Install IBM Cloud Private v2.1 on Red Hat Enterprise Linux v7

Introduction

This is a guide to creating a small IBM Cloud Private (ICP) cluster on RHEL v7.x. It is intended to enhance the installation instructions available in the ICP Knowledge Center (KC).

The phrase "ICP instance" is used in this document to refer to an installation of ICP.

The term "cluster" is used to mean the VMs that are under the control of a given ICP instance. At times in this guide the word "cloud" is used to mean the same thing as cluster.

This instruction guide assumes the VMs to be used for the ICP instance are provided to you by some providing entity.

Root access, either directly or through sudo, must be available to the person doing the ICP installation for all of the ICP machines (VMs) that will be members of the ICP cluster. If sudo is used, it is recommended that passwordless sudo is configured. Otherwise, the cluster configuration file (config.yml) will need the sudoer's password specified. An ICP installation as non-root is beyond the scope of this document.

IBM Cloud Private is built on Docker and Kubernetes. Cloud Foundry may also be part of an ICP instance. The installation and deployment of Cloud Foundry is outside the scope of this guide.

IBM Cloud Private has certain components (the "master" and "proxy" nodes, for example) that may be deployed as singletons in a simple installation as described in this guide. An installation that includes redundancy of all components is beyond the scope of this guide.

The installation described in this document uses Docker CE. Installing Docker EE is outside the scope of this document.

NOTE: As of March 2017, Docker broke out two builds, one referred to as Community Edition (CE) and the other referred to as Enterprise Edition (EE). Docker EE is intended to be used on RHEL. Docker EE requires a subscription and payment for a license. Docker CE and Docker EE are intended to be functionally identical. Docker EE comes with full support as opposed to Docker CE, which only has "community" support, i.e., if you run into a problem you may not be able to get support in a timely manner.

NOTE: If you want to use Docker CE on RHEL, get the Docker CE packages built for Centos. Packages built for Centos have binary compatibility with RHEL.

For Docker on RHEL information see: "Get Docker EE for Red Hat Enterprise Linux".

Getting started overview

This section provides a big picture summary of the installation process.

- An IBM Cloud Private (ICP) installation is usually made up of multiple virtual machines that are collectively referred to as a cluster. (This document may also refer to the collection of machines as a cloud or an ICP instance.) Individual machines are referred to as nodes. An ICP installation includes machines with a special role as itemized here:
  - Boot-master - The machine where the ICP control is installed. (It is typical to combine the "boot" and "master" into one machine.)
  - Management - The simple installation used to create this document combines the management role with the boot-master node.
  - Proxy - Machine used for request routing
  - Multiple worker nodes

- The ICP v2.1 Knowledge Center section Supported operating systems and platforms, has a list of supported operating systems. ICP is supported on RHEL 7. ICP is not supported on RHEL 6.

- System requirements: The ICP v2.1 Knowledge Center section Hardware Requirements and Recommendations, has a table describing the system requirements for each of the types of nodes in an ICP instance. The installation described in this document is a "multi-node cluster".

- It is a really good idea that all machines used for ICP have access to the RHEL yum repositories (os, optional and extras) in order to install various RHEL packages that are pre-requisites for ICP. Many data centers have a Red Hat Satellite server available.

- It is a really good idea for all the machines in the ICP cluster to have access to the public Internet. The public Docker yum repository makes it convenient to install the latest version of Docker CE. Docker Hub is convenient for access to commonly available Docker images.

The ICP installation in a nutshell:

1. Customize RHEL for Docker and ICP.
2. Install Docker on the boot-master.
3. Set up RSA based ssh login from the Boot-Master to all nodes in the cluster.
4. Run the ICP inception installer on the boot-master.

Some other steps may need to be taken depending on specific circumstances and requirements:

- Configure access to RHEL yum repositories.
- Configure `/etc/hosts` files on all cluster members if DNS is not available to resolve host names and IP addresses.
- Update RHEL to the latest patch level.
- Install NTP.
- Install Python Docker modules to support the convenient use of Docker APIs in Python scripts.
- Install Docker on each cluster member VM in addition to the boot-master VM. (This gives you full control over what version of Docker is installed, but more importantly, Docker on each VM is needed for the next step.)
- Use Docker on each cluster member VM to pre-load the ICP Docker images rather than let the inception installation load the ICP Docker images. (It turns out to be expedient to copy the ICP image tar-ball to each cluster member VM and then load the local Docker registry from that tar-ball rather than waiting for the inception installer to do that part of the installation.)

Basic RHEL configuration

The sub-sections in this section describe some basic RHEL configuration required to support ICP cluster members. We are calling this "basic" configuration because it is typical that a RHEL VM will be configured as described in these sub-sections.

If you are creating your own virtual machine, you can do all these steps on your initial VM before cloning it.

If you are using VMs that were deployed for you, then it is likely the VMs are already configured as described in these sub-sections. You should confirm with your VM provider or by doing the basic checks described below, that all the VMs that are going to be part of the ICP cluster have been configured as described in these sub-sections.

Configure network interface to start on boot

NOTE: This section describes steps you won't need to do for a virtual machine deployed for you in a typical virtualization platform. If you are building your own VM, you will likely need to complete these steps.

By default, RHEL 7 network interfaces are not started at boot time. This tends to be inconvenient. This section describes the steps to configure a network interface to start at boot time.

To find out the names of the network interfaces on a machine you can use the `iconfig` command. The name of each network interface is in the first column.

The network interface configuration files are in `/etc/sysconfig/network-scripts/`. The file names include the name of the network interface as seen in the `ifconfig` command output.

1. Edit the file in `/etc/sysconfig/network-scripts` associated with the network interface to be started at boot time, e.g., `/etc/sysconfig/network-scripts/ifcfg-ens33`.

2. Change the value of `ONBOOT` from no to yes: `ONBOOT=yes`

3. Save the changes.

4. If desired, test by rebooting:

   ```
   shutdown -r now
   ```

When the VM comes back up the network interface should be UP/RUNNING. The `ifconfig` command includes the status of each interface.

Configure the host name

This section describes the configuration of the host name for RHEL 7 VMs.

NOTE: This step is unnecessary and is **not advisable** in scenarios where the VMs were provided to you. Check with your VM provider, system administrator and/or network administrator before changing a host name.

Host name considerations usually involve using naming conventions provided by the network and system administrators.

Be sure to use a fully qualified domain name (FQDN) for the value of the host name.

Some sample "toy" host names: `bootmaster`, `proxy`, `worker01`, etc.

There are a couple of different places where the host name is specified.

For RHEL 7 the host name can be set using the `hostnamectl` command.

```
hostnamectl set-hostname bootmaster01.site.org.com
```

See the man pages for hostnamectl for more information.

Additional notes on host name:

1. The host name is stored in the `/etc/hostname` file. (NOTE: This file should only have the text of the host name on a single line with no newline character.)

2. There may be a HOSTNAME directive in the `/etc/sysconfig/network` file.

3. A reboot is needed to have the host name change take effect: `shutdown -r now`

Enable remote login for root via ssh

NOTE: For RHEL v7.x, by default root can login via ssh using a password.

The configuration for ssh is in `/etc/ssh/sshd_config`. You will notice that `PermitRootLogin` is commented out. However, `UsePAM` is set to yes. A PAM configuration file for `sshd` is in `/etc/pam.d`. Configuration of the PAM plugin for `sshd` is beyond the scope of this document.

Yum repository configuration

NOTE: A RHEL virtual machine provided for you will very likely already have a yum repository configured, most likely using a Red Hat Satellite (RHS) server. This section is intended to provide guidance for those who need to configure a yum repository.

NOTE: You may need to provide a userid and password as part of the yum repository URL. If you are using an ID with an @ character in it, e.g., an Internet email address, use %40 in place of the @ character. Otherwise the repository URL is misinterpreted because an @ character marks the beginning of the host name in the URL.

You need to set up the repos for yum to be able to install additional packages and get OS updates.

The yum repo definition files are in `/etc/yum.repos.d/`. Any file in that directory with a .repo extension will be treated as a repo definition.

Each file may have multiple repositories defined.

Each repo definition typically has at least 5 attributes:

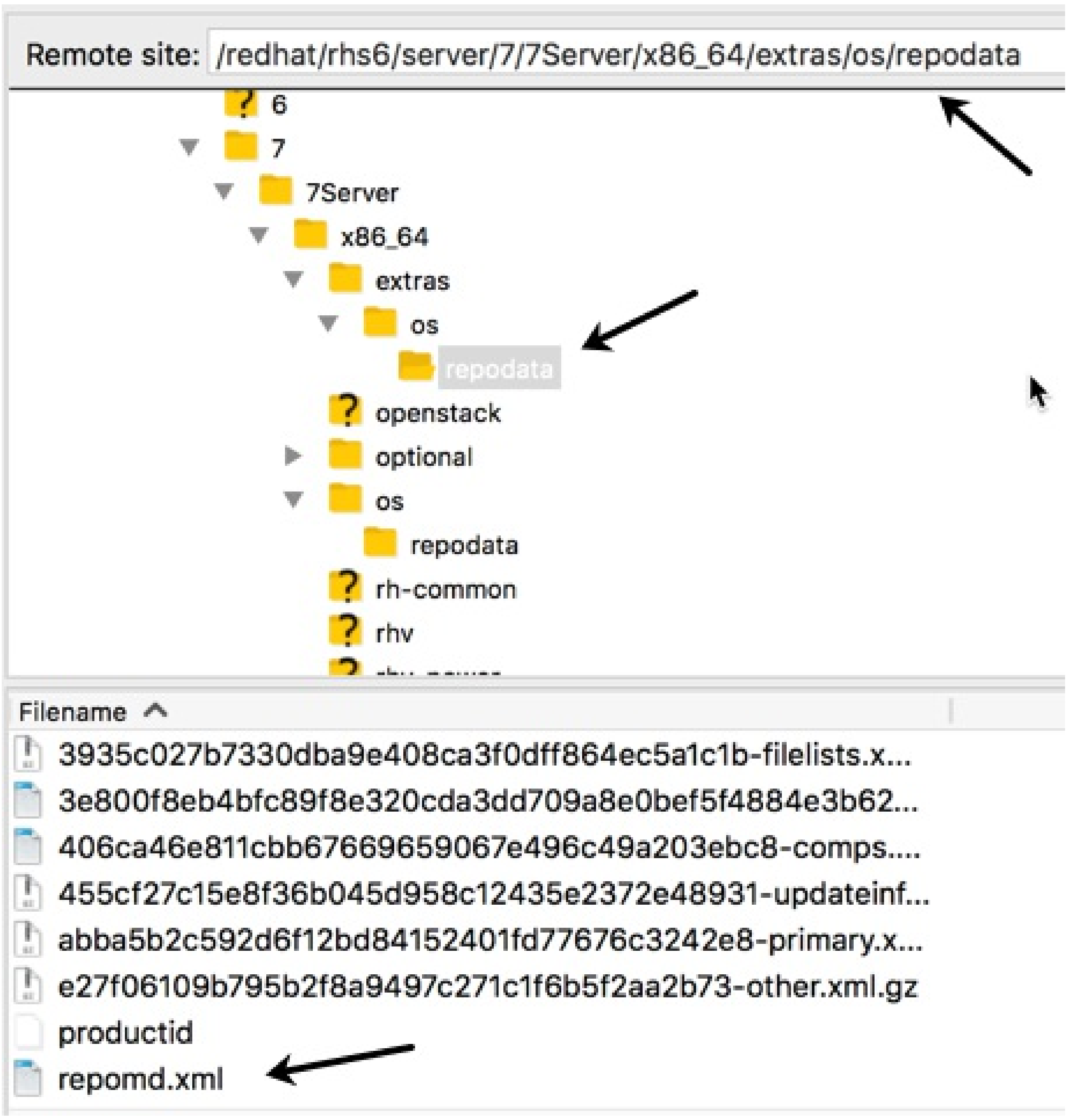
```
[rhel-os]
name=Red Hat Enterprise Linux at my site
enabled=1
gpgcheck=0
baseurl=<protocol>://<userid>:<password>@<repo_host>/<repo_path>
```

The `<protocol>` could be ftp or http(s) for remote repos, or file for a local repo.

If the repository requires a `<userid>` and `<password>`, that is included in the URL as shown.

See the Red Hat documentation Configuring Yum and Yum Repositories for more details.

The needs to point to a directory with a `repodata` sub-directory where a file named `repomd.xml` is found. If you need to explore a repository to determine the , something like Filezilla is very handy to use for exploration. You can also confirm your user ID and password in getting to the repo. (See figure below.)



Remote site: /redhat/rhs6/server/7/7Server/x86_64/extras/os/repodata

```
? 6
▼ 7
  ▼ 7Server
    ▼ x86_64
      ▼ extras
        ▼ os
            repodata
        ? openstack
        ▶ optional
        ▼ os
            repodata
        ? rh-common
        ? rhv
```

Filename

```
3935c027b7330dba9e408ca3f0dff864ec5a1c1b-filelists.x...
3e800f8eb4bfc89f8e320cda3dd709a8e0bef5f4884e3b62...
406ca46e811cbb67669659067e496c49a203ebc8-comps....
455cf27c15e8f36b045d958c12435e2372e48931-updateinf...
abba5b2c592d6f12bd84152401fd77676c3242e8-primary.x...
e27f06109b795b2f8a9497c271c1f6b5f2aa2b73-other.xml.gz
productid
repomd.xml
```

In the figure above the `<repo_path>` text would be: `/redhat/rhs6/server/7/7Server/x86_64/extras/os/`

You may need to explore a given collection of yum repositories in order to figure out where various packages are located. Packages are typically spread across multiple directories such as "os", "optional" and "extras".

Depending on how DNS is configured, you may need to add an entry in the `/etc/hosts` file for the `<repo_host>`.

Once you have configured the yum repository you can do a quick test to confirm the configuration file is correct:

```
yum repolist
```

Yum caches its repository information as a performance enhancement. If you want to "clean" the cache to make sure you are not using stale information about yum repositories, use:

```
yum clean all
```

Once you have the desired yum repositories configured, you can proceed with any RHEL configuration that requires additional packages (rpms) to be installed.

At some point while using yum, you may see "Given file does not exist" errors such as:

```
rhel-optional/updateinfo       FAILED
ftp://<userid>:<password>@<repo_host>:/redhat/rhs6/server/7/7Server/x86_64/optional
Trying other mirror.
rhel-optional/primary          FAILED
ftp://<userid>:<password>@<repo_host>:/redhat/rhs6/server/7/7Server/x86_64/optional
Trying other mirror.
ftp://<userid>:<password>@<repo_host>:/redhat/rhs6/server/7/7Server/x86_64/optional
Trying other mirror.
ftp://<userid>:<password>@<repo_host>:/redhat/rhs6/server/7/7Server/x86_64/optional
```

If you inspect the yum repository, you will notice that the `<uuid1>-updateinfo.xml.gz` and `<uuid2>-primary.xml.gz` files have a new UUID.

A `yum clean all` will likely clean up such errors.

Update RHEL

This section describes the steps to update RHEL.

NOTE: This is an optional step and may not be necessary depending on the virtual machine that has been provided to you. You may also not be permitted to do a full update, as that may move your RHEL to a version that is not yet supported by your operations team. For example, if the VM is running RHEL 7.3 a full update will result in RHEL 7.4.

If you are building a VM from scratch, then you should do a full RHEL update to pick up updates since the release of the RHEL image you are using for the initial install.

It is assumed you have configured your VM with yum repositories.

1. Do a yum update (`yum -y update`) - This gets all the latest patches for everything already installed.

2. Then reboot. (`shutdown -r now`). You need to reboot to get to the latest kernel.

Install NTP

This step is only needed if you are building a virtual machine. NTP will be installed on a VM provided to you.

NTP is needed to keep the time synchronized with the rest of the world. All of the VMs in the ICP cluster will need to share a common notion of time, and the usual approach to keeping time is to use NTP.

NOTE: If you are using virtual machines provided to you, it is very likely NTP is already installed and enabled for startup at machine boot.

NOTE: If you are using virtual machines provided to you, and NTP is not installed and in use, the VMs may be using some other time provider, such as the hypervisor. Check with your provider to determine if it is necessary to install NTP.

1. Install NTP

   ```
   yum -y install ntp
   ```

2. Check the NTP configuration in `/etc/ntp.conf`

See the Red Hat documentation, Configure NTP, for more detailed guidance.

NOTE: The default `/etc/ntp.conf` content is likely sufficient. You may want to add one or more local time providers to the list of servers provided by Red Hat:

```
server 0.rhel.pool.ntp.org iburst
server 1.rhel.pool.ntp.org iburst
server 2.rhel.pool.ntp.org iburst
server 3.rhel.pool.ntp.org iburst
```

- Enable the NTP daemon. (This will make sure ntpd starts up when the machine is booted.)

  NOTE: The name of the service is **ntpd**, not ntp. (Go figure.)

  ```
  systemctl enable ntpd
  ```

- Start the NTP service.

  ```
  systemctl start ntpd
  ```

- Check the NTP service status.

  ```
  systemctl status ntpd
  ```

- If you need to stop the NTP service:

  ```
  systemctl stop ntpd
  ```

- To get a list of peer servers in use:

  ```
  ntpq -p
  ```

  NOTE: Leave NTPD started and enabled (so that it starts at boot time).

Configure /etc/hosts

This section describes the steps to add entries to the `/etc/hosts` file of each cluster member for all the hosts in the cluster.

NOTE: This section can be skipped if DNS is being used for host name resolution. You can use `nslookup` on the IP addresses of a sampling of cluster members to determine if there are DNS entries for the cluster member VMs. If not, then you need to configure `/etc/hosts`.

NOTE: The "minimal" RHEL install does not include bind-utils, which is the RPM that contains the `nslookup` command. If you are using a minimal RHEL image, then you need to install bind-utils if you want to use `nslookup`. (`yum -y install bind-utils`)

- For each VM in the cluster, edit `/etc/hosts` and add and entry for each VM in the cluster.

In some circumstances you can edit `/etc/hosts` once on the boot-master and then `scp` the hosts file to the other members of the cluster. This expedient is only feasible if the all VMs in the cluster are freshly deployed VMs and they all have the same content in `/etc/hosts` when they are initially deployed, e.g., the default content.

Check the file system sizing

The file system size minimum requirements are described in the ICP v2.1 Knowledge Center section, (See Table 3). The "important" note following the table suggests mounting `/var/lib/etcd`, `/var/lib/registry` and `/opt/ibm/cfc` on separate paths associated with larger disks.

The file system requirements as described in the ICP v2.1 KC documentation are reproduced in the following table:

Location	Minimum Disk Space
`/var/lib/docker`	>40 GB (This may not be enough.)
`/var/lib/etcd`	>1 GB
`/var/lib/registry`	Large enough to host the Docker images you expect to load into the local registry. Docker images for ICP itself are on the order of 8 GB.
`/opt/ibm/cfc`	>100 GB
`/var/lib/kubelet`	>10 GB w/o Vulnerbility Advisor
`/var/lib/kubelet`	>100 GB w/ Vulnerability Advisor

NOTE: See the section in the ICP v2.1 Knowledge Center,

The RHEL 7 documentation for provides detailed information about the mount command.

Special RHEL configuration

The sub-sections in this section describe RHEL configuration that is not typical. Even on a VM provided to you, you will very likely need to take the steps described in these sub-sections in order to prepare the machine to be a member of an ICP cluster.

vm.max_map_count

The map_max_count determines the maximum number of memory map areas a process can have. Docker requires that the max_map_count be substantially greater than the default (65530). This section describes the steps to setting the `vm.max_map_count` to an appropriate number.

NOTE: Do not confuse the `sysctl` command with the `systemctl` command. The command for getting and setting system parameters is `sysctl` not `systemctl`.

To make an immediate change to the `vm.max_map_count` system parameter:

```
sysctl -w vm.max_map_count=262144
```

NOTE: The above command writes the value of max_map_count to the file `/proc/sys/vm/max_map_count`. However, the `vm.max_map_count` will revert to its default value on reboot.

In order to have the `vm.max_map_count` carry over through a reboot, edit the `/etc/sysctl.conf` file and add a line to define the value:

```
vm.max_map_count=262144
```

If you want to see the value of a system control variable just use: `sysctl <name>`, e.g.,

```
sysctl vm.max_map_count
```

Some background on RHEL system parameters

RHEL system parameters can be configured in several places with a well-defined precedence. The `/etc/sysctl.conf` file is intended for use by the "local" system administrator. Parameter settings in `/etc/sysctl.conf` have the highest precedence with respect to the value settings. Other locations where system configuration parameters are read in order of precedence are: `/etc/sysctl.d/*.conf`, `/run/sysctl.d/*.conf` and `/usr/lib/sysctl.d/*.conf`. There are other locations for system configuration parameters as well. See the man pages for sysctl and sysctl.d for more details.

NOTE: It is recommended that configuration parameter file names have a leading 2-digit number followed by a dash in order to clearly indicate the ordering in which the files should be processed at the time the machine is booted. (The files are processed in the lexical ordering of their names.)

The following observations apply to a default RHEL image. The specific VM you are using may be configured differently.

- On a default RHEL image, the `/etc/sysctl.conf` file has nothing in it, and comments in `/etc/sysctrl.conf` refer to using files in `/usr/lib/sysctl.d`.
- On a default RHEL image, `/usr/lib/sysctl.d` has three files:

  ls /usr/lib/sysctl.d/
  00-system.conf 50-default.conf 60-libvirtd.conf
- On a default RHEL image, none of the above files has anything in it having to do with `vm.max_map_count`.
- On a default RHEL image, there is nothing in `/run/sysctl.d/` (The sysctl.d directory does not exist.)
  The `/etc/sysctl.d` has only the file, `99-sysctl.conf`, but that file has nothing in it except the preface comments.

Delete the /var/lib/mysql directory

If the `/var/lib/mysql` directory exists on any of the ICP cluster VMs, the install will fail on that VM. At least on some RHEL 7 installations, it seems mysql gets a directory in `/var/lib` even if it is not used for anything.

- On all VMs in the cluster/cloud, make sure there is no `mysql` directory in `/var/lib`, i.e.,

  ```
  rmdir /var/lib/mysql
  ```

Installing docker community edition using a yum repository

You have two options for installing Docker:

1. Install Docker only on the boot-master machine and let Docker be installed on all of the other cluster members as part of the ICP installation.

2. Install Docker on the boot-master and all of the cluster members. This install guide uses this option because it tends to be faster to install Docker on each machine. Once Docker is installed on each machine, the ICP Docker images can be loaded into the local Docker registry on each machine, which is another trick to speed up the ICP installation.

This section describes the steps to install Docker Community Edition on RHEL v7 using a yum repository. If you have access to the Internet and can get to **download.docker.com** you can use the yum repository defined there. Otherwise, it is assumed you have access to a yum repository with a recent version of Docker Community Edition available.

Docker Community Edition is identical in behavior to Docker Enterprise Edition. IBM Cloud Private is supported on Docker Community Edition, or older versions of Docker before the differentiation occurred between Docker editions. The installation of Docker Enterprise Edition is beyond the scope of this document.

A typical RHEL yum repository may have the docker RPMs, but they may not be the current version. It is recommended that the docker version available at download.docker.com be used.

NOTE: This installation scenario assumes Internet connectivity and access to **docker.com**.

The Docker documentation, *Get Docker CE for CentOS* has detailed information on Docker Community Edition installation. The instructions here are derived from the Docker documentation.

NOTE: The yum-config-manager utility is part of the yum-utils RPM. If your machine doesn't have yum-config-manager then you need to install yum-utils (`yum -y install yum-utils`). (A RHEL "minimal install" does not include yum-utils. Yum-utils has some Python related pre-reqs that also get installed.)

- Set up the docker yum repository

```
yum-config-manager --add-repo https://download.docker.com/linux/centos/docker-c
```

You should see output similar to this:

```
Loaded plugins: langpacks, product-id
  adding repo from: https://download.docker.com/linux/centos/docker-ce.repo
  grabbing file https://download.docker.com/linux/centos/docker-ce.repo to /etc
  repo saved to /etc/yum.repos.d/docker-ce.repo
```

- Install Docker CE.

```
yum -y install docker-ce
```

NOTE: The docker-ce install has a pre-req of container-selinux. If there is no container-selinux in your yom repositories the above command will fail. (The container-selinux package is in the RHEL "extras" repo.)

A work-around to the above install is described here: https://github.com/docker/for-linux/issues/20If The following command was taken from the work-aournd:

```
yum -y install --setopt=obsoletes=0 docker-ce-17.03.2.ce-1.el7.centos.x86_64 docker
```

- Start and enable the docker daemon.

```
systemctl start docker
systemctl enable docker
```

- Run the usual `docker run hello-world` to confirm the installation.

```
docker run hello-world
```

The main thing to check for in the output from hello-world:

```
Hello from Docker!
This message shows that your installation appears to be working correctly.
```

You shouldn't see any errors when running the docker hello-world smoke test.

Things that can go wrong with Docker install

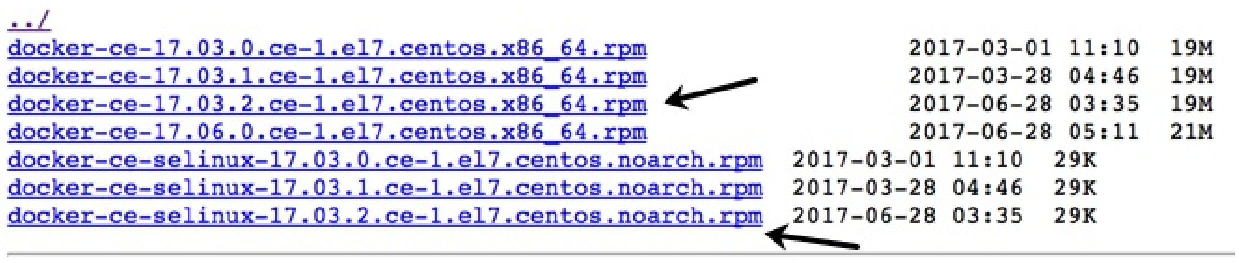
1. Your RHEL install doesn't have a `container-selinux` version greater than 2.9. See https://stackoverflow.com/questions/45272827/docker-ce-on-rhel-requires-container-selinux-2-9

2. Your RHEL install doesn't have yum-config-manager. You need to install yum-utils (`yum install -y yum-utils`)

Installing docker community edition using RPMs

In some contexts, you may not be able to get access to the Docker repo site or any other external site that has the docker packages. In that case you need to install using the RPMs.

For RHEL, get the Centos RPMS. You can get the Centos RPMs here: https://download.docker.com/linux/centos/7/x86_64/stable/Packages/



```
../
docker-ce-17.03.0.ce-1.el7.centos.x86_64.rpm              2017-03-01 11:10   19M
docker-ce-17.03.1.ce-1.el7.centos.x86_64.rpm              2017-03-28 04:46   19M
docker-ce-17.03.2.ce-1.el7.centos.x86_64.rpm              2017-06-28 03:35   19M
docker-ce-17.06.0.ce-1.el7.centos.x86_64.rpm              2017-06-28 05:11   21M
docker-ce-selinux-17.03.0.ce-1.el7.centos.noarch.rpm  2017-03-01 11:10   29K
docker-ce-selinux-17.03.1.ce-1.el7.centos.noarch.rpm  2017-03-28 04:46   29K
docker-ce-selinux-17.03.2.ce-1.el7.centos.noarch.rpm  2017-06-28 03:35   29K
```

You need the SELinux RPM.

See the ICP Knowledge Center section, Supported Docker versions for a list of supported Docker versions.

1. Copy a container-selinux package to the machine where Docker is to be installed.

2. Copy the RPMs to the machine where the Docker install is to be completed.
3. The install oder is container-selinux, docker-ce-selinux

This sample command line is intended to be executed in the directory where the RPMs are located:

```
yum -y install container-selinux-1.12.5-14.el7.x86_64.rpm
yum -y install docker-ce-selinux-17.03.2.ce-1.el7.centos.noarch.rpm
yum -y install docker-ce-17.03.2.ce-1.el7.centos.x86_64.rpm
```

That should complete the Docker installation.

To finish things off, start and enable docker and run the hello-world smoke test as described in the above section.

Install Python Docker support

This section describes the steps for installing Python Docker support modules. The Docker modules that get installed allow all the usual Docker commands to be used within a Python script.

Installing the Python Docker support modules is optional. If you don't intend to use Python for scripting of Docker operations, then this section can be skipped.

NOTE: Python has a `docker` package and a `docker-py` package. They do not appear to be equivalent or synonyms for the same thing. The installation of the `docker` package appears to include the `docker-py` package, but not vice versa.

In order to install the Python Docker support modules, pip needs to be installed. (Pip is the Python package manager.) In order to install pip, the python-setuptools package needs to be installed.

- Install Python setup tools. (Python setuptools may already be installed.)

```
yum -y install python-setuptools
Loaded plugins: langpacks, product-id, search-disabled-repos, subscription-mana
Package python-setuptools-0.9.8-4.el7.noarch already installed and latest versi
Nothing to do
```

- Install pip.

```
easy_install pip
Searching for pip
Reading https://pypi.python.org/simple/pip/
Best match: pip 9.0.1
...
Adding pip 9.0.1 to easy-install.pth file
Installing pip script to /usr/bin
Installing pip2.7 script to /usr/bin
Installing pip2 script to /usr/bin

Installed /usr/lib/python2.7/site-packages/pip-9.0.1-py2.7.egg
Processing dependencies for pip
Finished processing dependencies for pip
```

- Install Python Docker support modules.

```
pip install docker
```

After the install of docker you should see the following directories:

```
# ls -l /usr/lib/python2.7/site-packages/docker*
/usr/lib/python2.7/site-packages/docker:
api    auth.py    client.py    constants.py    errors.py    __init__.py    models      tl
auth   auth.pyc   client.pyc   constants.pyc   errors.pyc   __init__.pyc   ssladapter  tl

/usr/lib/python2.7/site-packages/docker-2.5.1.dist-info:
DESCRIPTION.rst  INSTALLER  METADATA  metadata.json  RECORD  top_level.txt  WHEEL

/usr/lib/python2.7/site-packages/docker_py-1.10.6.dist-info:
DESCRIPTION.rst  INSTALLER  METADATA  metadata.json  RECORD  top_level.txt  WHEEL

/usr/lib/python2.7/site-packages/dockerpycreds:
constants.py  constants.pyc  errors.py  errors.pyc  __init__.py  __init__.pyc  stor

/usr/lib/python2.7/site-packages/docker_pycreds-0.2.1.dist-info:
DESCRIPTION.rst  INSTALLER  METADATA  metadata.json  RECORD  top_level.txt  WHEEL
```

MountFlags in docker.service

The MountFlags setting needs to be done on all machines in the cluster/cloud.

It is assumed that docker has been installed. (You won't see a `docker.service` file in `/lib/systemd/system` if docker has not been installed.)

1. Edit the file: `/lib/systemd/system/docker.service`
2. To the Service section, add the line:

   ```
   MountFlags=shared
   ```

Here is the Service section of `docker.service` after the `MountFlags` property has been added at the end of the section.

```
[Service]
Type=notify
# the default is not to use systemd for cgroups because the delegate issues still
# exists and systemd currently does not support the cgroup feature set required
# for containers run by docker
ExecStart=/usr/bin/dockerd
ExecReload=/bin/kill -s HUP $MAINPID
# Having non-zero Limit*s causes performance problems due to accounting overhead
# in the kernel. We recommend using cgroups to do container-local accounting.
LimitNOFILE=infinity
LimitNPROC=infinity
LimitCORE=infinity
# Uncomment TasksMax if your systemd version supports it.
# Only systemd 226 and above support this version.
#TasksMax=infinity
TimeoutStartSec=0
# set delegate yes so that systemd does not reset the cgroups of docker containers
Delegate=yes
# kill only the docker process, not all processes in the cgroup
KillMode=process
MountFlags=shared
```

Starting and enabling Docker

This section has commands for starting and enabling docker and checking its status.

After Docker is installed, you need to start it.

To start docker:

```
# systemctl start docker
```

To get docker status:

```
# systemctl status docker
```

To enable docker (so that it starts on machine reboot):

```
# systemctl enable docker
Created symlink from /etc/systemd/system/multi-user.target.wants/docker.service to
```

To stop docker:

```
# systemctl stop docker
```

Configure passwordless ssh among cluster/cloud members

The "boot master" VM needs to have root access via ssh to the other members of the cloud.

NOTE: In the description below, it is assumed that DNS is in use and the host names for the ICP cluster VMs are registered in the DNS. If DNS is not in use, then the `/etc/hosts` files on each of the ICP cluster VMs must have been set up to map host names to IP addresses. Hence, host names are used in the samples. (The ssh-copy-id command requires the use of host names.)

NOTE: Substitute your actual host names In the sample commands in this section.
For the ICP KC instructions to do this work, see "Sharing SSH keys among cluster nodes": https://www.ibm.com/support/knowledgecenter/SSBS6K_2.1.0/installing/ssh_keys.html

- Login to the boot-master node as root

- On the boot-master, as root, from root’s home directory (/root) execute:

  ```
  # ssh-keygen -t rsa -P ''
  ```

  Upper case P and two single quotes for no password.

  When prompted, hit Enter/Return to accept the default location for the new key file:

  ```
  Generating public/private rsa key pair.
  Enter file in which to save the key (/root/.ssh/id_rsa):
  Your identification has been saved in /root/.ssh/id_rsa.
  Your public key has been saved in /root/.ssh/id_rsa.pub.
  ...
  ```

- Now, executing a directory listing on /root/.ssh should show two files: id_rsa, id_rsa.pub. (A known_hosts file may also be present.)

  ```
  # ls -l ./.ssh
  total 8
  -rw-------. 1 root root 1675 Jun 30 12:11 id_rsa
  -rw-r--r--. 1 root root  402 Jun 30 12:11 id_rsa.pub
  ```

- Using the `ssh-copy-id` command from root's home directory, copy the resulting id_rsa key file to each node in the cluster (including the boot-master node on which you are currently operating).

NOTE: The copy of the SSH ID to other hosts requires the use of the target host name in the ssh-copy-id command. Do not use an IP address, you will not be able to get past the authentication step when you attempt to enter the password for root on the target host.

In the command below `<master>` is used as a placeholder for the actual boot-master fully qualified host name (FQDN).

```
# ssh-copy-id -i ./.ssh/id_rsa.pub root@<master>
```

You will be prompted to confirm that you want to connect to the `<master>`. Then you will be prompted for root's password on `<master>`, which is the target for this first passwordless ssh configuration.

NOTE: If you are not prompted to confirm that you want to connect to the target machine, and for the root password of the target machine, then make sure the target machine has a .ssh directory in /root. The permissions on the .ssh directory should be 700. Also make sure you can ping the target host by host name. (DNS or `/etc/hosts` on the boot-master needs to be configured to allow the target host name to be resolved.)

- Now try logging into the machine, with: `ssh root@<master>` and check to make sure that only the key(s) you wanted were added.

At this point you should see two additional files in the .ssh directory:

```
# ls -l .ssh
total 16
-rw-------. 1 root root  402 Jun 30 12:17 authorized_keys
-rw-------. 1 root root 1675 Jun 30 12:11 id_rsa
-rw-r--r--. 1 root root  402 Jun 30 12:11 id_rsa.pub
-rw-r--r--. 1 root root  191 Jun 30 12:17 known_hosts
```

- Repeat for each additional server in the cluster/cloud. (As above, you will need to answer yes to add the ECDSA key for each host to the known_hosts file and provide the root password of the target host.)

In the commands below, `<proxy>` and `<worker_##>` is used as a placeholder for the fully qualified host names (FQDN) for machines in the cluster.

```
# ssh-copy-id -i ./.ssh/id_rsa.pub root@<proxy>
# ssh-copy-id -i ./.ssh/id_rsa.pub root@<worker_01>
# ssh-copy-id -i ./.ssh/id_rsa.pub root@<worker_02>
etc
```

- When this is complete, you should be able to ssh from the boot-master node to each of the other nodes as root without having to provide a password. You can test this by executing and ssh from the boot-master host to any of the other members of the ICP cluster:

  ```
  [root@<master> ~]# ssh root@<proxy>
  Last login: Thu Jun 29 14:44:34 2017
  [root@<proxy> ~]# exit
  logout
  Connection to <proxy> closed.
  [root@<master> ~]# ssh root@<worker_01>
  Last login: Fri Jun 30 09:39:31 2017
  ```

```
[root@<worker_01> ~]# exit
logout
Connection to <worker_01> closed.
[root@<master> ~]#
etc
```

If you cannot gain access via SSH without a password, check the known_hosts and authorized_keys files on the hosts other than the boot-master.

Install IBM Cloud Private v2.1

This is the start of the description of the steps to install IBM Cloud Private.

Prerequisite steps

1. If you are building you own VM, you should have already created a clone of the ICP base VM for each VM in the cluster. At a minimum, this would be the boot-master, the proxy and a couple of worker nodes.

2. If you are using VMs provided to you, then you should have completed all the steps to getting Docker running on at least the boot-master machine. The install process includes installing Docker on each cluster member. As an expedient we recommend pre-installing Docker on each cluster member. (See the *Copy and load ICP docker image tar ball to all cluster VMs* section below for details.)

3. DNS or the `/etc/hosts` file on each VM should be configured with the proper entries so that each VM can resolve the address of the other members of the cluster/cloud.

4. SSH needs to have been set up such that the "boot master" VM can ssh to each of the other VMs in the cluster/cloud as root without using a password.

5. The product install image should be available on the boot-master machine. If not, download the product archives from Passport Advantage (IBM customer) or eXtreme Leverage (IBM internal). You can find the GA release by searching on, *IBM Cloud Private*.

6. The ICP Knowledge Center (KC) installation instructions for ICP Cloud Private Enterprise are rooted in the section: Intalling ICP Cloud Private Enterprise.

7. On all VMs in the ICP cluster, if firewalld is running, stop it and disable it until after the ICP install completes.

To see if firewalld is running, use:

```
# systemctl status firewalld
```

To stop and disable firewalld, use:

```
# systemctl stop firewalld
# systemctl disable firewalld
Removed symlink /etc/systemd/system/dbus-org.fedoraproject.FirewallD1.service.
Removed symlink /etc/systemd/system/basic.target.wants/firewalld.service.
```

NOTE: The firewall only needs to be disabled during install. It gets enabled again on all members of the cluster/cloud after the install has completed.

NOTE If you are creating an ICP cluster with VMs (members) on more than one network segment/VLAN, then there may be physical firewalls that need to be configured to allow the ICP installation to proceed. See the ICP Knowledge Center section, Default ports, for the list of ports that must be open for installation and configuration of an ICP instance.

Some additional "boot master" pre-installation steps

This section has some steps that need to be taken on the boot master before the actual installation command can be run.

NOTE: In these instructions, the root directory of the installation is referred to as `<ICP_HOME>`. A common convention is to install ICP in a directory that includes the ICP version in the directory name.

- It is assumed that Docker is installed and running on the boot-master machine.
- It is assumed that the ICP images archive has been loaded into the Docker registry on the boot-master machine.

```
tar -xf ibm-cloud-private-x86_64-2.1.0.tar.gz -O | docker load
```

- (On the boot-master) Extract the ICP boot meta-data to the `<ICP_HOME>/cluster` directory:

```
# cd <ICP_HOME>
# docker run -v $(pwd):/data -e LICENSE=accept ibmcom/icp-inception:2.1.0-ee cp
```

The above command creates a directory named `cluster` in `<ICP_HOME>`. The `cluster` directory has the following contents:

```
# ls -l cluster
-rw-r--r--. 1 root root 3998 Oct 30 06:37 config.yaml
-rw-r--r--. 1 root root   88 Oct 30 06:37 hosts
drwxr-xr-x. 4 root root   39 Oct 30 06:37 misc
-r--------. 1 root root    1 Oct 30 06:37 ssh_key
```

- Add the IP address of all the cluster/cloud members to the `hosts` file in `<ICP_HOME>/cluster`.

  NOTE: The ICP hosts file must use IP addresses. Host names are not used.

- Copy the ssh key file to the /cluster. (This overwrites the empty ssh_key file already there.)

```
# cp ~/.ssh/id_rsa ssh_key
cp: overwrite ‘ssh_key’? y
```

- Check the permissions on the ssh_key file and make sure they are read-only for the owner (root). If necessary, change the permissions on the ssh_key file in `<ICP_HOME>/cluster` to "read-only" by owner, i.e., root.

- Check the access:

```
# ls -l ssh_key
-r--------. 1 root root 1675 Jun 30 13:46 ssh_key
```

- If the access is not read-only by owner, then change it:

```
# chmod 400 ssh_key
```

- Check again to make sure you changed it correctly.

- Copy/move the "image" archive (`ibm-cloud-private-x86_64-2.1.0.tar.gz`) to the images directory in `<ICP_HOME>/cluster` . (You first need to create the images directory.) In the command below it is assumed the image archive is located initially in `<ICP_HOME>` .

  From `<ICP_HOME>/cluster` :

  ```
  # mkdir images
  # mv `<ICP_HOME>/ibm-cloud-private-x86_64-2.1.0.tar.gz` images
  ```

Working with the config.yaml file is described in the next section.

Configuring config.yaml on the boot master

For information on the content of config.yaml, see the ICP KC section, Cluster configuration settings.

For a simple sandbox deployment, the content of config.yaml can remain as is.

Things that can be left as-is for a small sandbox environment:

- network_type calico
- network_cidr: 10.1.0.0/16
- service_cluster_ip_range: 10.0.0.1/24
- For a simple cluster, everything else in config.yaml remains commented out.

There are many parameters that may be set in config.yaml. It is a good idea to read through the file to become familiar with the options.

Other things that you may need to check

This section has a collection of items that have led to a failure in the installation process. This is a work in progress and is a place to keep track of this sort of stuff that seems a bit random.

- Make sure all the VMs in the cluster/cloud are running.

You may want to double check the following on each VM that is a member of the cluster:

- The network interface on each VM is started.
- The firewall on each VM is disabled.

- If you pre-installed Docker on each VM, then check that Docker is running on each VM.
- Docker must be installed and running on the boot-master VM.
- The ICP docker images must be loaded into the Docker registry on the boot-master VM.

Copy and load ICP docker image tar ball to all cluster VMs

This section assumes that Docker is pre-installed on all of the cluster member VMs. Installing Docker on each VM uses the same steps as installing Docker on the boot-master VM.

It is expedient to pre-load the Docker registry on each VM that is a member of the ICP cluster. The installation process run from the boot-master machine will recognize that the Docker registry is up-to-date on the other cluster member machines and skip the step of copying and loading the image tar ball to the Docker registry on the given machine. The gain in the time it takes to load the registry is achieved because you can open as many shells as needed to do the copy and load operations concurrently.

1. Copy the ICP image tar ball to all machines. (You can open multiple shells on the boot-master machine and start an `scp` of the image tar ball to each machine in the cluster.)

2. Open a shell on each VM in the cluster and extract the docker images and load them into the docker registry:

   ```
   tar -xvf ibm-cloud-private-x86_64-2.1.0-beta-2.tar.gz -O | docker load
   ```

3. On all but the boot-master machine, the ICP image tar file can be removed once the docker load completes. On the boot-master machine the ICP image tar file gets moved to an images directory in `<ICP_HOME>/cluster`.

NOTE: If you are building an ICP virtual machine, you can run the extract and load on the base VM image so that all cloned VMs have the docker registry pre-loaded with the ICP images.

Run the ICP install command

Docker is used to run the install for all members of the cluster/cloud. The command is shown below after some introductory notes. (This takes some time depending on the number of machines in the cluster. If you haven't pre-loaded the Docker images used by ICP, the image file gets copied to each VM and the images get loaded as part of the installation.) Run the install from `<ICP_HOME>/cluster` directory.

NOTE: It is assumed Docker is installed on the boot-master VM.

NOTE: It is assumed the ICP v2.1 images have been loaded into the local docker registry on the boot-master VM.

NOTE: In the docker commands below, $(pwd) is the current working directory of the shell where the command is run, i.e. `<ICP_HOME>/cluster`. It is assumed there are no space characters in the current working directory path. (It is a really bad idea to use space characters in directory and file names.) If you happen to have space characters in the current working directory path, then surround the $(pwd) with double quotes.

NOTE: It is OK to run this command multiple times to get things installed on all members of the cluster/cloud should problems show up with a particular cluster/cloud member. At least for basic problems, the error messages are very clear about where the problems are, e.g., network connectivity, firewall issues, docker not running.

NOTE: During the installation all information messages go to stdout/stderr. If you want to capture a log of the installation process, you need to direct output to a file. The docker command line below uses `tee` to capture the log and also allow it to be visible in the shell window. A logs directory in `<ICP_HOME>/cluster>` was created to hold the log files. The log file will have escape character sequences in it for color coding the text output, but it is readable.

```
# docker run --net=host -t -e LICENSE=accept -v $(pwd):/installer/cluster ibmcom/ic
```

A common convention (not shown here) is to include a date stamp in the file name of the install log that gets written to /tmp (in this case) as well as a log number (in this case 1). The log number can be incremented each time the command is rerun if you want to save each log file.

NOTE: If you need to get more detail for installation problem determination purposes add a `-vvv` to the command line after the install verb, e.g.,

```
# docker run -e LICENSE=accept --net=host --rm -t -v $(pwd):/installer/cluster ibmc
```

- When the install completes, you want to see all "ok" and no "failed" in the recap.

```
PLAY RECAP ***************************************************************************
```

```
xxx.xx.xxx.50              : ok=109  changed=36   unreachable=0    failed=0
xxx.xx.xxx.52              : ok=109  changed=36   unreachable=0    failed=0
xxx.xx.xxx.57              : ok=137  changed=36   unreachable=0    failed=0
xxx.xx.xxx.60              : ok=163  changed=55   unreachable=0    failed=0
localhost                  : ok=216  changed=114  unreachable=0    failed=0
```

- Problem determination is based on the installation log. The error messages are relatively clear. If the recap contains a non-zero failed count for any of the cluster members or something is unreachable, then grep/search the install log for "failure" to determine begin the problem determination process.

- Assuming the install went correctly move on to some basic "smoke tests" described in the section below.

- Once the installation completes successfully and you have performed some basic tests, the firewall on each cluster member will need to be configured to open ports as described in the ICP Knowledge Center section, Default ports. Port 8443 on the master needs to be open to get to the ICP console.

Start and enable the firewalld on all cluster members

You may want to hold off on this step until some basic smoke tests have been executed. See the "Basic ICP smoke tests" section below.

After the install completes, configure firewall rules on each cluster member according to the ICP Knowledge Center section, Default ports.. Then start and enable firewalld on each cluster/cloud member.

Simple ICP "smoke" tests

This section documents some basic measures to confirm correct ICP operation.

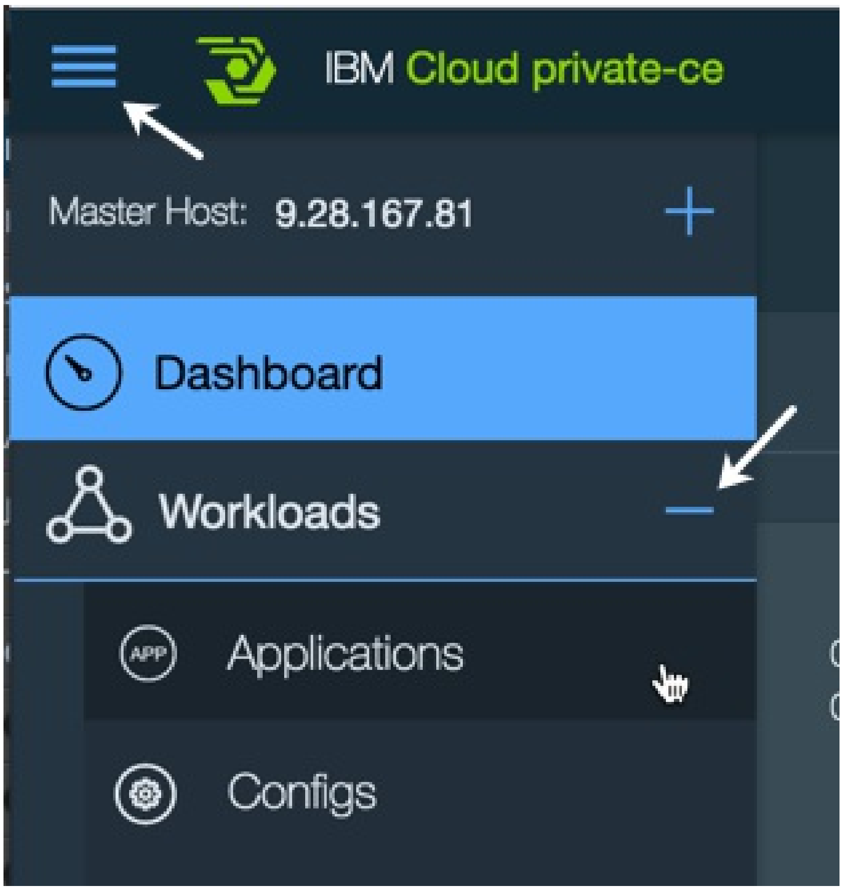
1. The simplest "smoke test" is to fire up the ICP admin console:

   `https://<boot_master>:8443/`

Default user ID and password: admin/admin

2. Check that all processes are "available". In the ICP admin console you can see the

workloads via the "hamburger" menu in the upper left corner margin. (See figure below.)



Troubleshooting installation issues

This section is a holding area for a collection of troubleshooting tips.

1. Install using the `-vvv` and piping output to tee to a log file is the first step. Examine the log file for the first sign of an error. Attempt the same command manually as the log indicates is having a problem to try to get to root cause.

2. Make sure the docker images repository has the correct images in it. For example, kubernetes-ee may not be present. Or the wrong version of kubernetes or some other image is in the docker images registry/repository.

Uninstall IBM Cloud Private

This section describes the steps to uninstalling ICP. You may need to do this if things go wrong and you want to do a clean install.

```
# docker run -e LICENSE=accept --net=host --rm --name=installer -t -v $(pwd):/insta
```

The following directories should not exist on any nodes in the cluster/cloud:

```
/var/lib/etcd/
/var/lib/kubelet/
/etc/cfc/
```

Miscellaneous useful docker commands

This section holds a collection of sub-sections where various useful docker commands are documented.

Getting a list of docker container status

The `docker ps` command is likely one of the first commands you will want to know and you will use it often. You can add the -a option to see all containers, i.e., those that have exited as well as those still running.

```
# docker ps
```

or

```
# docker ps -a
```

use

```
# docker help ps
```

to get more information on ps options.

Getting a shell inside the container

The command below will open a shell console in a container for the given docker image. (You will need to use an appropriate image name for the local docker registry.)

```
# docker run -e LICENSE=accept --net=host --rm -it -v "$(pwd)":/installer/cluster -
```

Getting a list of local docker registry content

It is useful to get a list of what is in the local docker registry. (The term registry is misused by docker. The docker registry is really a repository, i.e., it holds the docker images, not just a list of where the images are located.)

The docker command is simple:

```
docker images
```

Once ICP is loaded into the local docker repository, there are a lot of images. You will likely want to grep for some string that is part of the image of interest to cut down the amount of output from a full docker images list.

RHEL 7 network interface overview

This section describes some basic information about networking for RHEL 7.

RHEL 7 networking is controlled by the Network Manager (network service). Normally the network service will be running and it will be started at boot time.

The usual `systemctl` commands are used for dealing with the network service.

```
systemctl status|start|stop|restart network
```

For example:

```
systemctl status network
network.service - LSB: Bring up/down networking
Loaded: loaded (/etc/rc.d/init.d/network; bad; vendor preset: disabled)
Active: active (exited) since Thu 2017-06-29 16:51:39 EDT; 2 days ago
Docs: man:systemd-sysv-generator(8)
...
```

Even though the network service may be running, that does not mean a particular network interface is running.

To view the status of the network interfaces on a machine (and to get the names of the interfaces) use the `ifconfig` command.

```
ifconfig -a
```

The commands for starting and stopping a network interface are `ifup` (start), `ifdown` (stop). You need to provide the interface name.

For example, suppose the name of the interface is `ens33`.

To stop the ens33 interface:

```
ifdown ens33
Device 'ens33' successfully disconnected.
```

To start the ens33 interface:

```
ifup ens33
Connection successfully activated (D-Bus active path: /org/freedesktop/NetworkManag
```

The `ifup` and `ifdown` commands work through the Network Manager (i.e., the network service).

For a lot more details on RHEL 7 networking see the various sections in the Introduction to Red Hat Enterprise Linux Networking chapter of the RHEL documentation.