

## Network and Edge Reference System Architectures - Single Server

Develop and verify cloud-native services on a single server setup based on 4th Gen Intel® Xeon® Scalable processor platform.

### Introduction

The Reference System Architectures (Reference System<sup>1</sup>) are a cloud-native, forward-looking Kubernetes\*-cluster template solution for network implementations. They provide Ansible\* playbooks that define configuration profiles for fast, automatic deployment of needed cluster services and capabilities.

This document is a quick start guide to configure the **Container Bare Metal Reference System Architecture (BMRA)** or the **Virtual Machine Reference System Architecture (VMRA)** on a single **4th Gen Intel® Xeon® Scalable processor** based platform.

The Reference System has a variety of configuration profile settings for different network traffic workloads. **This quick start guide has selected the Remote Central Office-Forwarding Configuration Profile.** For details on this and other Configuration Profiles, and other hardware options, refer to the User Guides listed in the [Reference Documentation](#) section.

The Release 23.07 also includes other Workload specific Quick Start Guides as listed in the [Reference Documentation](#) section.



### Hardware and Software BOM

Following is the list of the hardware and software components that are required for setting up the system on a single server:

Ansible host	Laptop or server running a UNIX base distribution
Target Server	4th Gen Intel® Xeon® Scalable processor based server – Quanta S6Q (S2EG3SEQ8B)
Ethernet Adapter	Intel® Ethernet Network Adapter E810-CQDA2 or Intel® Ethernet Controller XXV/XL710
OS	Ubuntu 22.04 LTS and RHEL 9.2
BIOS	Max Performance Turbo BIOS configuration is recommended (refer to Chapter 3.8 of <a href="#">BMRA User Guide</a> )
BMRA software	<a href="https://github.com/intel/container-experience-kits/">https://github.com/intel/container-experience-kits/</a>

For details of the hardware and software BOM for the **Remote Central Office-Forwarding Configuration Profile**, refer to the BMRA and VMRA User Guides listed in the [Reference Documentation](#) section.

The **Remote Central Office-Forwarding Configuration Profile** normally enables Intel® QAT and Intel® SGX.

Intel® DLB, Intel® DSA, and Intel® Scalable IOV SW are set as optional in the **Remote Central Office-Forwarding Configuration Profile**.

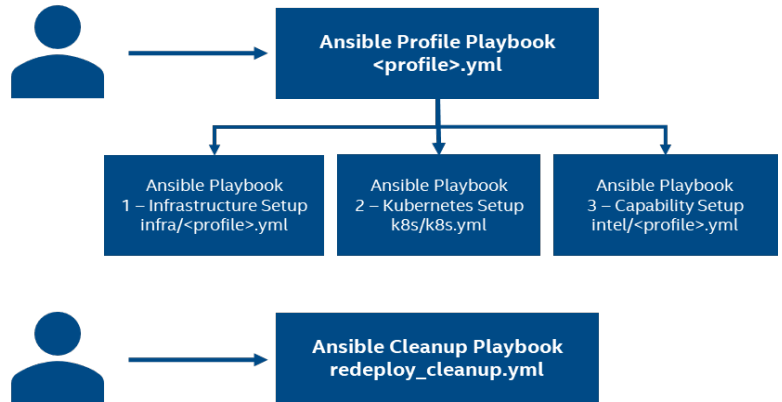
<sup>1</sup> In this document, "Reference System" refers to the Network and Edge Reference System Architecture.

## Getting Started

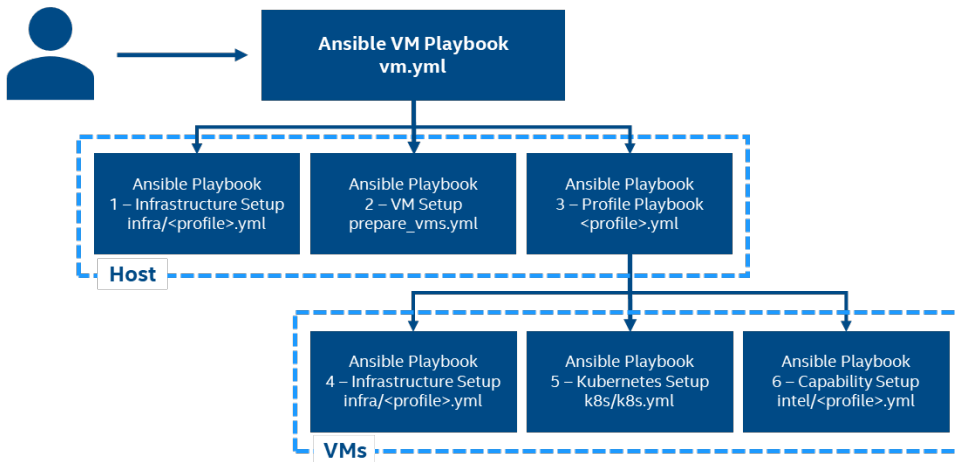
Ansible playbooks are used to install the Bare Metal (BMRA) and Virtual Machine (VMRA).

**BMRA** - provisioning is split into three steps:

1. **Infrastructure**
2. **Kubernetes**
3. **Capabilities**



**VMRA** installation is split between the host and the VMs. On the host, the steps are: **Infrastructure** and **VM Setup**. Once VMs have been created, the Ansible inventory is updated, and the same three steps used for BMRA are repeated for the virtual machines (VMs).



## Step 1 - Set Up the System

Refer to [Network and Edge Bare Metal Reference System Architecture User Guide](#) or [Network and Edge Virtual Machine Reference System Architecture User Guide](#): Section 6.1.

The below mentioned steps assume that both the Ansible host and target server are running Ubuntu as the operating system. For RHEL, use 'yum' or 'dnf' as the package manager instead of 'apt'.

### Ansible Host

1. Install necessary packages (some might already be installed):
 

```
# sudo apt update
# sudo apt install -y python3 python3-pip openssh-client git build-essential
# pip3 install --upgrade pip
```
2. Generate a SSH keypair if needed (check /root/.ssh/):
 

```
# ssh-keygen -t rsa -b 4096 -N "" -f ~/.ssh/id_rsa
```
3. Copy the public key to the target server:
 

```
# ssh-copy-id root@<target IP>
```
4. Verify passwordless connectivity to the target server:
 

```
# ssh root@<target IP>
```



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### Target Server

1. Install necessary packages (some might already be installed):

```
# sudo apt install -y python3 openssh-server lshw
```

2. As part of the configuration in [Step 3](#), information about PCI devices for SR-IOV must be specified.
3. Find the relevant PCI IDs (bus:device.function) using 'lspci', and note down the IDs for later when configuring host\_vars on the Ansible host:

```
# lspci | grep Eth
18:00.0 Ethernet controller: Intel Corporation Ethernet Controller E810-C for QSFP (rev 01)
18:00.1 Ethernet controller: Intel Corporation Ethernet Controller E810-C for QSFP (rev 01)
```

### Target Server - Additional steps (only needed for VMRA)

For VMRA information about PCI, IDs of Virtual Functions (VFs) must be specified for the configuration of VMs.

1. Using device 18:00.0 as an example, create VFs for the device:

```
# echo "2" > /sys/bus/pci/devices/0000\:18\:00.0/sriov_numvfs
```

2. Find the relevant PCI IDs for the SR-IOV VFs:

```
# lspci | grep Eth | grep Virtual
18:01.0 Ethernet controller: Intel Corporation Ethernet Adaptive Virtual Function (rev 01)
18:01.1 Ethernet controller: Intel Corporation Ethernet Adaptive Virtual Function (rev 01)
```

## Step 2 - Download and Install

Refer to [Network and Edge Bare Metal Reference System Architecture User Guide](#) or [Network and Edge Virtual Machine Reference System Architecture User Guide](#): Section 2.5.

### Ansible Host

1. Download the source code from GitHub repository for the Reference System server:

```
# git clone https://github.com/intel/container-experience-kits/
# cd container-experience-kits
# git checkout v23.07
```

2. Set up Python\* virtual environment and install dependencies:

```
# python3 -m venv venv
# source venv/bin/activate
# pip3 install -r requirements.txt
```

3. Install Ansible dependencies for the Reference System:

```
# ansible-galaxy install -r collections/requirements.yml
```

Download & Install



Ansible  
Playbook

## Step 3 – Configure

Refer to [Network and Edge Bare Metal Reference System Architecture User Guide](#) or [Network and Edge Virtual Machine Reference System Architecture User Guide](#): Section 7.4.

The **Remote Central Office-Forwarding** configuration profile (remote\_fp) is used for this deployment. The BMRA and VMRA configuration steps are different.

### Configure BMRA

#### Ansible Host

1. Generate the configuration files:

```
# make k8s-profile PROFILE=remote_fp ARCH=spr
```

2. Update the **inventory.ini** file to match a one server deployment. The values for <target hostname> and <target IP> must be updated to match the target system.

```
# vim inventory.ini
[all]
<target hostname> ansible_host=<target IP> ip=<target IP> ansible_user=root
localhost ansible_connection=local ansible_python_interpreter=/usr/bin/python3
```

Configure



```
[vm_host]

[kube_control_plane]
<target hostname>

[etcd]
<target hostname>

[kube_node]
<target hostname>

[k8s_cluster:children]
kube_control_plane
kube_node

[all:vars]
ansible_python_interpreter=/usr/bin/python3
```

3. Update the `host_vars` filename with the target machine's hostname:

```
# mv host_vars/node1.yml host_vars/<target hostname>.yml
```

To utilize features depending on SR-IOV and Intel® QAT,, `host_vars` must be updated with information about the PCI devices on the target server. The example below can be used as a reference for the configuration but should be updated to match the correct PCI IDs of the target server.

4. Update `host_vars/<target_hostname>.yml` with PCI device information specific to the target server:

```
# vim host_vars/<target hostname>.yml
dataplane_interfaces:
  - bus_info: "18:00.0" # Use the SR-IOV PCI ID here
    pf_driver: ice
    ddp_profile: "ice_comms-1.3.40.0.pkg"
    default_vf_driver: "iavf"
    sriov_numvfs: 6
    sriov_vfs: # This is optional but can be used to change
the driver of specific VFs. Any VF not specified here will use the "default_vf_driver"
specified above.
      vf_00: "vfio-pci"
      vf_05: "vfio-pci"
```

**Note:** Additional details about the configuration options and values can be found as comments in the file.

**Note:** Be sure to remove the square brackets [ ] that follows the 'dataplane\_interfaces' configuration option by default.

5. (Optional) The Key Management Reference Application (KMRA), which is set as false by default, can be enabled by setting the `pccs`, `apphsm`, and `ctk_loadkey` containers to true. To use KMRA, an API key must be requested from <https://api.portal.trustedservices.intel.com/provisioning-certification> (click on "Subscribe").

Once the API key has been acquired, update `group_vars/all.yml` with the primary key:

```
# vim group_vars/all.yml
kmra:
  pccs:
    enabled: true # enable PCCS application
    api_key: "ffffffffffffffffffffffffffffffffffff" # Replace with API Key
  apphsm:
    enabled: true # enable AppHSM application
  ctk_loadkey_demo:
    enabled: true # enable CTK demo application
```

**Note:** Without the API Key, the KMRA application will not work.

6. If the server is behind a proxy, update `group_vars/all.yml` by updating and uncommenting the lines for `http_proxy`, `https_proxy`, and `additional_no_proxy`.

```
# vim group_vars/all.yml
## Proxy configuration ##
http_proxy: "http://proxy.example.com:port"
https_proxy: "http://proxy.example.com:port"
additional_no_proxy: ".example.com,mirror_ip"
```

7. (Required) Apply required patches for Kubespray:

```
# ansible-playbook -i inventory.ini playbooks/k8s/patch_kubespray.yml
```

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- (Optional, recommended) Verify that Ansible can connect to the target servers, by running the below command and checking the output generated in the `all_system_facts.txt` file:

```
# ansible -i inventory.ini -m setup all > all_system_facts.txt
```

- (Optional, recommended) Check dependencies of components enabled in `group_vars` and `host_vars` with the packaged dependency checker. This step is also run by default as part of the main playbook:

```
# ansible-playbook -i inventory.ini playbooks/preflight.yml
```

## Configure VMRA

### Ansible Host

- Generate the configuration files:

```
# make vm-profile PROFILE=remote_fp ARCH=spr
```

- Update the `inventory.ini` file to match a one server deployment. The values for `<target hostname>` and `<target IP>` must be updated to match the target system. Do not remove or modify the commented lines with `"vm-ctrl-1"` and `"vm-work-1"`.

```
# vim inventory.ini

[all]
<target hostname>    ansible_host=<target IP> ip=<target IP> ansible_user=root
localhost            ansible_connection=local ansible_python_interpreter=/usr/bin/python3

[vm_host]
<target hostname>

[kube_control_plane]
#vm-ctrl-1

[etcd]
#vm-ctrl-1

[kube_node]
#vm-work-1

[k8s_cluster:children]
kube_control_plane
kube_node

[all:vars]
ansible_python_interpreter=/usr/bin/python3
```

- Update the filename of the `host_vars` file for the target machine:

```
# mv host_vars/host-for-vms-1.yml host_vars/<target hostname>.yml
```

- To utilize features depending on SR-IOV and Intel® QAT, `host_vars` must be updated with information about the PCI devices on the server. The below example can be used as a reference for the configuration but should be updated to match the correct PCI IDs of the target server.

Due to the additional layer of virtualization through the VMs, both `host_vars/<target hostname>.yml` and `host_vars/vm-work-1.yml` will need to be updated with PCI information:

```
# vim host_vars/<target hostname>.yml
dataplane_interfaces:
  - bus_info: "18:00.0"          # Use the SR-IOV PCI ID here
    pf_driver: ice
    ddp_profile: "ice_comms-1.3.40.0.pkg"
    default_vf_driver: "vfio-pci" # The driver here should always be "vfio-pci"
    sriov_numvfs: 6

vms:
  - type: "ctrl"
    (...)
  - type: "work"
    (...)
pci:
  - "18:01.0"          # Use the SR-IOV VF PCI ID(s) here
  - "18:01.1"          # Use the SR-IOV VF PCI ID(s) here
```

**Note:** Additional details about the configuration options and values can be found as comments in the file.

**Note:** Be sure to remove the square brackets `[]` that follows the `'dataplane_interfaces'` configuration option by default.

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- After updating the PCI assignment to the worker VM, the configuration in `host_vars/vm-work-1.yml` must be updated to use these devices. Take note of the PCI IDs used here, as they follow the order in which the devices are assigned to the VM above. Using this example, the VF with ID `"18:01.0"` above is the first in the list, which will correspond to `"06:00.0"` inside of the VM as shown below. Similarly, `"18:01.1"` will be `"07:00.0"` in the VM.

```
# vim host_vars/vm-work-1.yml
dataplane_interfaces:
  - bus_info: "06:00.0"
    pf_driver: iavf # Do not modify the value of "pf_driver"
    sriov_numvfs: 0 # Do not modify the value of "sriov_numvfs"
    default_vf_driver: "igb_uio" # Do not modify the value of "default_vf_driver"
  - bus_info: "07:00.0"
    pf_driver: iavf
    sriov_numvfs: 0
    default_vf_driver: "igb_uio"
```

- If the server is behind a proxy, update `group_vars/all.yml` by updating and uncommenting the lines for `http_proxy`, `https_proxy`, and `additional_no_proxy`.

```
# vim group_vars/all.yml
## Proxy configuration ##
http_proxy: "http://proxy.example.com:port"
https_proxy: "http://proxy.example.com:port"
additional_no_proxy: ".example.com,mirror_ip"
```

- (Optional) It is recommended that you check dependencies of components enabled in `group_vars` and `host_vars` with the package dependency checker:

```
# ansible-playbook -i inventory.ini playbooks/preflight.yml
```

- (Optional) Verify that Ansible can connect to the target server, by running the below command and checking the output generated in the `all_system_facts.txt` file:

```
# ansible -i inventory.ini -m setup all > all_system_facts.txt
```

- Apply a patch for the Kubespray submodule:

```
# ansible-playbook -i inventory.ini playbooks/k8s/patch_kubespray.yml
```

## Step 4 – Deploy

Refer to [Network and Edge Bare Metal Reference System Architecture User Guide](#) or [Network and Edge Virtual Machine Reference System Architecture User Guide](#): Section 2.5.5.

### Ansible Host

Now the Reference System can be deployed. The command used depends on the choice between [BMRA] and [VMRA] above:

```
[BMRA] # ansible-playbook -i inventory.ini playbooks/remote_fp.yml
[VMRA] # ansible-playbook -i inventory.ini playbooks/vm.yml
```

Deploy



## Step 5 – Validate

Refer to [Network and Edge Bare Metal Reference System Architecture User Guide](#) or [Network and Edge Virtual Machine Reference System Architecture User Guide](#): Section 5.

### Ansible Host

- To interact with the Kubernetes CLI (`kubectl`), start by connecting to a controller node in the cluster, which can be done using the below commands for either BMRA or VMRA:

```
(BMRA) # ssh root@<target ip>
(VMRA) # ssh vm-ctrl-1 # Uses an alias specified in /root/.ssh/config
```

- Once connected, the status of the Kubernetes cluster can be checked:

```
# kubectl get nodes -o wide
# kubectl get pods --all-namespaces
```

Validate



Note: For single node Kubernetes deployment using BMRA, both controller and worker node are the same.

Additional feature verification tests can be found here:

<https://github.com/intel/container-experience-kits/tree/master/validation/verification-manual>

### Reference Documentation

The [Network and Edge Bare Metal Reference System Architecture User Guide](#) provides information and full set of installation instructions for a BMRA.

The [Network and Edge Virtual Machine Reference System Architecture User Guide](#) provides information and full set of installation instructions for a VMRA.

The [Network and Edge Cloud Reference System Architecture User Guide](#) provides the means to develop and deploy cloud-native applications in a CSP environment and still experience Intel® technology benefits.

The [Network and Edge Reference System Architectures Portfolio User Manual](#) provides additional information for the Reference Systems including a complete list of reference documents.

Other available Quick Start Guides:

- [Network and Edge Reference System Architectures - vRAN Setup with FlexRAN™ Software Quick Start Guide](#)
- [Network and Edge Reference System Architectures - 5G Core UPF Quick Start Guide](#)
- [Network and Edge Reference System Architectures - CDN Quick Start Guide](#)
- [Network and Edge Reference System Architectures - Edge Analytics Video Structuring Server \(VSS\) Quick Start Guide](#)
- [Network and Edge Reference System Architectures - Video Production Quick Start Guide](#)
- [Network and Edge Reference System Architectures - 5G vRAN Security Quick Start Guide](#)

Other collaterals, including technical guides and solution briefs that explain in detail the technologies enabled in the Reference System are available in the following location: [Network & Edge Platform Experience Kits](#).

### Document Revision History

REVISION	DATE	DESCRIPTION
001	May 2022	Initial release.
002	June 2022	Added more references in the Getting Started section.
003	July 2022	Updated for BMRA Release 22.06.
004	October 2022	Updated for BMRA Release 22.08.
005	December 2022	Updated for BMRA Release 22.11.
006	March 2023	Updated for BMRA Release 23.02.
007	July 2023	Updated for BMRA Release 23.07.



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