterOS v6.48.3 configuration for the VPN connection, including the 'Peers' and 'VPN4 Routes' tabs.

| Name | VPN ID | State | Virtual Private Gateway | Transit | Customer Gateway | Custc | Inside Ip Version |
|-------------|-----------------------|-----------|-------------------------------------|---------|---------------------------------|---------|-------------------|
| OCP-AWS-VPN | vpn-09b388013af12f43f | available | vgw-0eefea522dd3d54b7 OCP-AWS-VPC | - | cgw-0236efffd4142265c FB20... | 99.6... | IPv4 |

VPN Connection: vpn-09b388013af12f43f

Tunnel State

| Tunnel Number | Outside IP Address | Inside IPv4 CIDR | Inside IPv6 CIDR | Status | Status Last Changed | Details |
|---------------|--------------------|-------------------|------------------|--------|-----------------------------------|--------------|
| Tunnel 1 | 44.193.171.69 | 169.254.177.16/30 | - | UP | July 19, 2021 at 9:36:50 AM UTC-5 | 2 BGP ROUTES |

RouterOS v6.48.3 (stable)

Instances VRFs Peers Networks Aggregates VPN4 Routes Advertisements

Add New Refresh All Resend All

1 item

| Name | Instance | Remote Address | Remote AS | M... | R... | TTL | Remote ID | Uptime | Prefix Count | State |
|-----------------------------|----------|----------------|-----------|------|------|-----|----------------|----------|--------------|-------------|
| BGP-vpn-09b388013af12f43f-0 | default | 169.254.177.17 | 64512 | no | no | 255 | 169.254.177.17 | 01:11:24 | 1 | established |

RouterOS v6.48.3 (stable)

Instances VRFs Peers Networks Aggregates VPN4 Routes Advertisements

2 items

| Peer | Prefix | Next hop | AS Path | Origin | Local Pref. | MED |
|-----------------------------|-----------------|----------------|---------|--------|-------------|-----|
| BGP-vpn-09b388013af12f43f-0 | 172.27.202.0/23 | 169.254.177.18 | | igp | 0 | |
| BGP-vpn-09b388013af12f43f-0 | 172.27.200.0/23 | 169.254.177.18 | | igp | 0 | |

- B. Configure Route 53 Inbound for remote worker node (rwn) to access route 53 private zone records.

The screenshot displays the AWS Route 53 console. The left sidebar shows the navigation menu with 'Route 53' selected. The main content area shows the 'Inbound endpoint: ocp-aws-ipsec-inbound-ep' configuration. The configuration details include the ID, Status, Host VPC, Name, and Security group. Below this, the 'IP addresses (2)' section shows a table of IP addresses and their associated subnets and availability zones.

Route 53 > Resolver > Inbound endpoints > ocp-aws-ipsec-inbound-ep

Inbound endpoint: ocp-aws-ipsec-inbound-ep

ocp-aws-ipsec-inbound-ep Configuration

| ID | Status | Host VPC |
|----------------------------|-------------|-----------------------|
| rsivr-in-26b0b4372897404c8 | Operational | vpc-00b42ffa5d9d0c0c2 |

| Name | Security group |
|--------------------------|----------------------|
| ocp-aws-ipsec-inbound-ep | sg-03af5ae2f1844d8a5 |

IP addresses (2)

| IP address | IP address ID | Status | Subnet | Availability Zone |
|-------------|-----------------------|----------|--------------------------|-------------------|
| 10.0.143.58 | rmi-b3c121bc12ce49c2a | Attached | subnet-0f403f59a95b32184 | us-east-1a |
| 10.0.0.159 | rmi-2ca530decf6045da9 | Attached | subnet-08eae15e7865bd18a | us-east-1a |

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C. Configure aws vpc subnets, security groups for return path to on-premise routers.

Security Groups (1/1) Info

Filter security groups

Security group ID: sg-03af5ae2f1844d8a5 Clear filters

| <input checked="" type="checkbox"/> | Name | Security group ID | Security group name | VPC ID | Description | Owner |
|-------------------------------------|------|----------------------|---------------------|-----------------------|----------------------------|--------------|
| <input checked="" type="checkbox"/> | - | sg-03af5ae2f1844d8a5 | default | vpc-00b42ffa5d9d0c0c2 | default VPC security group | 617321736485 |

sg-03af5ae2f1844d8a5 - default

Details **Inbound rules** Outbound rules Tags

Inbound rules (2/3)

Filter security group rules

| <input checked="" type="checkbox"/> | Name | Security group rule... | IP versi... | Type | Protocol | Port ra... | Source | Description |
|-------------------------------------|------|------------------------|-------------|-------------|----------|------------|----------------------|-------------|
| <input checked="" type="checkbox"/> | - | sgr-041a43cd6da1cfab2 | IPv4 | All traffic | All | All | 172.27.200.0/23 | - |
| <input checked="" type="checkbox"/> | - | sgr-0064c02d6fed3f786 | IPv4 | All traffic | All | All | 172.27.202.0/23 | - |
| <input type="checkbox"/> | - | sgr-047bee048411b1... | - | All traffic | All | All | sg-03af5ae2f1844d8a5 | - |

VPC > Route tables > rtb-0dc2aa0bc964fbf5e > Edit route propagation

Edit route propagation

Route table basic details

Route table ID

rtb-0dc2aa0bc964fbf5e

Edit route propagation

| Virtual Private Gateway | Propagation |
|-------------------------------------|--|
| vgw-0eeffa522dd3d54b7 / OCP-AWS-VPC | <input checked="" type="checkbox"/> Enable |

Cancel Save

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Route tables (1/8)

Filter route tables

VPC: vpc-00b42ffa5d9d0c0c2

Clear filters

| Name | Route table ID | Explicit subnet associ... | Edge associations | Main | VPC | Owner ID |
|-----------------------|-----------------------|---------------------------|-------------------|------|---------------------------------|--------------|
| ocp-aws-ipsec-fgct... | rtb-07f2d973524359c1e | subnet-0f403f59a95b3... | - | No | vpc-00b42ffa5d9d0c0c2 ocp-... | 617321736485 |
| ocp-aws-ipsec-fgct... | rtb-0945c234b9693987b | subnet-064b6e568d75b... | - | No | vpc-00b42ffa5d9d0c0c2 ocp-... | 617321736485 |
| ocp-aws-ipsec-fgct... | rtb-09758d9841e5d6626 | subnet-02a287f50dfb3... | - | No | vpc-00b42ffa5d9d0c0c2 ocp-... | 617321736485 |
| ocp-aws-ipsec-fgct... | rtb-0dc2aa0bc964fbf5e | 6 subnets | - | Yes | vpc-00b42ffa5d9d0c0c2 ocp-... | 617321736485 |
| ocp-aws-ipsec-fgct... | rtb-03cf5e02b08c6dbc2 | subnet-0fef68b9584df... | - | No | vpc-00b42ffa5d9d0c0c2 ocp-... | 617321736485 |
| ocp-aws-ipsec-fgct... | rtb-0bcb279c48b3196b5 | subnet-07f002e1e8483... | - | No | vpc-00b42ffa5d9d0c0c2 ocp-... | 617321736485 |
| - | rtb-06140256e6034d3ce | - | - | No | vpc-00b42ffa5d9d0c0c2 ocp-... | 617321736485 |
| ocp-aws-ipsec-fgct... | rtb-05e61c84473e92edb | subnet-0ac9ceecbf8982... | - | No | vpc-00b42ffa5d9d0c0c2 ocp-... | 617321736485 |

Routes (5)

Filter routes

Both

| Destination | Target | Status | Propagated |
|-----------------|-----------------------|--------|------------|
| pl-63a5400a | vpc-0cb537f3b2b377ae3 | Active | No |
| 172.27.202.0/23 | vgw-0eefea522dd3d54b7 | Active | Yes |
| 172.27.200.0/23 | vgw-0eefea522dd3d54b7 | Active | Yes |
| 10.0.0.0/16 | local | Active | No |
| 0.0.0.0/0 | lgw-0ebf1fd6287b9bab9 | Active | No |

4.0 Build your Remote Worker Node (RWN) on Premise

a. Boot your remote worker node with RHCOS Live ISO Image. (Ref: [Repo](#))

```
[core@ip-172-27-201-49 ~]$ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: enp0s25: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether f4:4d:30:65:a0:64 brd ff:ff:ff:ff:ff:ff
    inet 172.27.201.49/23 brd 172.27.201.255 scope global dynamic noprefixroute enp0s25
        valid_lft 376sec preferred_lft 376sec
    inet6 fe80::f823:f9ea:c63c:c427/64 scope link noprefixroute
        valid_lft forever preferred_lft forever

[core@ip-172-27-201-49 ~]$ netstat -arn
Kernel IP routing table
Destination        Gateway         Genmask         Flags   MSS Window  irtt Iface
0.0.0.0            172.27.201.254 0.0.0.0         UG        0 0          0 enp0s25
172.27.200.0       0.0.0.0        255.255.254.0   U         0 0          0 enp0s25

[core@ip-172-27-201-49 ~]$ cat /etc/resolv.conf
# Generated by NetworkManager
search ec2.internal
nameserver 10.0.143.58
nameserver 10.0.0.159
nameserver 10.0.0.2

[core@ip-172-27-201-49 ~]$ hostname -f
ip-172-27-201-49.ec2.internal
```

On-Premise Site Router Address

AWS Route53 Inbound IP

AWS EC2 Reverse DNS Provided Hostname for RWN

b. Retrieve your worker ignition file

“curl -H "Accept: application/vnd.coreos.ignition+json; version=3.2.0" -k -o worker.ign <https://api-int.<clustername>.<domain-name>:22623/config/worker>”

```
[core@ip-172-27-201-49 ~]$ curl -H "Accept: application/vnd.coreos.ignition+json; version=3.2.0" -k -o worker.ign https://api-int.ocp-aws-ipsec.narlabs.io:22623/config/worker
% Total % Received % Xferd Average Speed Time Time Current
Dload Upload Total Spent Left Speed
100 184k 100 184k 0 0 389k 0 --:--:-- --:--:-- --:--:-- 389k

[core@ip-172-27-201-49 ~]$ ll
total 188
-rw-rw-r-- 1 core core 189103 Jul 19 15:17 worker.ign
```

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c. Bootstrap (install -> reboot) your worker with downloaded ignition file.

```
[core@ip-172-27-201-49 ~]$ ll
total 188
-rw-rw-r--. 1 core core 189103 Jul 19 15:17 worker.ign
[core@ip-172-27-201-49 ~]$ sudo coreos-installer install /dev/sda --ignition-file worker.ign
Installing Red Hat Enterprise Linux CoreOS 47.83.202105220305-0 (Ootpa) x86_64 (512-byte sectors)
> Read disk 3.5 GiB/3.5 GiB (100%)
Writing Ignition config
Install complete.
[core@ip-172-27-201-49 ~]$ sudo reboot now
```

5.0 Admit your new worker node to cluster

A. Verify & correct your Kubelet.service and 00-multus.conf compare -> guide.

```
Description=Kubernetes Kubelet
Wants=rpc-statd.service network-online.target crio.service
After=network-online.target crio.service
After=ostree-finalize-staged.service

[Service]
Type=notify
ExecStartPre=/bin/mkdir --parents /etc/kubernetes/manifests
ExecStartPre=/bin/rm -f /var/lib/kubelet/cpu_manager_state
EnvironmentFile=/etc/os-release
EnvironmentFile=/etc/kubernetes/kubelet-workaround
EnvironmentFile=/etc/kubernetes/kubelet-env

ExecStart=/usr/bin/hyperkube \
  kubelet \
  --config=/etc/kubernetes/kubelet.conf \
  --bootstrap-kubeconfig=/etc/kubernetes/kubeconfig \
  --kubeconfig=/var/lib/kubelet/kubeconfig \
  --container-runtime=remote \
  --container-runtime-endpoint=/var/run/crio/crio.sock \
  --runtime-cgroups=/system.slice/crio.service \
  --node-labels=node-role.kubernetes.io/worker,node.openshift.io/os_id=${ID} \
  --node-ip=${KUBELET_NODE_IP} \
  --minimum-container-ttl-duration=6m0s \
  --volume-plugin-dir=/etc/kubernetes/kubelet-plugins/volume/exec \
  --pod-infra-container-image=quay.io/openshift-release-dev/ocp-v4.0-art-dev@sha256:4a2f77cfc83e981b62edb84b58c6520a09b6ea11e91e635ae91b5d56cf33873a \
  --v=${KUBELET_LOG_LEVEL}

Restart=always
RestartSec=10

[Install]
WantedBy=multi-user.target
[core@ip-172-27-201-49 ~]$ cat /etc/kubernetes/cni/net.d/00-multus.conf
{ "cniVersion": "0.3.1", "name": "multus-cni-network", "type": "multus", "namespaceIsolation": true, "loglevel": "verbose", "binDir": "/opt/multus/bin", "readinessIndicatorFile": "/var/run/multus/cni/net.d/10-ovn-kubernetes.conf", "kubeconfig": "/etc/kubernetes/cni/net.d/multus.d/multus.kubeconfig", "delegates": [ {"cniVersion": "0.4.0", "name": "ovn-kubernetes", "type": "ovn-k8s-cni-overlay", "ipam": {}, "dns": {}, "logFile": "/var/log/ovn-kubernetes/ovn-k8s-cni-overlay.log", "logLevel": "4", "logFile-maxsize": 100, "logFile-maxbackups": 5, "logFile-maxage": 5} ] }
```

B. Approve Pending CSRs.

```
Every 2.0s: oc get csr                                jumpserver.narlabs.io: Mon Jul 19 10:37:42 2021

NAME      AGE      SIGNERNAME                               REQUESTOR                                CONDITION
csr-78hmv 2m15s    kubernetes.io/kubelet-serving            system:node:ip-172-27-201-49.ec2.internal Approved, Issued
csr-c49fg 4m20s    kubernetes.io/kube-apiserver-client-kubelet system:serviceaccount:openshift-machine-config-operator:node-bootstrapper Approved, Issued

[core@ip-172-27-201-49 ~]$ oc get csr -o name | xargs oc adm certificate approve
certificatesigningrequest.certificates.k8s.io/csr-78hmv approved
certificatesigningrequest.certificates.k8s.io/csr-c49fg approved
```

C. Enlist new worker node

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```
[fenar@jumpserver ~]$ oc get nodes
NAME                                STATUS    ROLES    AGE      VERSION
ip-10-0-131-121.ec2.internal        Ready    worker   156m     v1.20.0+87cc9a4
ip-10-0-136-66.ec2.internal         Ready    master   165m     v1.20.0+87cc9a4
ip-10-0-145-15.ec2.internal         Ready    worker   155m     v1.20.0+87cc9a4
ip-10-0-151-137.ec2.internal        Ready    master   165m     v1.20.0+87cc9a4
ip-10-0-160-201.ec2.internal        Ready    master   165m     v1.20.0+87cc9a4
ip-10-0-167-91.ec2.internal         Ready    worker   156m     v1.20.0+87cc9a4
ip-172-27-201-49.ec2.internal       Ready    worker   4m22s    v1.20.0+87cc9a4
[fenar@jumpserver ~]$ oc debug node/ip-172-27-201-49.ec2.internal
Starting pod/ip-172-27-201-49ec2internal-debug ...
To use host binaries, run `chroot /host`
Pod IP: 172.27.201.49
If you don't see a command prompt, try pressing enter.
sh-4.4# chroot /host
sh-4.4# netstat -arn
Kernel IP routing table

```

| Destination | Gateway | Genmask | Flags | MSS Window | irtf | Iface |
|--------------|----------------|---------------|-------|------------|------|-------------|
| 0.0.0.0 | 172.27.201.254 | 0.0.0.0 | UG | 0 0 | 0 | br-ex |
| 10.128.0.0 | 10.128.4.1 | 255.252.0.0 | UG | 0 0 | 0 | ovn-k8s-mp0 |
| 10.128.4.0 | 0.0.0.0 | 255.255.254.0 | U | 0 0 | 0 | ovn-k8s-mp0 |
| 169.254.0.0 | 0.0.0.0 | 255.255.240.0 | U | 0 0 | 0 | ovn-k8s-gw0 |
| 172.27.200.0 | 0.0.0.0 | 255.255.254.0 | U | 0 0 | 0 | br-ex |
| 172.30.0.0 | 10.128.4.1 | 255.255.0.0 | UG | 0 0 | 0 | ovn-k8s-mp0 |

On-Premise Site Router

d. [Optional] See whats running on new rwn:

```
[core@ip-172-27-201-49 ~]$ sudo crictl ps
CONTAINER    IMAGE                                CREATED      STATE      NAME                                ATTEMPT      POD ID
de988e015f5a 679649b39d5e4b3ac39569b37ac8038fba0418a8c82fd6b04d4affc80fde4e 5 minutes ago Running    container-00 0 44557257a593d
5a2b05edeaff6 1c005219b608388d6fab14276d295a66adf44e1c71ff8623a1874d789681bffa 9 minutes ago Running    own-ipsec 0 1889a7159cee8
919ec234ed562 quay.io/openshift-release-dev/ocp-v4.0-art-dev@sha256:661c4a573886736ec86417a4411c1ff0bc4f4471e0f7221e42f05f509855c02 9 minutes ago Running    dns-node-resolver 0 2211689a0c2d4
a3e85c7afe55 ce9c13e0f0b91dbb86b0971d0044fb537f8cc90eeea1a3fc2b2df739618f7f2b 9 minutes ago Running    kube-rbac-proxy 0 2211689a0c2d4
aa8b30f09e764 ce9c13e0f0b91dbb86b0971d0044fb537f8cc90eeea1a3fc2b2df739618f7f2b 9 minutes ago Running    kube-rbac-proxy 0 326a07b1fd8aa
c5e3ac35f5e7b quay.io/openshift-release-dev/ocp-v4.0-art-dev@sha256:6f0461f48f59f44d6275fce9a434fb317a796851a7a0798eebc4e2d2ee9316f 9 minutes ago Running    dns 0 2211689a0c2d4
78714bc86ac3 quay.io/openshift-release-dev/ocp-v4.0-art-dev@sha256:a8fa25e1e0998d03e8205050855f41041b3fcccfe08b0f355ddc2052f4a87 9 minutes ago Running    network-metrics-daemon 0 326a07b1fd8aa
808c3d8f44428 quay.io/openshift-release-dev/ocp-v4.0-art-dev@sha256:a9db83f67aa4389811bad29af878d038e18bc39f63673fe77fe30f9b1bd97de 9 minutes ago Running    hello-openshift-canary 0 824ac4b18a622
615713edd6a35 quay.io/openshift-release-dev/ocp-v4.0-art-dev@sha256:a9db83f67aa4389811bad29af878d038e18bc39f63673fe77fe30f9b1bd97de 9 minutes ago Running    network-check-target-container 0 2430355b0f228
3b3ab09372eb7 b40608240a49e23b1d7776b6165b18692121a311cb867c4a21ba4a6578da95d 9 minutes ago Running    kube-multus 0 fb72ebacc7ba4
639cc378f04f8 ce9c13e0f0b91dbb86b0971d0044fb537f8cc90eeea1a3fc2b2df739618f7f2b 9 minutes ago Running    kube-rbac-proxy 0 7910877269b52
75053ac647eb a36d93743893931cb187cbe8bc3ec9916f223a0acc654b786a4739ab6fceb84 9 minutes ago Running    node-exporter 0 7910877269b52
9792793f521cd d4e81f44b3c4e91d52f0e88c0a035844922e1882a5257e9c9682a0ffa22329 9 minutes ago Running    csi-liveness-probe 0 30a3528751687
a0d1e6a68822d 202a33e23042b8d7691cd3404bf6c97dd14e08be3777b2c5044908a3d5c4cf2 9 minutes ago Running    node-ca 0 3e797044005ca
2f1d8a2af1cc 485a0713c821441e82559a0a2314e1455b7f2087053977a6fa79129a4a2882 9 minutes ago Running    csi-node-driver-registrar 0 30a3528751687
048ac75503de d490e32bd9496e5260be24c17cc3bb3d360224c90bcc0b7b32effc3f649ebd3 9 minutes ago Running    oauth-proxy 0 de554b2501501
1854c04dacc29 1c005219b608388d6fab14276d295a66adf44e1c71ff8623a1874d789681bffa 9 minutes ago Running    ovnkube-node 0 b25c0875c68f3
70793a9e4d14a 2f6049ff50722f9e10fa245ff20153225e244c397cfa30791d0dbb1bc45af2 9 minutes ago Running    tuned 0 b21c0db0f42c
6a33a8a204c79 ce9c13e0f0b91dbb86b0971d0044fb537f8cc90eeea1a3fc2b2df739618f7f2b 9 minutes ago Running    kube-rbac-proxy 0 b25c0875c68f3
d9ee93402a00e 810143c8f9eaf5bcbcc95e0e9f19907b4f4866169156e0467cb23a02a7498e 9 minutes ago Running    machine-config-daemon 0 de554b2501501
e5a36a3dccc7b6 1c005219b608388d6fab14276d295a66adf44e1c71ff8623a1874d789681bffa 9 minutes ago Running    own-controller 0 b25c0875c68f3
```

Side Note: If you plan to deploy stateful workloads (i.e. use of persistent volumes) , you need to create a new storage class that points to the local disk (you can leverage local storage operator from the operator hub).