

Keysight Open RAN Simulators, Cloud Edition

5.0.1

Deployment Guide

Notices

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Contact us

Keysight headquarters

1400 Fountaingrove Parkway
 Santa Rosa, CA 95403-1738
 Email address: support@keysight.com
 Website: <https://support.ixiacom.com/contact>

Support

Location	Phone number	Local time
<i>Americas</i>		
US, Canada	1-888-829-5558	8h00 – 17h00
Brazil	0800-892-0522	8h00 – 17h00
Mexico	001-888-829-5558	8h00 – 17h00
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Finland	0800-913-352	8h30 – 17h30
France	0800-917228	8h30 – 17h30
Germany	0800-0824099	8h30 – 17h30
India	1800-18-02552	8h30 – 17h30
Ireland	1800-949245	8h30 – 17h30
Israel	1-809-454975	8h30 – 17h30
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Luxembourg	0800-25112	8h30 – 17h30
Netherlands	0800-022-9086	8h30 – 17h30

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Spain	800-654386	8h30 – 17h30
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Australia	1-800-370-558	8h30 – 17h00
China Mainland	800-810-0005	8h30 – 17h30
	400-810-0005	8h30 – 17h30
Hong Kong	800-931-613	9h00 – 18h00
Japan	0120-421-621	9h00 – 17h30
Malaysia	1800-819 092	8h30 – 17h30
South Korea	080-770-0800	8h30 – 17h30
Singapore	800-101-3797	8h30 – 17h30
Taiwan	0800-699-880	9h00 – 18h00
Other	+65 6215 7600	8h30 – 17h30 (Singapore)

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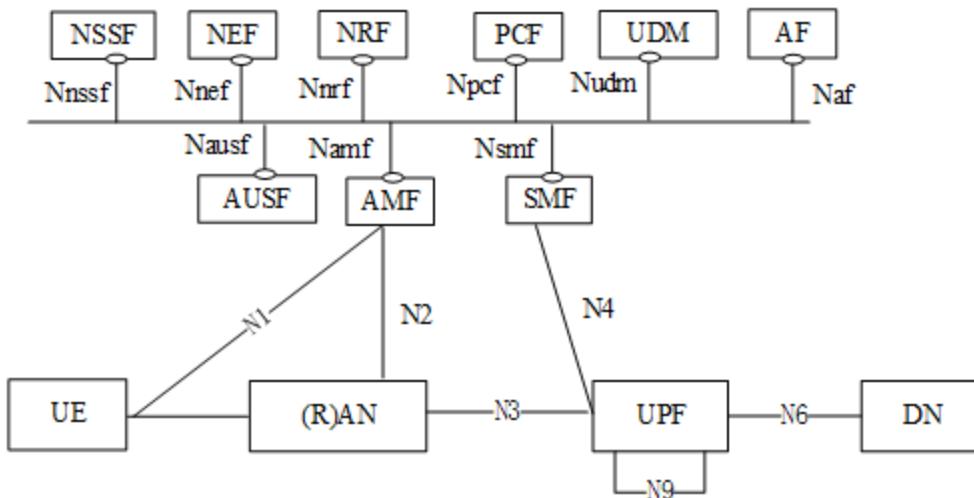
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CHAPTER 1**Test Methodologies for 5GC**

The 5G will lead in a large number of new applications – for use cases that are not even close to being possible in the 3G/4G regime. According to reasonable estimates, the world will have more than 1.1 billion 5G connections by 2025 (accounting for ~15% of the total connections). Along with artificial intelligence (AI) and edge computing, 5G wireless technology will be right at the heart of the burgeoning IoT revolution over the next half a decade or so, expected to play a major role in the development of Industry 4.0 in general, smart city applications, smart industrial software, powering connected cars, and smart homes & buildings. Seamless mobility, negligible latency, full scalability, and reliability will help 5G in making many high-end, mission-critical IoT projects implementable with ease.

Unlike 4G, which is determined by modulation and frequency (i.e., interface-defined), 5G will be the first-ever software-defined wireless standard. And this is a key aspect of the Control User Plane separation of SMF/UPF where LTE CUPS is being reused.

The 5G Core is represented by following network topology:



CHAPTER 2**ORAN-SIM CE Deployment on VMs**

This section contains the following topics:

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VMware ESXi Deployment

This section describes the steps needed to deploy ORAN-SIM CE on VMware ESXi.

Prerequisites

For a complete and correct functioning setup, make sure you have downloaded and installed the packages on your test environment:

- **Wireshark** capable to decode PFCP messages and IEs (at least 2.5.2).
This will be used to analyze the traffic captures.
- **Hypervisor** with available resources to deploy the virtual machine(s) hosting the Middleware, the Test Agents and License Server.
The examples below were done using VMware ESXi.
- **ORAN-SIM CE images** (three images: Middleware, Agent and License server). License Server image is optional, since it can be collocated with MW, but it is recommended to be installed on a separate VM. The images can be downloaded from KSM: <https://ksm.software.keysight.com>

IMPORTANT IP connectivity between VMs must to be ensured.

- You will need to use this machine to run ORAN-SIM CE tests. **ILU (Windows or Linux) cannot be used to run ORAN-SIM CE tests.**
- **Valid licenses** for License server. For deploying full 5G core and run Control plane and User plane traffic, the following licenses will be required:
 - Control plane licenses:
 - ORAN-SIM CE interface license simulation (**P89033A** x 11 pcs).

This license will enable Control plane testing. One license is needed for each simulated interface.

- 5GCore Performance enabler on VM: 1M UEs and 10k TPS for VM (**P89034A** x 1 pcs).
- User plane licenses:
 - User Plane Flow-based license (N3 and N6). Multiple QTY are needed if multiple flows are active simultaneously. Includes three Application Traffic Flows (TCP/UDP) and 10Gbps throughput capacity (**P89037A** x 2 pcs). The recommendation is to use this type of license as this will be suggested for all new customers.
 - As an alternative for the above license you can also use Tier-4 license (**P89030A** or **P89031A** x 2 pcs).

IMPORTANT These license types will enable User plane traffic and are not needed if ONLY control plane traffic is needed for future tests.

- Minimum supported resolution for ORAN-SIM CE UI is 1920x1080 (Full HD).

Hardware Requirements

By default, the VM for Middleware will reserve the following compute resources when installing the OVA:

- 8 x vCPUs
- 16 GB RAM
- 256 GB SSD

The test agent will reserve the following compute resources when installing the OVA:

- 4 x vCPUs
 - 4 GB RAM **out of which 1GB is reserved for HUGE MEM(IxStack over DPDK/Raw)**
- IMPORTANT** This value is for control plane only. If you are running app traffic the recommendation is to allocate minimum 16 GB RAM.

- 20 GB SSD

Running application traffic will require increasing agent resources. The recommendation for each agent will be in this case:

- 8 x vCPUs
- 32 GB RAM
- 20 GB SSD

Licensing server default resources

- 2 x vCPUs
- 8 GB RAM
- 100 GB SSD

Supported NICs in tests with IxStack over DPDK/Raw(TCP based traffic)

The list of supported NICs in tests with IxStack over DPDK/Raw(TCP based traffic):

- Intel X710 10G
- Intel XXV710 25G
- Intel XL710 40G
- Intel E810 25G
- Intel E810 100G
- Mellanox ConnectX-4/5 25G
- Mellanox ConnectX-4/5 100G
- Mellanox ConnectX-6 Dx 100G
- VMWare ESXi Virtual NIC (vmxnet3)

Supported drivers list:

- vmxnet3
- mlx4_core
- mlx5_core
- ixgbe
- ixgbefvf
- i40e
- i40evf
- iavf
- ice

ORAN-SIM CE Installation Procedure

ORAN-SIM CE

The ORAN-SIM CE installation procedure requires the following steps:

1. ORAN-SIM CE Middleware installation and configuration.
2. Agent(s) installation and configuration.
3. License Server installation and configuration.

IMPORTANT

The recommended order for booting up the VMs is the following:

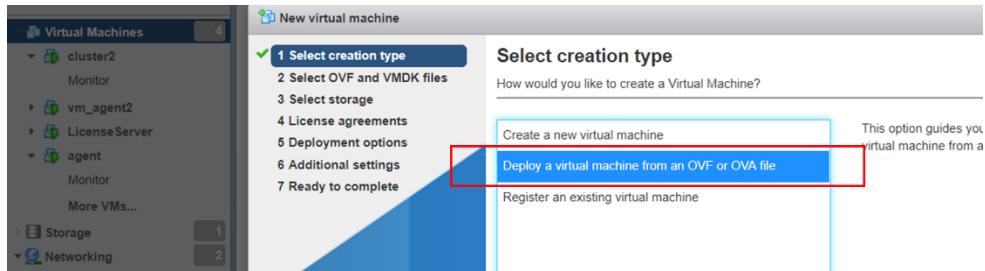
- first, the License Server, if a dedicated one has been deployed (this is the VM that uses the least amount of resources)
- next, the MW
- last, after a few minutes, start the agents one by one.

This order is also according to dependencies/communication between the VMs.

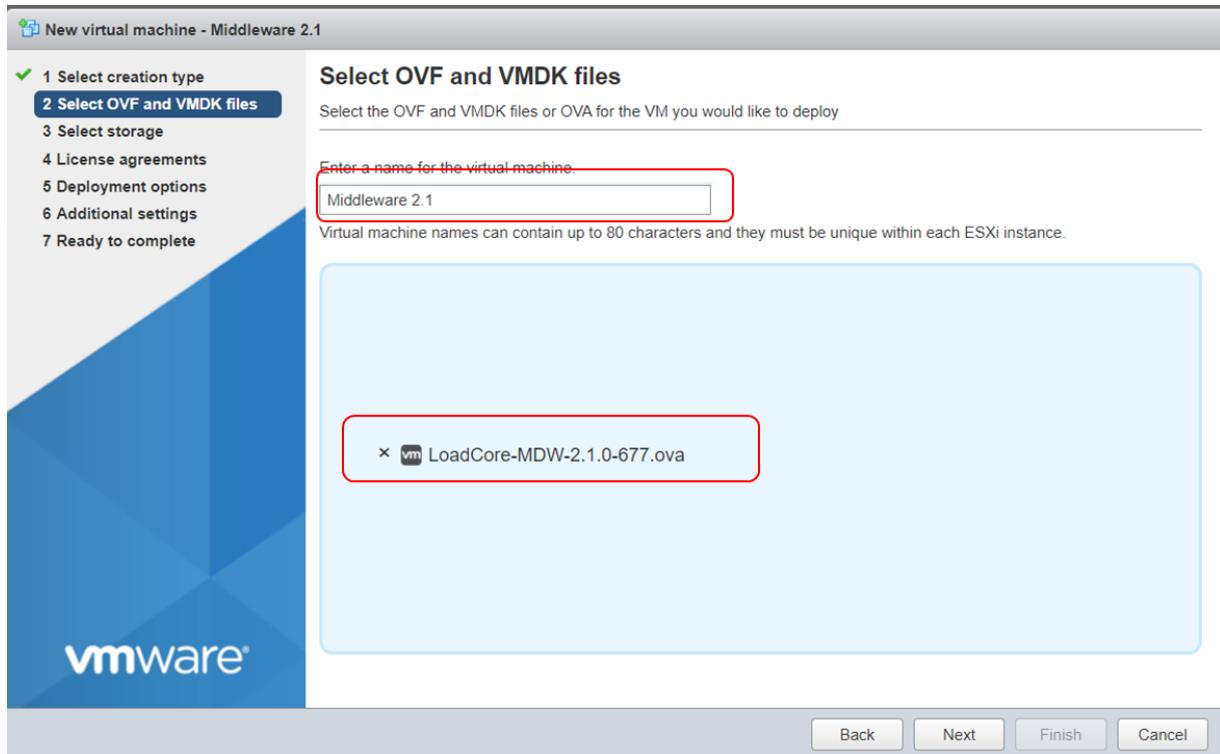
Middleware Installation

The installation procedure of the Middleware requires the following steps:

1. Log into your ESXi server and create a new VM machine using the Middleware OVA image.



2. Define a name for the VM machine. In this example, the name is **Middleware 2.1**.
3. Select the OVA image and select **Next > Next**.

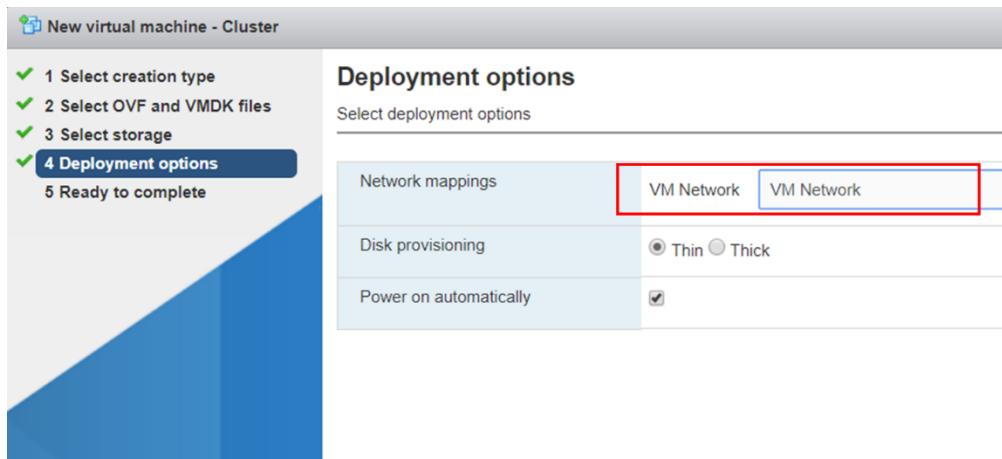


4. Select the network (vSwitch) where the Middleware should connect. By default, this is the **VM Network**.

You can select a different vSwitch/Network that you already created, just make sure that later on, there will be connectivity between this VM and the ones that will represent the Agents.

NOTE

Management interfaces (connecting MW and agents) support IPv6 DHCP, but not SLAAC.



5. Select **Next** and, then, **Finish**.
6. Wait for complete OVA deployment. When this is completed, you will see in the VM list on the ESXI console, your cluster VM, booted normally and with IP address assigned.



Thin provisioning method is also used in KVM setups. The disk size inside the ORAN-SIM CE Cluster VM is 250GB, but the `qcow2` image can be much smaller. The `qcow2` image is getting bigger with time according to demand.

For example ...

Linux host machine:

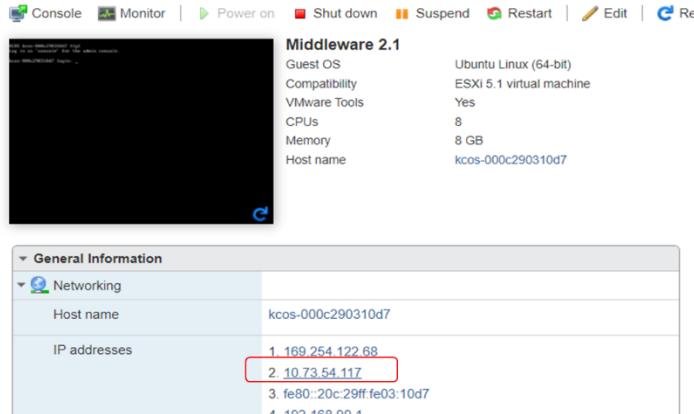
```
-rw-rw-r-- 1 root root 17G Sep 24 12:37 LoadCore-MW-w1.3.0-981.qcow2
```

Inside ORAN-SIM CE Cluster VM:

```
appsec@eagle-master-525400e6e71e:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            3.9G   0    3.9G  0% /dev
tmpfs           798M  6.0M  792M  1% /run
/dev/mapper/main-root  251G  14G  224G  6% /
tmpfs           3.9G   0    3.9G  0% /dev/shm
tmpfs           5.0M   0    5.0M  0% /run/lock
tmpfs           3.9G   0    3.9G  0% /sys/fs/cgroup
/dev/vda3        465M  61M  377M  14% /boot
/dev/vda2        241M  512   241M  1% /boot/efi
tmpfs           798M   0    798M  0% /run/user/1000
```

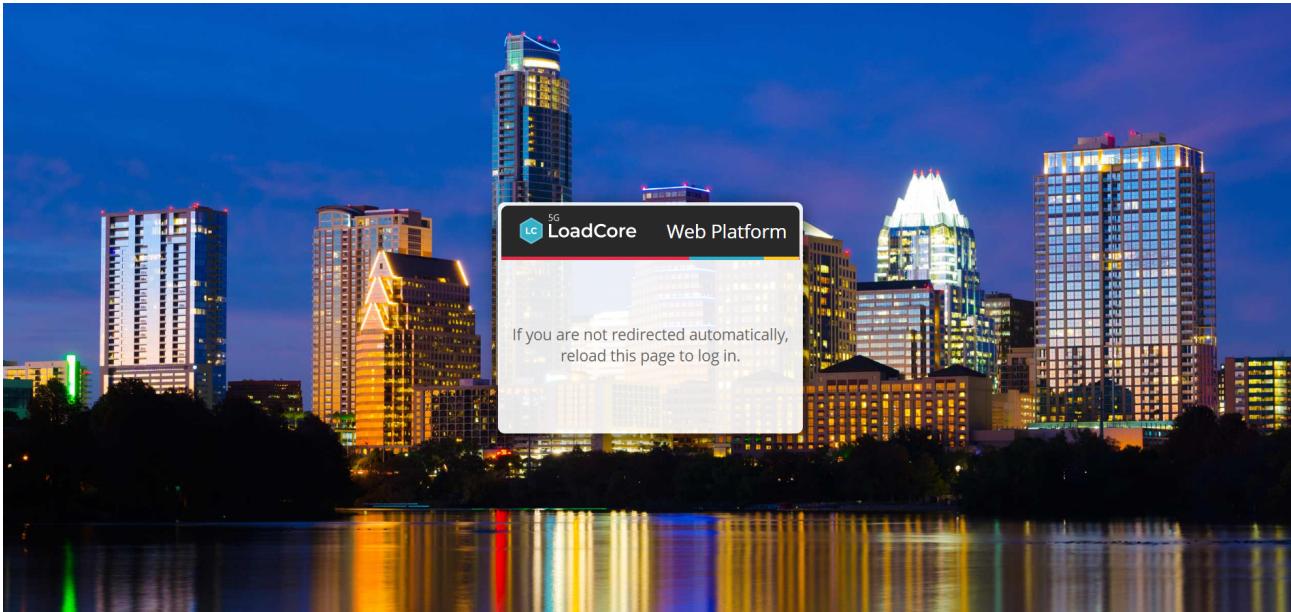
After the Middleware image is deployed, the next step is to access the ORAN-SIM CE UI.

To do this, use the IP address that was assigned to the Middleware VM machine.



Connect to the web UI to make sure that everything is working fine.

On your browser, type the IP address that was assigned for the Cluster - in this case <https://10.73.53.201>.



After accepting the EULA, you will be automatically routed to the authentication window.

There are two options:

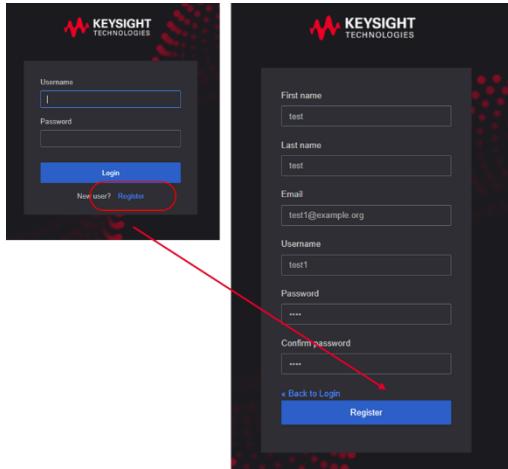
1. Create a [new user](#) using the **Register** link.
2. Use the default [administrator](#) account : **admin/admin**.

The administrator account will have access to the Access Control menu which includes additional configuration options, including user editing (for example, changing passwords).

Register a new user

To register a new user, do the following:

1. Select the **Register** link from the authentication window and fill in all the necessary info.



2. To create the user, select **Register**. You will be logged and redirected to the main LoadCore screen.

If needed, you can, you can click on the username(in this case **user1**) and the user properties window will be open, allowing you to change the your settings.

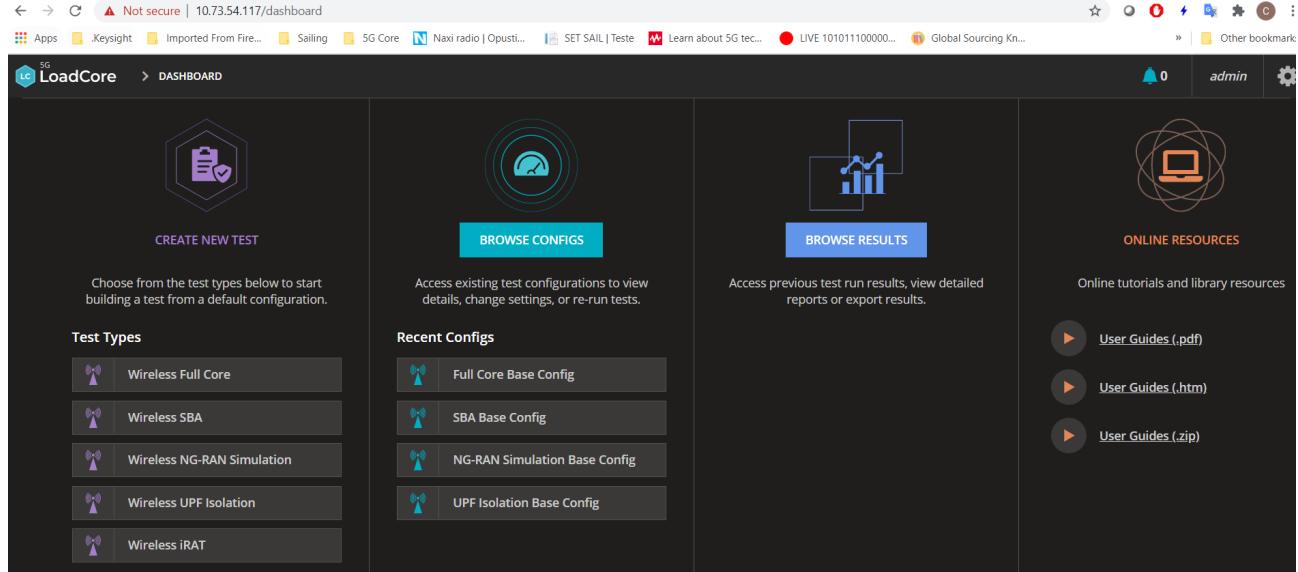
Edit Account	
Username	test1
Email *	test1@example.org
First name *	test
Last name *	test

* Required fields

Logging in with administrative rights

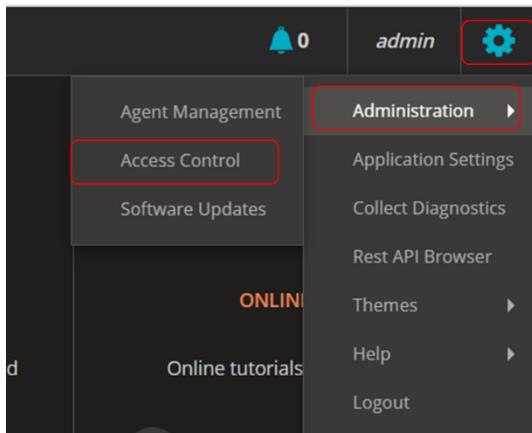
To log in with administrative rights use the following credentials: **admin/admin**.

This will log you to the ORAN-SIM CEsystem.



Using this admin rights, you can create the users to access the system, as follows:

1. Select the **Settings** icon > **Administration** > **Access Control**.



2. The Access Control window opens. Select the **Users** tab and, then, **Add User**.

The screenshot shows the Keysight Admin Console interface. On the left, there's a sidebar with various configuration options like Realm Settings, Clients, Roles, and Groups. Under Groups, the 'Users' option is highlighted with a red box. At the top right, there are buttons for 'Unlock users' and 'Add user', with the latter also highlighted by a red box.

3. Define a user with its corresponding details (in this example, the new user is **user1**).

The 'Add user' dialog box has fields for ID, Username (set to 'user1'), Email ('user1@example.org'), First Name ('user1'), Last Name ('User1'), User Enabled (ON), and Email Verified (OFF). It also includes a 'Required User Actions' dropdown and 'Save' and 'Cancel' buttons. A blue arrow points from the 'Email Verified' section towards the 'Select Action...' dropdown.

4. To configure a password for the user, select **Credentials** and define the password.

The user profile for 'User1' shows tabs for Details, Attributes, Credentials (highlighted with a red box), Role Mappings, Groups, Consents, and Sessions. In the 'Credentials' tab, there's a 'Manage Credentials' section with a 'Set Password' form. The 'Temporary' checkbox is set to 'ON'. The 'Password' and 'Password Confirmation' fields both contain '*****'. A red box highlights the 'Set Password' button.

In case you added multiple users, select **View all users** and select the **Edit** option for the user (in this example, **user1**).

Users						
Lookup						
ID	Username	Email	Last Name	First Name	Actions	
d02725f8-c5c7-4c9f-ae74...	admin	admin@example.org	Admin	Default	Edit	Delete
7313fc7f-db5f-457b-b4e0...	user1	user1@example.org	User1	user1	Edit	Delete
5db39e1e-1edc-4d3c-967...	wap-automation				Edit	Delete

If no DHCP server is available or you want to manually assign the IP address to be used by Middleware, you can log on the VM console for the deployed machine (for example, the console from ESXi hypervisor).

Log in with *console* credentials.

This will give you access to a predefined menu from where you can configure the networking settings.

Logging in with *console* means log in as console first, no password required and then log in as **admin** with password **admin** (all in small letters).

The IP address can be changed with command:

```
kcos networking ip set
```

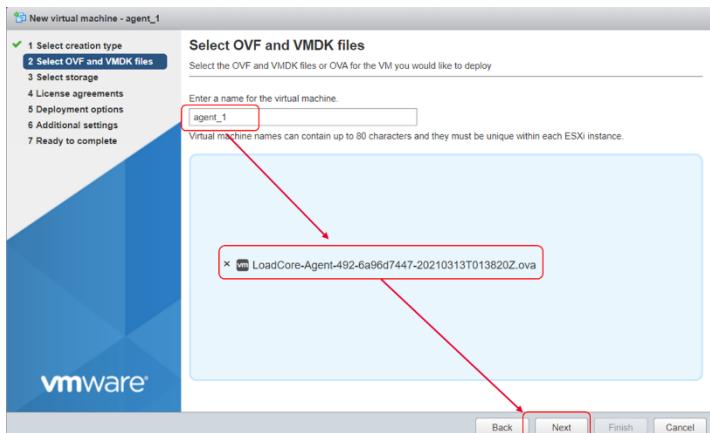
Agent(s) Installation

ORAN-SIM CE requires at least one Agent to emulate the 5G core nodes. The full 5G core topology can be run within a single agent if stateless UDP traffic will be required. For TCP based traffic you will need to install/use two agents.

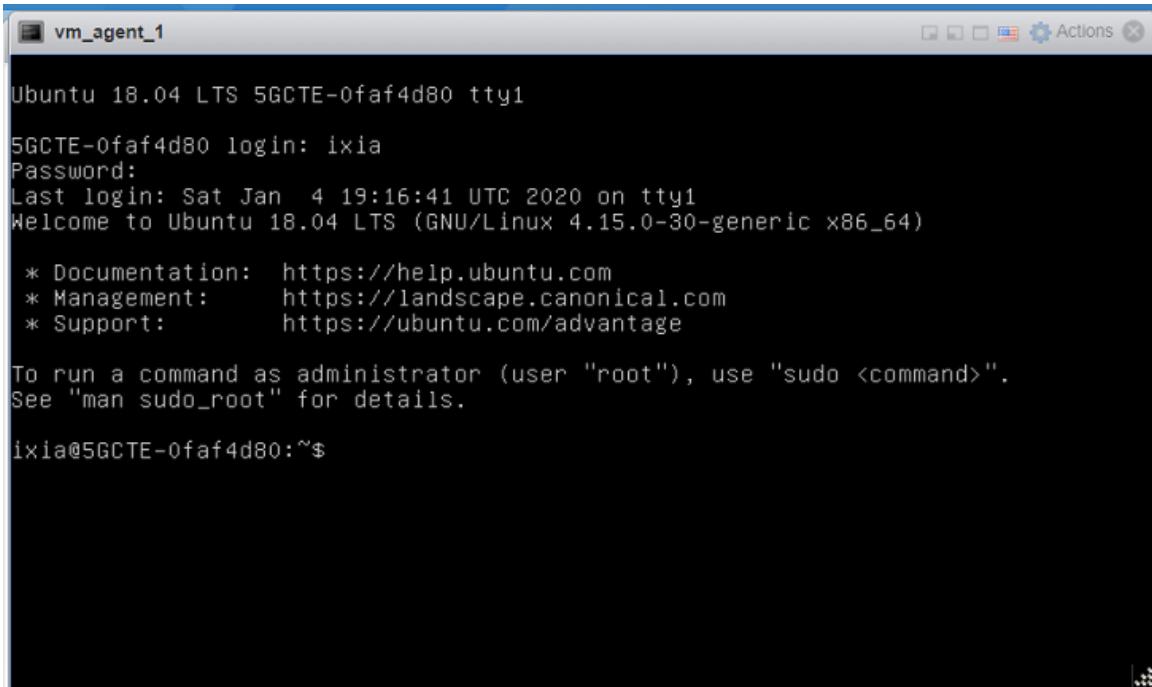
For this deployment, two agents will be installed.

The installation procedure is the same as for the Middleware (for more details, refer to [Middleware Installation](#)), with the following differences:

1. Select the agent image when the VM is created.
2. Set a different name for each VM machine (in this deployment **agent_1** is used for the first agent and **agent_2** for the second agent).



3. Accept the End User License Agreement.
4. Connect the agent to the same vSwitch represented by the **VM Network**.
5. Optionally, after the complete VM installation, log on to each agent using the console from ESXi or ssh, and set the agent name:
 - a. Default username/password : **ixia /ixia**



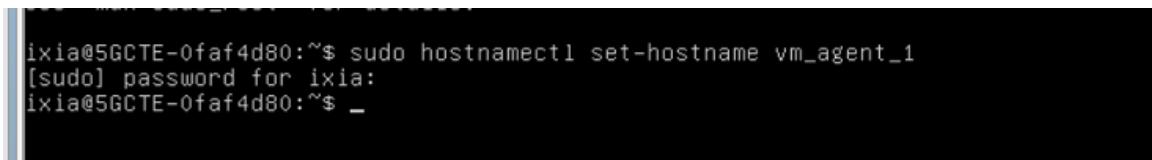
```
Ubuntu 18.04 LTS 5GCTE-0faf4d80 tty1
5GCTE-0faf4d80 login: ixia
Password:
Last login: Sat Jan  4 19:16:41 UTC 2020 on tty1
Welcome to Ubuntu 18.04 LTS (GNU/Linux 4.15.0-30-generic x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ixia@5GCTE-0faf4d80:~$
```

- b. Set the hostname to **agent_1** (use **agent_2** as the name for the second agent).

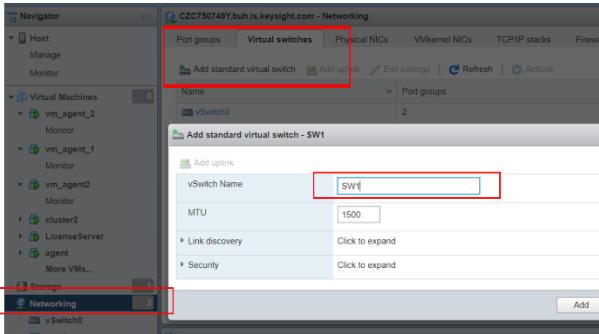


```
ixia@5GCTE-0faf4d80:~$ sudo hostnamectl set-hostname vm_agent_1
[sudo] password for ixia:
ixia@5GCTE-0faf4d80:~$
```

The agents should connect with the Middleware VM on one side and between them on the other side. The second connection represents the **test network**.

In order to do this, another NIC must be added to each VM agent, and connect it to a new vSwitch and PortGroup (**sw1 / test_network**), as follows:

1. Select **Networking > Virtual Switches > Add standard virtual switches** and set the **VSwitch Name** to **sw1**.

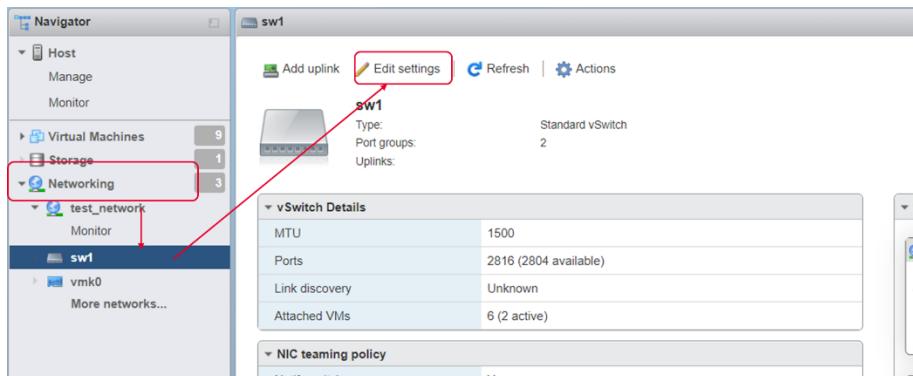


2. Select **Networking > Port Groups > Add port group** and set the port group name to **test_network**.

Name	Active ports
VM Network	5
Management Network	1
opran2	2

Since there are multiple IP addresses on the same interface, the **Promiscuous mode** on the vSwitch that is hosting the *test_network group* must be enabled (in the current setup, *sw1* is the vSwitch that has *test_network group*). This can be done as follows:

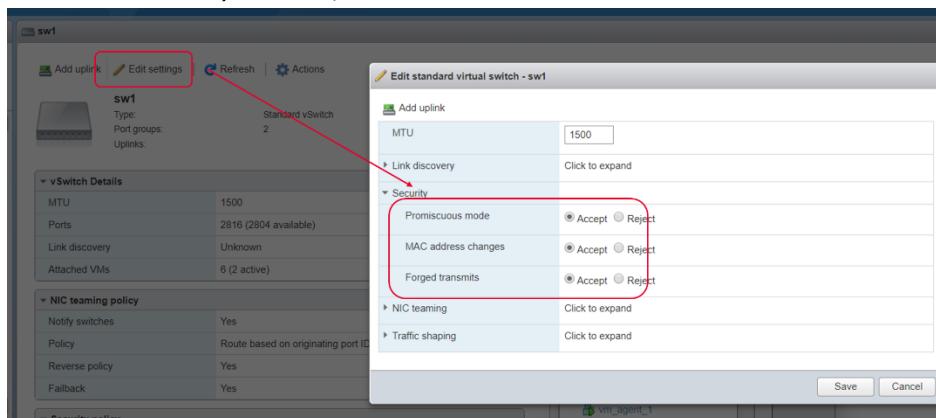
- From the ESXi console, select **Networking > sw1 > Edit settings**.



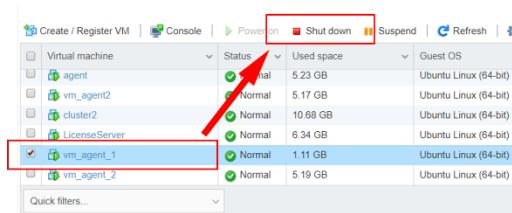
IMPORTANT

In case you are running Openstack on vmWare with VLANs enabled, you need to enable Promiscuous mode on the vswitches (from Reject to Accept) and set VLAN ID 4095 (all vlans).

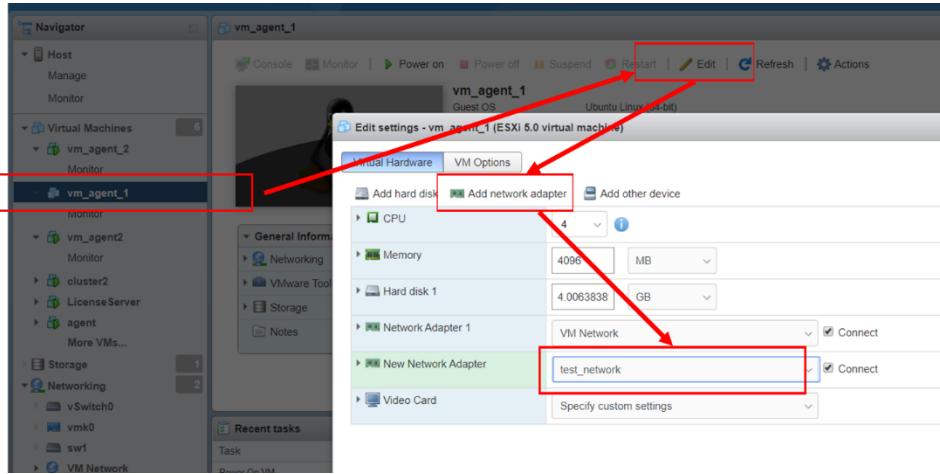
- From the Security section, enable Promiscuous mode and MAC address change.



- Increase the HDD size to 20GB.
- Power off the VM machines (**agent_1** and **agent_2**).



- Add additional NIC to each machine and connect it to test_network port group.



Each agent has two interfaces:

- one for management (**ens32**)
- one for test (**ens160**)

These interfaces can be displayed by running the `ifconfig` command in the agent ssh console:

```
ixia@agent_1:~$ ifconfig
ens32: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
      inet 10.73.51.91  netmask 255.255.248.0  broadcast 10.73.55.255
          inet6 fe80::20c:29ff:fe3:ca9a  prefixlen 64  scopeid 0x20<link>
            ether 00:0c:29:f3:ca:9a  txqueuelen 1000  (Ethernet)
            RX packets 126020  bytes 18866111 (18.8 MB)
            RX errors 0  dropped 5716  overruns 0  frame 0
            TX packets 676  bytes 78634 (78.6 KB)
            TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0

ens160: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
      inet6 fe80::20c:29ff:fe3:caa4  prefixlen 64  scopeid 0x20<link>
        ether 00:0c:29:f3:ca:a4  txqueuelen 1000  (Ethernet)
        RX packets 13  bytes 780 (780.0 B)
        RX errors 0  dropped 11  overruns 0  frame 0
        TX packets 12  bytes 920 (920.0 B)
        TX errors 0  dropped 0  overruns 0  carrier 0  collisions 0
```

The next step is to connect the agents VMs with the Middleware VM:

1. Connect to `agent_1` using ssh.
2. Run the `agent-setup.sh` script: `sudo ./agent_setup.sh`.
3. Provide the required information regarding the interfaces used in the test bed:
 - a. Enter the IP address or hostname of the middleware - in this setup **10.73.54.117**.
 - b. Would you like to change the management interface?: **n**. In this case, the **ens32** interface will be used as management interface (if you need to use another interfaces, type **y** and select it from the list).
 - c. Allow the agent to be rebooted from UI : **[y]**.

```

ixia@5GCTE-3fd2390080:~$ sudo ./agent-setup.sh
[sudo] password for ixia:

Enter the IP address or hostname of the middleware: 1.1.1.1

Selected interface ens32 with address 10.38.159.102 as management interface
Would you like to change the management interface? [y/n]: n

Do you want to allow this agent to be rebooted from the UI? [y/n]: y

Would you like to change the hostname to 5GCTE-00-0c-29-b0-d6-e0? [y/n]: n

Configuring NTP...
Restarting services...

Agent configuration complete
ixia@5GCTE-3fd2390080:~$ █

```

- d. Change the hostname: **n**.

Repeat the above steps for second agent (agent_2):

1. Connect to `vm_agent_2` using SSH.
2. Run the `agent-setup.sh` script: `sudo ./agent_setup.sh`.
3. Provide the required information regarding the interfaces used in the test bed:
 - a. The middleware IP address is **10.73.54.117** (the second agent is connecting to the same Cluster).
 - b. The management interface **ens32**.
 - c. Allow the agent to be rebooted from UI : **[y]**.
 - d. Change the hostname: **n**.

The `agent-setup.sh` script can also be run in a non-interactive way using the command: `sudo ./agent-setup.sh <mdw-ip> auto`.

This command will use as management interface the one which has an IP address assigned, the other interfaces found on the agent will be used for test.

If there is no DHCP server in the network, a static IP address needs to assigned to the agent.

```

Enter the IP address or hostname of the middleware: 1.1.1.1

Available network interfaces:
- ens32 - 00:0c:29:b0:d6:e0
- ens160 - 00:0c:29:b0:d6:ea
- ens192 - 00:0c:29:b0:d6:f4

Enter the name of the management interface: 32
Please enter a valid network interface name.
Enter the name of the management interface: ens32
Would you like to configure the management interface? [y/n]: y
  IPv4 address: 1.1.1.2
  Prefix length: 24
  Gateway (enter for none): 1.1.1.1
  DNS (enter for none):

Do you want to allow this agent to be rebooted from the UI? [y/n]: y

Would you like to change the hostname to 5GCTE-00-0c-29-b0-d6-e0? [y/n]: n

Configuring NTP...
Restarting services...

Agent configuration complete

```

If you need to change the automatically assigned IP address of the agent, refer to the instructions presented in [Appendix C](#).

License Manager Installation

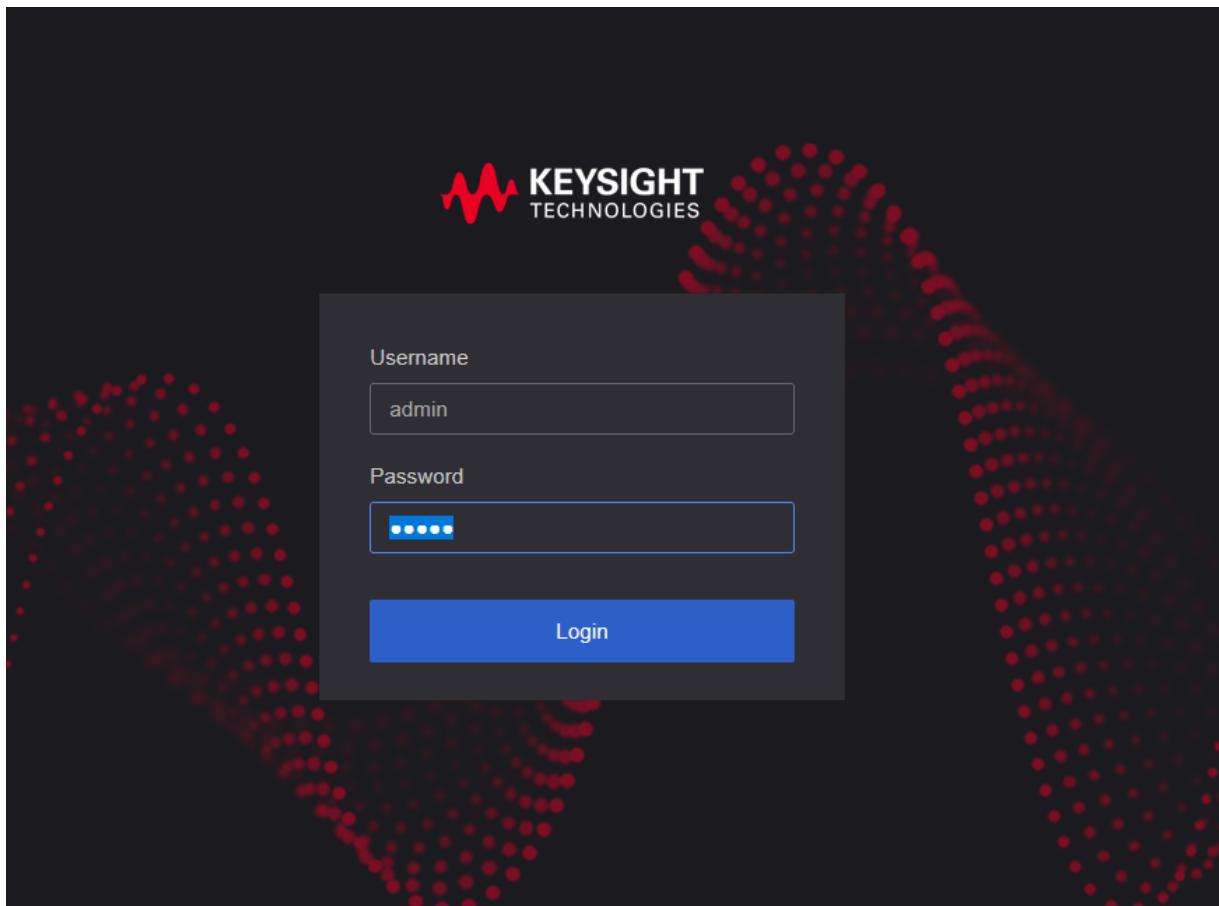
To install the License server on a separate VM machine, do the following:

1. Create a new VM machine on the ESXi server and select the License server OVA image.
2. Set a name for the VM (in this deployment the used name is **LicenseServer**).
3. Connect it to the same vSwitch with the Middleware and Agents (VM Network).
4. When the installation is completed, the license server boots normally in the ESXi console, with its IP address assigned:
 - In this deployment, the IP address is **10.73.53.17**.

Virtual machine	Status	Used space	Guest OS	IP address	Host name	Host CPU	Host memory
LicenseServer	Normal	6.36 GB	Ubuntu Linux (64-bit)	10.73.53.17	licensing-vm	27 MHz	908 MB

Now you can access the License Server UI and install the licenses:

1. On your browser, type the IP address that was assigned for the License Server.
2. Log in using the default username/password: **admin/admin**.



At this point, there are no licenses available on the newly installed server, therefore you must add the license codes you received (evaluation licenses can be obtained by sending an email to: Software-Eval-Request IX <software-eval-request.ix@keysight.com>.

To activate licenses, select the **Activate Licenses** button and add the license codes, select **Load Data** and then **Activate**.

Activate Licenses

Enter License Data:

Example:

```
889D-0CB0-BC3D-3179, 10
F5A5-CA75-1AED-COAC, 5
23a9798736-347903a1-b1ad4788-cfa78bb7-b17c98d7-90232753
```

Load Data

Select and edit activation codes:

Product	Description	Activation Code	Entitlement Code	Total	Available	To Activate

Activate
Close

After activation, for each license, details are displayed, as shown below:

Part ID	Product	Description	License Expiration	Maintenance Expiration	Activation Code	Quantity	Manage Reservation
P89040A-1NF	LoadCore	R-M4F-002-F WRLS 5G LoadCore, floating license, Control Plane impairment, 6-months, floating (single site) license	Nov 9, 2027, 12:00:00 AM	Nov 9, 2027, 12:00:00 AM	[REDACTED]	30	
P89048A-1NF	LoadCore	R-M4F-002-F WRLS 5G LoadCore, SCAS AMF, SMF, UPF, AUSF, UDM, NRF test libraries, 6-months, floating (single site) license	Nov 16, 2027, 12:00:00 AM	Nov 16, 2027, 12:00:00 AM	[REDACTED]	100	
P89048A-1NX	LoadCore	R-M4F-002-X WRLS 5G LoadCore, SCAS AMF, SMF, UPF, AUSF, UDM, NRF test libraries, 6-months, floating (single site) license	Nov 16, 2027, 12:00:00 AM	Nov 16, 2027, 12:00:00 AM	[REDACTED]	100	
P89048A-1NL	LoadCore	R-M4F-002-L WRLS 5G LoadCore, SCAS AMF, SMF, UPF, AUSF, UDM, NRF test libraries, 12-months, floating (single site) license	Nov 16, 2027, 12:00:00 AM	Nov 16, 2027, 12:00:00 AM	[REDACTED]	100	
P89037A-1NF	LoadCore	R-M4F-002-F WRLS 5G LoadCore, floating license for User Plane (10Gbps Pput), 6-months, floating (single site) license	Dec 12, 2027, 12:00:00 AM	Dec 12, 2027, 12:00:00 AM	[REDACTED]	100	
P89039A-1NF	LoadCore	R-M4F-002-F WRLS 5G LoadCore, floating license, high performance all-inclusive bundle (9 CP interfaces, 2M UEs, 20Gbps Pput), 6-months, floating (single site) license	Dec 12, 2027, 12:00:00 AM	Dec 12, 2027, 12:00:00 AM	[REDACTED]	100	
P89034A-1NF	LoadCore	R-M4F-002-F WRLS 5G LoadCore, floating license, performance enabler (UEs and Procedures per Sec), 6-months, floating (single site) license	Dec 12, 2027, 12:00:00 AM	Dec 12, 2027, 12:00:00 AM	[REDACTED]	100	
P89059A-1NF	LoadCore	R-M4F-002-F WRLS 5G LoadCore, floating license, IPSEC capability, 6-months, floating (single site) license	Dec 12, 2027, 12:00:00 AM	Dec 12, 2027, 12:00:00 AM	[REDACTED]	100	

To synchronize licenses, select the **Sync Licenses** button. This way, if licenses are activated, deactivated or renewed using the offline feature, you can sync all the changes.

To import licenses, go to **Offline Operations**, select **Import License** and select the file that contains the licenses.

The screenshot shows the Keysight License Manager interface. At the top, there's a navigation bar with the Keysight Technologies logo, a 'LICENSE MANAGER' link, and user information ('admin'). Below the navigation is a header for 'Keysight Licensing Offline Operations'. It contains instructions for performing offline licensing operations, mentioning steps like generating a request file and importing it later. Buttons for 'Generate Request' and 'Import License' are present. A note at the bottom states that confirmation codes must be entered within 48 hours. To the right of this modal, there's a 'Manage Reservation' section with a 'Deactivate Licenses' button. Below these are two main sections: 'Offline Operations' and 'License Statistics'. The 'Offline Operations' section has buttons for 'Activate Licenses', 'Sync Licenses', and 'Offline Operations'. The 'License Statistics' section has a 'Quantity' column and a 'Manage Reservation' button.

To deactivate licenses, use the **Deactivate Licenses** button. Set the **New Quantity** value for each license and, then, select **Perform Deactivation**.

By selecting the **License Statistics** button, you can view the details of the license features that are associated to the license that you have activated.

License Statistics							
Feature ↑ Search...							
User	Application	Consumed Count	Reserved Count	Remaining Reservation Duration			
Feature: LC_TestLib_SCAS_all, Available: 300 of 300							
-	-						
Feature: VMP-WRLS-5GC-INTERFACE, Available: 858 of 900							
e7285ea0-a2e5-49b9-af...	LoadCore N/A	10	0	00:00:00			
e7285ea0-a2e5-49b9-af...	LoadCore N/A	11	0	00:00:00			
bd0de644-5cce-460b-a...	LoadCore N/A	11	0	00:00:00			
e7285ea0-a2e5-49b9-af...	LoadCore N/A	10	0	00:00:00			
Feature: VMP-WRLS-5GC-RATE, Available: 29993 of 30000							
e7285ea0-a2e5-49b9-af...	LoadCore N/A	1	0	00:00:00			
e7285ea0-a2e5-49b9-af...	LoadCore N/A	1	0	00:00:00			
bd0de644-5cce-460b-a...	LoadCore N/A	1	0	00:00:00			
1	2						
Close							

ORAN-SIM CE allows you to use two types of license servers in order to manage licenses. From the ORAN-SIM CE Web UI select gear menu > **Application Settings**:

- **External License Server** - select this option to set an external license server (provide the license server IP address).

Application Settings

License Provider

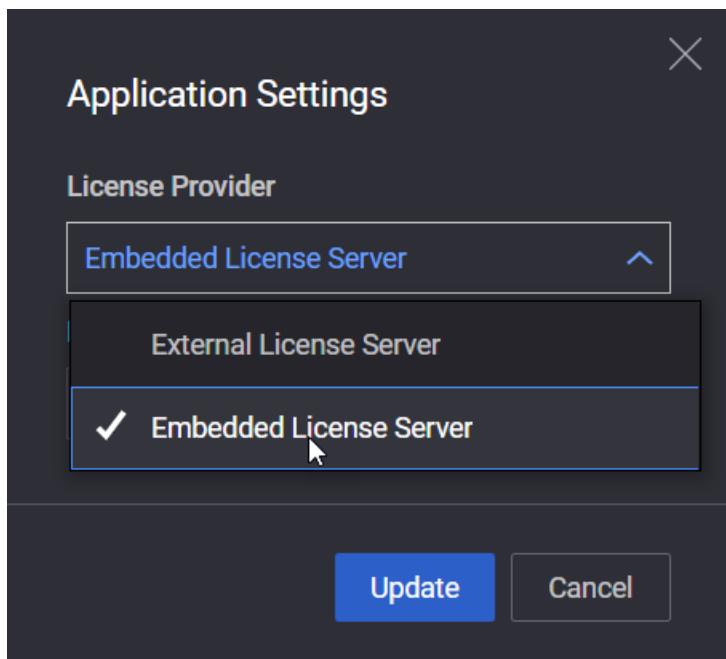
External License Server ▾

License Server IP

10.38.157.13

Update **Cancel**

- **Embedded License Server** - the license server that is included in ORAN-SIM CEMW.



Steps to Upgrade your License Server

NOTE The following procedures applies to LoadCore version 3.4 or earlier.

If you are using an embedded license server in an ESX/KVM/AWS/Azure virtual machine environment:

1. Download the licensing upgrade .tar file [here](#).
2. Sign in to the LoadCore UI by using the **admin** user credentials.
3. On the top right side, select **Administration > Software Updates**.
4. Choose **Select Packages for Upload**.
5. Select the downloaded .tar file.
6. Select **Start Update**. After the process starts, a progress indicator appears. When the patch installation is complete, you will receive a notification.

After this stage, the license server that is embedded inside the Virtual Machine is updated and ready to use.

If you are using an embedded license server in a Kubernetes (k8s/Anthos/OpenShift/EKS) environment:

1. Download the container licensing patch .zip file [here](#). In the zip archive, you will find the docker image for the new Embedded License Server, and also the folder with the charts modified.
2. Unzip the archive. After unzipping this archive, you will find the docker image and a folder.

3. Where you extracted LoadCore-MDW-3.4.0-3490-268-AGENT-3.4.0-9 archive, find a charts directory. Delete from that directory the kcos-licensing as follows:

- `rm -rf charts/kcos-licensing`
- Move the kcos-licensing folder (which is compressed in the zip archived) to the charts directory.

4. Load the docker image by using:

```
docker load -i <docker image name>
```

For example: `docker load -i kcos-licensing-0.3.5_20220727.134517.db24dc3f.tar.gz`

5. Tag the docker image as follows:

```
docker tag <IMAGE ID> <registry_name>/<project_name>/kcos-licensing:0.3.5_20220727.134517.db24dc3f
```

For example: `docker tag 014439e08129 default-route-openshift-image-registry.apps.cluster.keysight.lab/loadcore-root/kcos-licensing:0.3.5_20220727.134517.db24dc3f`

6. Push the image inside our repository.

```
docker push <registry_name>/<project_name>/kcos-licensing:0.3.5_20220727.134517.db24dc3f
```

For example: `docker push default-route-openshift-image-registry.apps.cluster.keysight.lab/loadcore-root/kcos-licensing:0.3.5_20220727.134517.db24dc3f`

7. Install LoadCore with the new Embedded License Server:

```
./loadcore-kube-setup install-mw
```

After this stage, the license server that is embedded inside the Kubernetes is updated and ready to use.

If you are using Licensing-1.7.0-4 and want to upgrade the image in-place:

1. Download the licensing patch .tar file [here](#).
2. Sign in to the Licensing UI by using the **admin** user credentials.
3. In the Licensing UI, select the **Gear** menu > **Administration** > **Software Updates**.
4. Choose **Select Packages for Upload** and select the downloaded .tar file.
5. Select **Start Update**. After the process starts, a progress indicator appears. When the patch installation is complete, you will receive a notification in the bottom right corner.

After this stage, the license server is updated and ready to use.

If you are using legacy licensing or Licensing-1.7.0-4 and want to deploy a new image:

1. Download the licensing image:
 - ESX image [here](#)
 - KVM image [here](#)
2. De-activate your licenses from the old licensing deployment.
If you are using offline licenses, please contact Support for deactivation / reactivation.

3. Deploy the downloaded images.
4. Activate your licenses on the new deployment.
5. Point your middleware to the new licensing deployment.

IMPORTANT If you are upgrading from License Server release earlier than 1.7.04, you must be aware that the CLI has changed.

To log in, type `console`, and when prompted, use the default username and password:
admin/admin.

If necessary, please refer to the [*KCOS CLI Reference Guide*](#) in order to obtain the DHCP IP address of the License Server.

To interact with the License Server, refer to the [License Manager Installation](#) section presented above.

Amazon AWS Deployment

This section describes the steps needed to deploy ORAN-SIM CE in Amazon AWS.

Prerequisites

For a complete and correct functioning setup, make sure you have downloaded and installed the packages on your test environment:

- **Wireshark** capable to decode PFCP messages and IEs (at least 2.5.2).
This will be used to analyze the traffic captures.
- **AWS account**
The examples presented in this guide were done using a Full Core topology deployed in B2B scenario (no real/external DUT).
- **ORAN-SIM CE images** (three images: one for Middleware, for Test Agents and one for License Server).

There are few options to get the images:

- Get AMI images from AWS Marketplace.
<https://aws.amazon.com/marketplace/search/results?searchTerms=keysight>
Regions supported: eu-north-1, ap-south-1, eu-west-3, eu-west-2, eu-west-1, ap-northeast-2, ap-northeast-1, sa-east-1, ca-central-1, ap-southeast-1, ap-southeast-2, eu-central-1, us-east-1, us-east-2, us-west-1, us-west-2
- Get the shared images from our AWS account. For this you need to contact the Support Eng. assigned to help with this activity.

- **AWS Cloudformation templates**

The ORAN-SIM CE setup can be also deployed using Cloudformation templates. The templates can be found at the following location:

<https://github.com/Keysight/loadcore/tree/main/AWS>

How to use Cloudformation templates:

<https://docs.aws.amazon.com/AWSCloudFormation/latest/UserGuide/GettingStarted.Walkthrough.html>

- **Valid licenses** for License server. For deploying full 5G core and run Control Plane and User Plane traffic, the following licenses are required:

- Control plane licenses:
 - ORAN-SIM CE interface license simulation (**P89033A** x 11 pcs).
This license will enable Control Plane testing. One license is needed for each simulated interface.
 - 5G Core Performance enabler on VM: 1M UEs and 10k TPS for VM (**P89034A** x 1 pcs).
- User Plane licenses:
 - User Plane Flow-based license (N3 and N6). Multiple QTY are needed if multiple flows are active simultaneously. It includes three Application Traffic Flows (TCP/UDP) and 10Gbps throughput capacity (**P89037A** x 2 pcs). The recommendation is to use this type of license as this will be suggested for all new customers.

- As an alternative for the above license you can also use Tier-4 license (**P89030A** or **P89031A** x 2 pcs).

IMPORTANT These license types will enable User Plane traffic and are not needed if only Control Plane traffic is needed for future tests.

- **Skills needed by a user:**

- 5G core network knowledge
- familiarity with AWS EC2, EBS and VPC services
- in case the user wants to run automated tests, REST API knowledge is required in their choice programming language

Resource requirements in AWS

ORAN-SIM CE Middleware instance resources

By default, the VM for Middleware will reserve the following compute resources:

- 8 x vCPUs
- At least 16 GB RAM
- 256 GB SSD

Recommended instance types: **m4.2xlarge, t2.2xlarge, c4.4xlarge, c5.2xlarge, c5.4xlarge**.

ORAN-SIM CE Test Agent instance resources

The **Test Agent** will reserve the following compute resources:

- 4 x vCPUs
- 4 GB RAM **out of which 1GB is reserved for HUGE MEM(DPDK)**

IMPORTANT This value is for Control Plane only. If you are running app traffic the recommendation is to allocate minimum 16 GB RAM.

- 20 GB SSD

Recommended instance types: **c4.2xlarge, c5.2xlarge, t2.xlarge, t2.2xlarge, c4.4xlarge, c4.8xlarge, c5.xlarge, c5.4xlarge, c5.9xlarge**.

Licensing server default resources

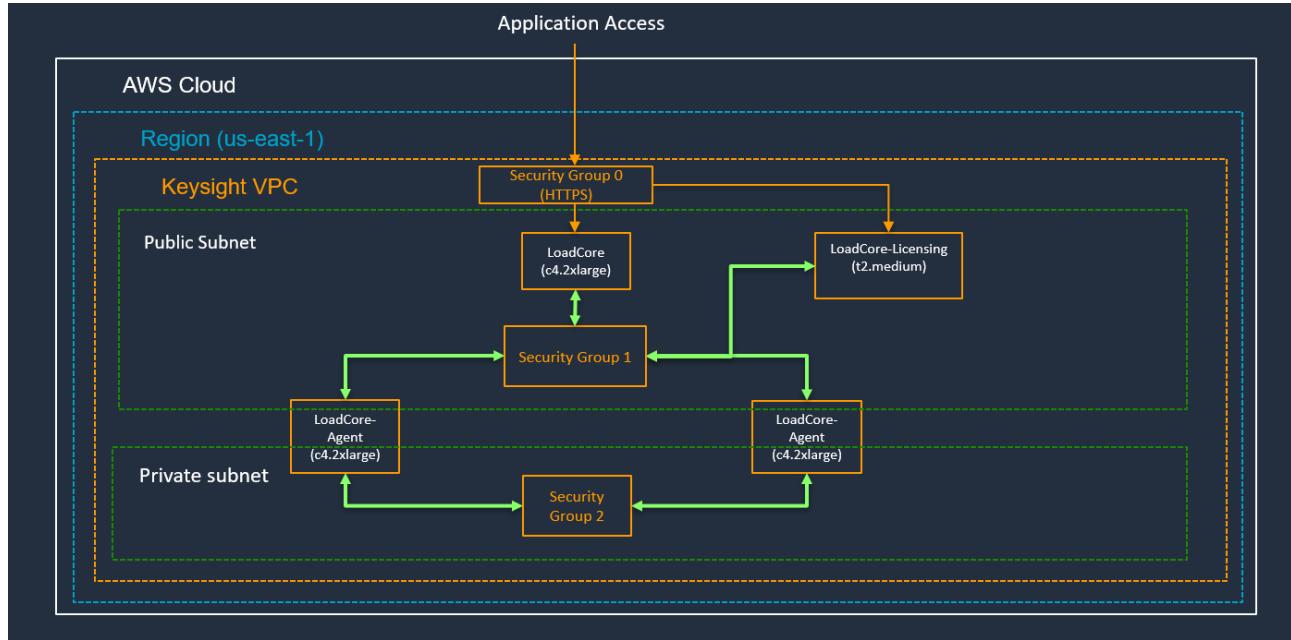
- 2 x vCPUs
- 4 GB RAM
- 11 GB SSD

Recommended instance types: **t2.medium, t2.large, t2.xlarge, c4.large, c4.xlarge**.

AWS services and components

Amazon **Virtual Private Cloud** (Amazon VPC) enables you to launch AWS resources into a virtual network that you have defined. Amazon VPC is the networking layer for Amazon EC2 and it is logically isolated from other virtual networks in the AWS Cloud.

The following diagram explains how LoadCore can be deployed in AWS:



For LoadCore deployment, you can reuse an already existing VPC or create a new one.

In this guide, a new VPC is created, as presented in the following topics.

Create a Virtual Private Cloud

You can create an Amazon Virtual Private Cloud as follows:

1. Select **AWS Management Console > Services > VPC**.

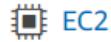
AWS services

Find Services

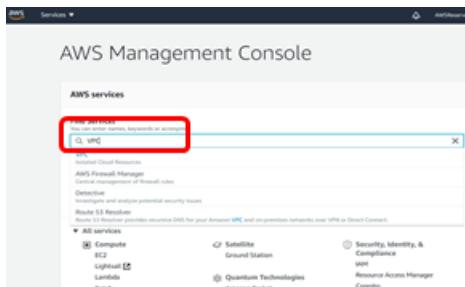
You can enter names, keywords or acronyms.

Example: Relational Database Service, database, RDS

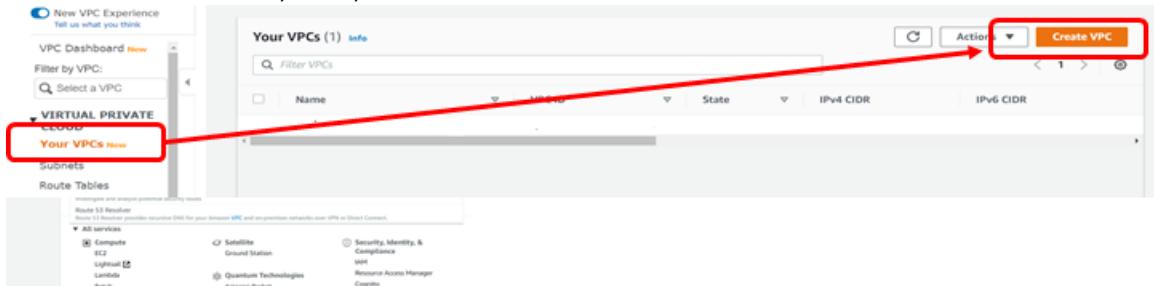
▼ Recently visited services



You can also use **Find Services** option and search for VPC:



2. Select **Your VPC** and, then, select **Create a VPC**.



3. We will define **loadcore-vpc** with a **10.0.0.0/16** mask network (IPv4 CIDR). Later on, we will define two subnets in this CIDR block:

Create VPC [Info](#)

A VPC is an isolated portion of the AWS cloud populated by AWS objects, such as Amazon EC2 instances.

VPC settings

Name tag - optional
 Creates a tag with a key of 'Name' and a value that you specify.

IPv4 CIDR block [Info](#)

IPv6 CIDR block [Info](#)

- No IPv6 CIDR block
- Amazon-provided IPv6 CIDR block
- IPv6 CIDR owned by me

Tenancy [Info](#)

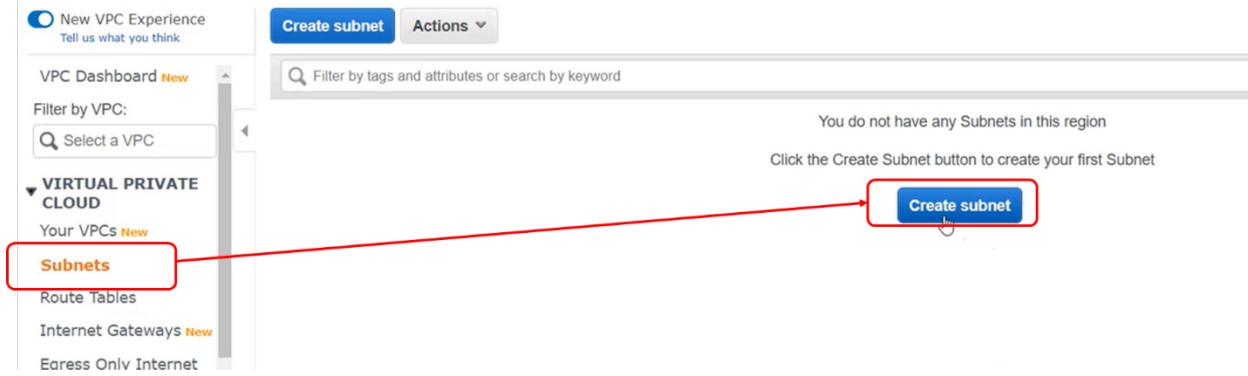
4. At the end of this operation you should have the following result:

Your VPCs (1/1) Info		Actions		Create VPC	
<input type="text"/> Filter VPCs					
<input checked="" type="checkbox"/>	Name	VPC ID	State	IPv4 CIDR	IPv6 CIDR
<input checked="" type="checkbox"/>	loadcore-vpc	vpc-0f83e58ca0488394d	Available	10.0.0.0/16	-

Create the management and test subnets

You need to create two subnets inside the VPC defined at the previous step, one subnet to be used for management and the other one to be used for test.

A *subnet* is a range of IP addresses in your VPC. You can launch AWS resources into a specified subnet. Use a public subnet for resources that must be connected to the internet, and a private subnet for resources that will not be connected to the internet.



We will use **10.0.0.0/24** for management (with the name **mgmt.-subnet**) and **10.0.10.0/24** for test (with the name **test.-subnet**).

The subnet can be created as follows (in this example, the management subnet):

1. Select the **VPC ID** (there will be only one VPC – the one created at the previous step). If you are reusing an existing VPC, make sure to select the correct VPC ID.
2. Define the subnet TAG (this is the name assigned to the subnet).
3. Define the subnet IP addresses (in this case **10.0.0.0/24**).
4. Select **Create Subnet**.

VPC ID
Create subnets in this VPC.
vpc-0f83e58ca0488394d (loadcore-vpc)

Associated VPC CIDRs
IPv4 CIDRs
10.0.0.0/16

Subnet settings
Specify the CIDR blocks and Availability Zone for the subnet.

Subnet 1 of 1

Subnet name
Create a tag with a key of 'Name' and a value that you specify.
mgmt-subnet
The name can be up to 256 characters long.

Availability Zone Info
Choose the zone in which your subnet will reside, or let Amazon choose one for you.
No preference

IPv4 CIDR block Info
10.0.0.0/24

▼ Tags - optional

Repeat the steps presented above for test subnet also (using **10.0.10.0/24** IP definition).

After creating the two subnets, your console should display the following image:

- The **Subnet ID** is automatically assigned.
- Both subnets should belong to the same VPC.

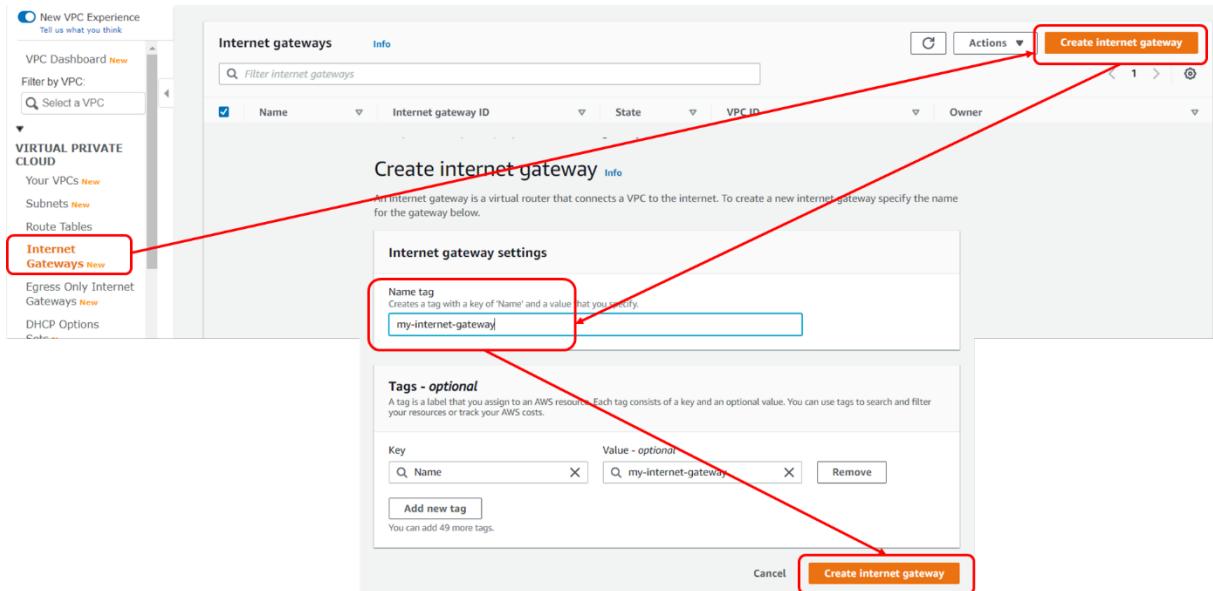
Subnets (2) Info					
<input type="checkbox"/>	Name	Subnet ID	State	VPC	IPv4 CIDR
<input type="checkbox"/>	mgmt-subnet	subnet-0a87408455ab56c3e	Available	vpc-0f83e58ca0488394d lo...	10.0.0.0/24
<input type="checkbox"/>	test-subnet	subnet-04267cc8ce65eb610	Available	vpc-0f83e58ca0488394d lo...	10.0.10.0/24

Create the Internet Gateway

An internet gateway is a VPC component that enables communication between your VPC and the Internet.

To use an internet gateway, attach it to your VPC and specify it as a target in your subnet route table for internet-routable IPv4 or IPv6 traffic. An internet gateway performs network address translation (NAT) for instances that have been assigned public IPv4 addresses.

We will name it **my-internet-gateway**, after that, we need to attach it to our VPC.



The newly created gateway is in the state **Detached**, with no VPC ID associated. Therefore, we need to attach it to our VPC:

1. Select the gateway.
2. Select **Actions** and, then, select **Attach to VPC**.

- Select the previous defined VPC.

VPC > Internet gateways > Attach to VPC (igw-08edd18d8e0167ea9)

Attach to VPC (igw-08edd18d8e0167ea9) Info

VPC
Attach an internet gateway to a VPC to enable the VPC to communicate with the internet. Specify the VPC to attach below.

Available VPCs
Attach the internet gateway to this VPC.

X

▶ AWS Command Line Interface command

Cancel Attach internet gateway

At the end of this step, the following image should be displayed:

Internet gateways (1/1) <small>Info</small>						C	Actions ▾	
<input checked="" type="checkbox"/>	Name	Internet gateway ID	State	VPC ID	Owner			
<input checked="" type="checkbox"/>	my-internet-gateway	igw-08edd18d8e0167ea9	Attached	vpc-0f83e58ca0488394d loadcore-vpc	672779868767			

Assign traffic routes

The next step is to assign traffic routes, in order to pass the external traffic through the gateway that we just defined. This can be done as follows:

- Select the **Route table** menu (a *route table* contains a set of rules, called *routes*, that are used to determine where network traffic from your subnet or gateway is directed).
- Select **Add Route** and define the default rate: **0.0.0.0/0**.
- For **Target**, select **Internet Gateway** and select the gateway previously defined.
- Select **Save Routes**.

Route Tables > Edit routes

Edit routes

Destination	Target	Status
10.0.0.0/16	local	active
0.0.0.0		

Add route Internet Gateway

* Required

If you select **Routes**, the following configuration should be displayed:

The screenshot shows the AWS Route Tables interface. At the top, there is a table with columns: Name, Route Table ID, Explicit subnet associations, Edge associations, Main, and VPC ID. One row is selected with the ID rtb-09038b62a74cab699. Below the table, a message says "Route Table: rtb-09038b62a74cab699". Underneath, there are tabs: Summary, Routes (which is selected), Subnet Associations, Edge Associations, Route Propagation, and Tags. A button "Edit routes" is visible. A dropdown menu "View" shows "All routes". The main content area displays a table with columns: Destination, Target, and Status. Two entries are listed: "10.0.0.0/16" with target "local" and status "active", and "0.0.0.0/0" with target "igw-08edd18d8e0167ea9" and status "active".

Configure Security Groups

To protect the AWS resources in each subnet, you can use multiple layers of security, including security groups and network access control lists (ACL).

A security group acts as a virtual firewall for your instance to control inbound and outbound traffic. When you launch an instance in a VPC, you can assign up to five security groups to the instance. Security groups act at the instance level, not the subnet level. Therefore, each instance in a subnet in your VPC can be assigned to a different set of security groups.

You might set up network ACLs with rules similar to your security groups in order to add an additional layer of security to your VPC.

By default, when the VPC was created, also a Security Group was automatically defined.

We will define a name for it (**loadcore-sg**) and configure the inbound rules:

The screenshot shows the AWS Security Groups interface. On the left, there is a sidebar with various AWS services: Spot Requests, Savings Plans, Reserved Instances, Dedicated Hosts (New), Capacity Reservations, Images, AMIs, Elastic Block Store, Volumes, Snapshots, Lifecycle Manager, Network & Security (Security Groups New), Elastic IPs (New), and Placement Groups. The "Security Groups" section is highlighted. In the main area, there is a table titled "Security Groups (1/1) Info". A modal window is open, showing the "Edit Name" field with the value "loadcore-sg". Below the field are "Cancel" and "Save" buttons. The table in the background shows one entry: "Name" (loadcore-sg), "Security group ID" (sg-0ddefault), "Security group name" (default), and "VPC ID" (vpc-0f83e58ca0488394d).

Now we need to define Inbound security rules, as follows:

1. Select the security group ID and go on Inbound rules.
2. Select **Add rule**.
 - For security reasons we will allow the traffic only for specific ports used by ORAN-SIM CE and originated from a single IP address(the one used to access the internet).

The screenshot shows the 'Edit inbound rules' interface for a specific security group. At the top, there are filters for Type (All traffic), Protocol (All), Port range (All), and Source (Custom). A search bar contains the identifier 'sg-0dcc6656aeeb6c9cd'. Below these, a list of existing rules is shown, with the first rule being 'sg-0dcc6656aeeb6c9cd'. At the bottom left, a prominent 'Add rule' button is highlighted with a red box.

- We will permit the following:
 - SSH, to access the ORAN-SIM CE VMs,
 - HTTP, HTTPS, used by ORAN-SIM CE for configuration, interaction between nodes,
 - Custom: 7443 port, that is used by the License Server,
 - For all traffic we will select *My IP*, and the browser will automatically fill it with the outgoing IP address that you have (in this case **188.25.103.79**).

At the end of this step, you should have the following rules in your Security Group:

The screenshot shows the 'Inbound rules' page with five rules listed:

- HTTP (TCP, port 80) - Source: 188.25.103.79/32
- SSH (TCP, port 22) - Source: 188.25.103.79/32
- HTTPS (TCP, port 443) - Source: 188.25.103.79/32
- Custom TCP (TCP, port 7443) - Source: 188.25.103.79/32

An 'Add rule' button is visible at the bottom left.

Create Key Pairs

The final step is to create the key pair, as presented below.

The screenshot shows the 'Create key pair' wizard in the AWS Management Console. The top navigation bar indicates the user is in the EC2 service under 'Key pairs'. The main title is 'Create key pair'. A sub-section titled 'Key pair' defines it as a set of security credentials used for connecting to instances. The 'Name' field is filled with 'lc-keypair'. A note below says the name can include up to 255 ASCII characters and cannot have leading or trailing spaces. The 'File format' section offers two options: 'pem' (selected) and 'ppk' (selected). 'pem' is for OpenSSH and 'ppk' is for PuTTY. There is a 'Tags (Optional)' section with a button to 'Add tag' and a note that 50 more tags can be added. At the bottom right are 'Cancel' and 'Create key pair' buttons.

LoadCore Components Installation

Until now, we have created the minimum infrastructure required to deploy the ORAN-SIM CE components.

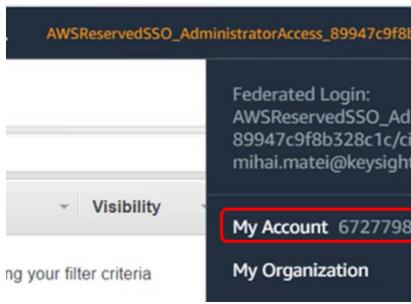
In AWS, the images that we are using are in AMI format.

An Amazon Machine Image (AMI) provides the information required to launch an instance. You must specify an AMI when you launch an instance. You can launch multiple instances from a single AMI when you need multiple instances with the same configuration. You can use different AMIs to launch instances when you need instances with different configurations.

The AMI images can be found on AWS marketplace or can be shared from our AWS account.

In this deployment, we will use shared images.

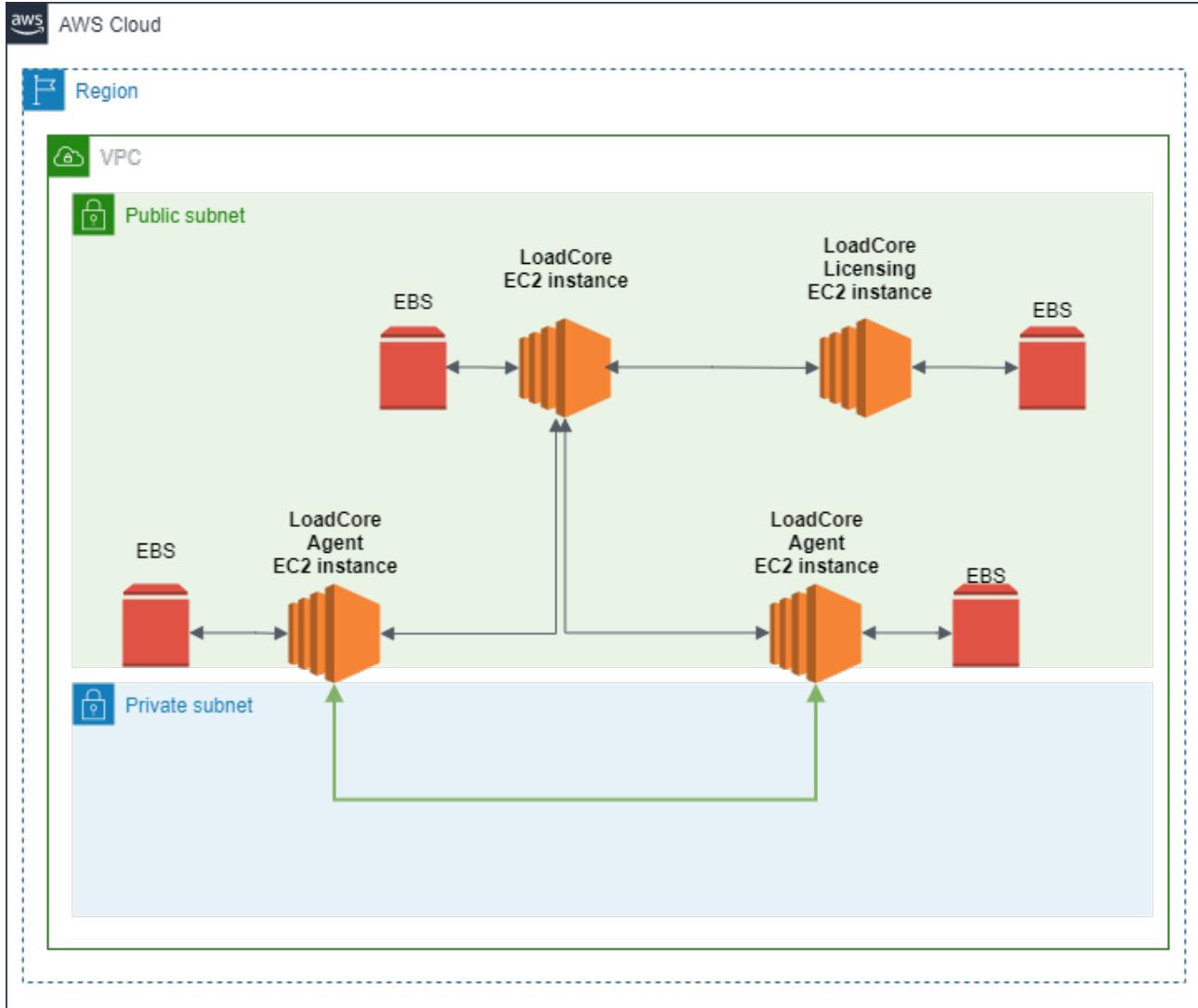
To get access to them, please contact our Support or PM team. You need to provide your AWS account ID to get access to the shared images.



In order to install the ORAN-SIM CE Middleware, Test Agents and License server, the AMI images should be available for you, in your AWS account.

The installation process basically consists of launching the AMI images.

The following diagram illustrates some of the AWS services used by ORAN-SIM CE deployment:



Middleware Installation

The installation procedure of the Middleware requires the following steps:

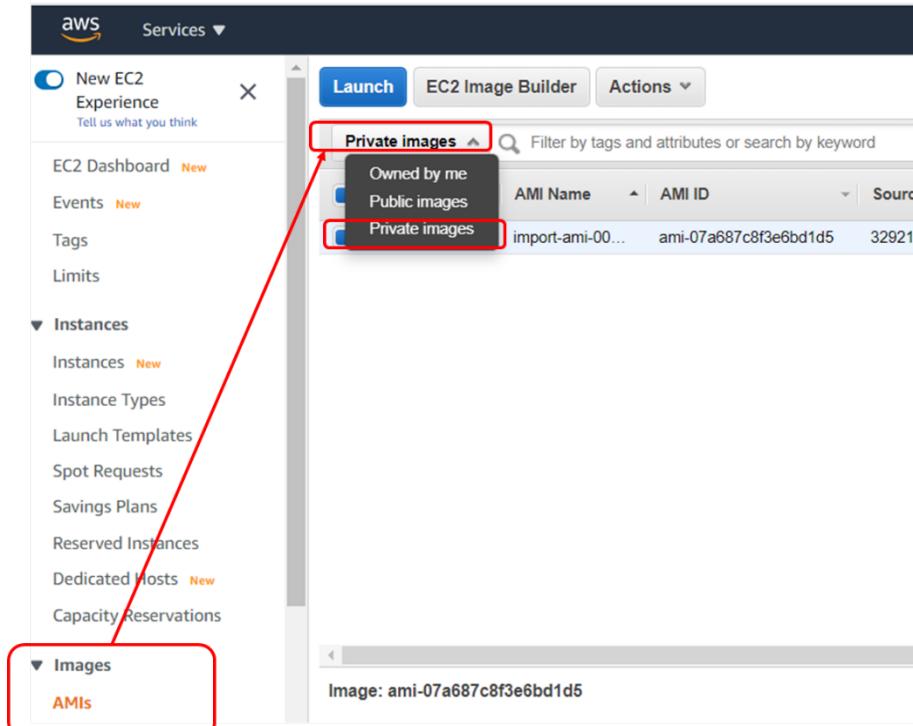
- From the main console, select **Services > EC2 > Images > AMI**.

The browser will automatically display the **images that you own**, therefore, if you do not have other images you created, the list will be empty.

Select **Private Image** and you will find the installation images that were shared with you.

The AMIs can be also found on AWS Marketplace at the following location:

<https://aws.amazon.com/marketplace/search/results?searchTerms=keysight>



You can also give a name to the AMI image, to be easily identified (in this case **LC-MW-1.3**).

Name	AMI Name	AMI ID	Source	Owner	Visibility	Status
LC-MW-1.3	import-ami-00...	ami-07a687c8f3e6bd1d5	329217284442/i...	329217284442	Private	available

Once you have the image available, select it and select **Launch**.

The launch process will request additional info, which is meant to adjust the resources in AWS.

The general advice here is to select the same amount of resources as in the other installation (for example, ESXi):

- Select the Instance type:

- Select **c5.2xlarge**.

The screenshot shows a list of AWS instance types. The 'c5.2xlarge' option is highlighted with a red box and has a checkmark next to it, indicating it is selected. Other visible options include c5.large, c5.4xlarge, c5.xlarge, c5.12xlarge, c5.24xlarge, c5.9xlarge, and another c5.2xlarge entry below it. A sidebar on the right provides filtering options like 'Free tier eligible' and links to 'Browse more AMIs' and 'Compare instance types'.

Instance Type	Description
c5.large	Family: c5 2 vCPU 4 GiB Memory On-Demand Linux pricing: 0.085 USD per Hour On-Demand Windows pricing: 0.177 USD per Hour
c5.4xlarge	Family: c5 16 vCPU 32 GiB Memory On-Demand Linux pricing: 0.68 USD per Hour On-Demand Windows pricing: 1.416 USD per Hour
c5.xlarge	Family: c5 4 vCPU 8 GiB Memory On-Demand Linux pricing: 0.17 USD per Hour On-Demand Windows pricing: 0.354 USD per Hour
c5.12xlarge	Family: c5 48 vCPU 96 GiB Memory On-Demand Linux pricing: 2.04 USD per Hour On-Demand Windows pricing: 4.248 USD per Hour
c5.24xlarge	Family: c5 96 vCPU 192 GiB Memory On-Demand Linux pricing: 4.08 USD per Hour On-Demand Windows pricing: 8.496 USD per Hour
c5.2xlarge	Family: c5 8 vCPU 16 GiB Memory On-Demand Linux pricing: 0.34 USD per Hour On-Demand Windows pricing: 0.708 USD per Hour
c5.9xlarge	Family: c5 24 vCPU 72 GiB Memory
c5.2xlarge	Family: c5 8 vCPU 16 GiB Memory On-Demand Linux pricing: 0.34 USD per Hour On-Demand Windows pricing: 0.708 USD per Hour

- Configure the Instance Details:

- VPC – select the VPC we defined. In our case there is only one, but if you have multiple VPCs, you need to select the one you want to use to deploy ORAN-SIM CE.
- Select the management subnet.

- Select **Add Storage**.

By default, the **Size** will come with 100 GB.

For long duration tests, you need to increase the size to 256 GB.

Step 4: Add Storage

Your instance will be launched with the following storage device settings. You can attach additional EBS volumes and instance store volumes to your instance. You can edit the settings of the root volume. You can also attach additional EBS volumes after launching an instance, but not instance store volumes. [Learn more about storage options in Amazon EC2](#).

The screenshot shows the 'Add New Volume' section of the AWS instance configuration. It displays a table with columns for Volume Type, Device, Snapshot, Size (GiB), and Volume Type. The 'Root' volume is listed with a size of 100 GiB, which is highlighted with a red box. The volume type is set to 'General Purpose SSD (gp2)'. There is also an 'Add New Volume' button at the bottom.

Volume Type	Device	Snapshot	Size (GiB)	Volume Type
Root	/dev/sda1	snap-0a30da8b309439f13	100	General Purpose SSD (gp2)

- There is no need to define Tags, select **Configure Security Group**.
 - Select the security group we previously defined.
 - Select **Review and Launch**.

Step 6: Configure Security Group
A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to set up a web server and allow Internet traffic to reach your instance, add rules that allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. Learn more about Amazon EC2 security groups.

Assign a security group:	<input type="radio"/> Create a new security group	<input checked="" type="radio"/> Select an existing security group					
Security Group ID	sg-0dcc6656aeeb6c9cd	Name	default	Description	default VPC security group	Actions	Copy to new
Inbound rules for sg-0dcc6656aeeb6c9cd (Selected security groups: sg-0dcc6656aeeb6c9cd)							
Type	Protocol	Port Range	Source	Description			
HTTP	TCP	80	188.25.103.79/32				
All traffic	All	All	sg-0dcc6656aeeb6c9cd (default)				
SSH	tcp	22	188.25.103.79/32				

Review and Launch

2. Select **Launch**.

This will display a pop-up menu from where you can select/create a key pair. If you already have a key pair (and you downloaded it), you can select that one, otherwise you can create a new one, and download it from here, as shown below:

- Select **Create a new key pair**.
- Define a name for it: **lc-keypair**.
- Select **Download Key Pair**.
- Select **Launch Instances**.

Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about [removing existing key pairs from a public AMI](#).

<input type="radio"/> Create a new key pair
Key pair name
lc-keypair

Download Key Pair

You have to download the **private key file** (*.pem file) before you can continue. **Store it in a secure and accessible location**. You will not be able to download the file again after it's created.

Launch Instances

3. At this point, the instance is launched, as shown below.

Launch Status

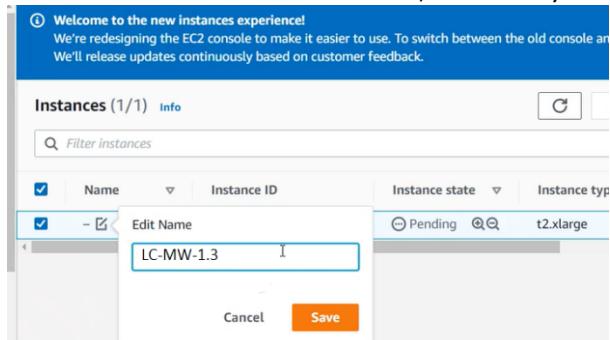
Your instances are now launching
The following instance launches have been initiated: i-0cbcf768f02edab2e [View launch log](#)

i Get notified of estimated charges
Create billing alerts to get an email notification when estimated charges on your AWS bill exceed an amo

How to connect to your instances

Your instances are launching, and it may take a few minutes until they are in the **running** state, when they will be ready to terminate your instances.

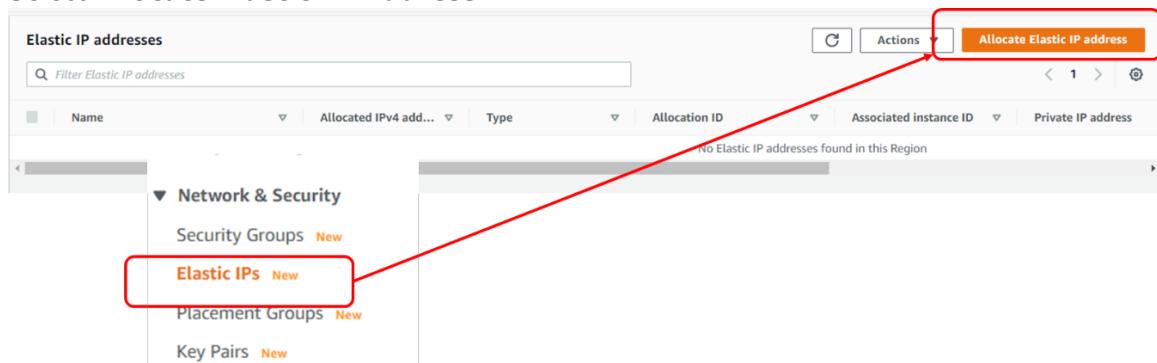
You can also define a name for it, to be easy to identify it (in this case **LC-MW-1.3**).



4. To access the Middleware UI, we will need to assign an Elastic IP.

To do this, select the Elastic IP menu:

- Select **Allocate Elastic IP Address**.



Allocate Elastic IP address

Allocate an Elastic IP address from a public IPv4 address pool, or use global IP addresses from AWS Global Accelerator. You can have one Elastic IP associated with a running instance at no charge. You're charged for additional Elastic IPs that are associated with the instance, Elastic IPs that are associated with stopped instances or unattached network interfaces, and unassociated Elastic IPs. [Learn more](#)

Elastic IP address settings

Public IPv4 address pool
Public IP addresses are allocated from Amazon's pool of public IP addresses, from a pool that you own and bring to your account, or from a pool that you own and continue to advertise..

- Amazon's pool of IPv4 addresses
- Public IPv4 address that you bring to your AWS account(option disabled because no pools found) [Learn more](#)
- Customer owned pool of IPv4 addresses(option disabled because no customer owned pools found) [Learn more](#)

Global static IP addresses
AWS Global Accelerator can provide global static IP addresses that are announced worldwide using anycast from AWS edge locations. This can help improve the availability and latency for your user traffic by using the Amazon global network. [Learn more](#)

[Create accelerator](#)

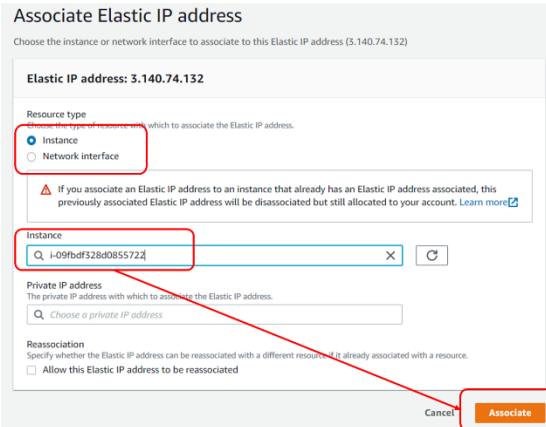
[Cancel](#)
Allocate

- The new IPv4 Public IP address will be allocated from AWS pool.
- Associate this IP address with the Middleware instance.

Elastic IP address allocated successfully.
Elastic IP address 3.140.74.132
[Associate this Elastic IP address](#)

Elastic IP addresses (1/1)					
<input type="text"/> Filter Elastic IP addresses				Actions ▾	
Public IPv4 address: 3.140.74.132 X		Clear filters		Allocate Elastic IP address	
Name	Allocated IPv4 add...	Type	Allocation ID	A	View details
-	3.140.74.132	Public IP	eipalloc-09f0e35dabc978f2c	Associate Elastic IP address	Release Elastic IP addresses

- Select the Middleware instance id, and then, select **Associate**:



IMPORTANT This is the IP address of the web UI and you will also use it to install the wireless components.

Using an SSH client we can connect to the middleware using public key authentication:

```
ssh -i <private-key> loadcore@<Elastic_IP_address>
```

Agent(s) Installation

In LoadCore, you can use two different stacks, Linux Stack or IxStack:

- Linux Stack is used for Stateless UDP traffic.
- IxStack is used for Application traffic. This can work with Raw Sockets or over DPDK/Raw.

There are environments where you cannot use IxStack over DPDK/Raw or is not available.

In AWS is not possible to bind the interface to IxStack over DPDK/Raw, therefore we will use raw sockets for Application traffic.

In order to use raw sockets, you need to make some changes.

By default, when you create an instance, you assign from AWS some default interfaces, called VIF, but these interfaces cannot be bind, as they do not have a PCI address. With this default interface you can run only Stateless UDP tests (with Linux Stack).

If Application traffic is needed, we will use a different instance that will give you access to two different interfaces/drivers:

- intel sriov, driver ixgbe vf
- ena driver

Enhanced networking support

All [current generation](#) instance types support enhanced networking, except for T2 instances.

You can enable enhanced networking using one of the following mechanisms:

Elastic Network Adapter (ENA)

The Elastic Network Adapter (ENA) supports network speeds of up to 100 Gbps for supported instance types.

The current generation instances use ENA for enhanced networking, except for C4, D2, and M4 instances smaller than m4.16xlarge.

Intel 82599 Virtual Function (VF) interface

The Intel 82599 Virtual Function interface supports network speeds of up to 10 Gbps for supported instance types.

The following instance types use the Intel 82599 VF interface for enhanced networking: C3, C4, D2, I2, M4 (excluding m4.16xlarge), and R3.

SRIOV support should be enabled from AWS CLI.

The installation procedure of the Agent(s) requires the following steps:

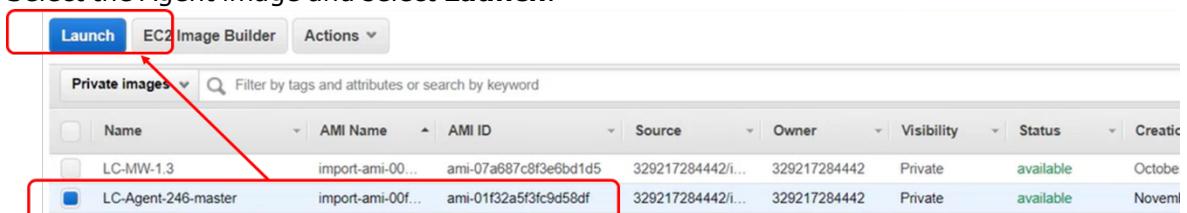
- From the main console, select **Services > EC2 > Images > AMI**.

The browser will display the AMI images shared for your account.

The AMIs can be also found on AWS Marketplace at the following location:

<https://aws.amazon.com/marketplace/search/results?searchTerms=keysight>

Select the Agent image and select **Launch**.



Select **t2.xlarge** for instance type:

<input type="checkbox"/>	t2	t2.medium	2	4	EBS only	-	Low to Moderate
<input type="checkbox"/>	t2	t2.large	2	8	EBS only	-	Low to Moderate
<input checked="" type="checkbox"/>	t2	t2.xlarge	4	16	EBS only	-	Moderate
<input type="checkbox"/>	t2	t2.2xlarge	8	32	EBS only	-	Moderate

Select **Next**.

- Configure the instance details.

Select the VPC and assign the network interface in the management subnet.

By default, the instance comes with only one interface. For our agent installation we need to add the second interface to be used for test. To do that:

- Scroll down to the network interfaces and select **Add Device**.



- Assign it to the test subnet (previously defined).

Step 3: Configure Instance Details

Network Interfaces

Device	Network Interface	Subnet	Primary IP	Secondary IP addresses
eth0	New network interface	subnet-0a87408e	Auto-assign	Add IP
eth1	New network interface	subnet-0a87408e	Auto-assign	Add IP

For eth1, the 'Subnet' dropdown is set to 'subnet-0a87408e'. The 'Primary IP' dropdown is set to 'Auto-assign'. The 'Secondary IP addresses' section contains two entries: 'subnet-0a87408455ab56c3e (mgmt-subnet) 10.0.0.0/24 us-east-2a' and 'subnet-04267cc8ce65eb610 (test-subnet) 10.0.10.0/24 us-east-2a'. A red box highlights this row. Below the table, a message says: 'We can no longer assign a public IP address to your instance' with a note: 'The auto-assign public IP address feature for this instance is disabled because you specified multiple network interfaces to instances with one network interface. To re-enable the auto-assign public IP address feature, please specify only one network interface per instance.'

Select **Next**.

3. Add Storage.

By default, the image comes with 17GB assigned. This can be increased if more space is necessary. Simple tests can run with this value, otherwise define 20GB.

Select **Next**.

4. There is no need to add tags. Select **Next**.

5. Define the Security Group by selecting the previously defined security group.

Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can add rules to allow specific traffic to reach your instance. For example, if you want to allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select from an existing one below. [Learn more](#) about Amazon EC2 security groups.

Assign a security group: Create a new security group Select an existing security group

Security Group ID	Name	Description
sg-0dcc6656aeeb6c9cd	default	default VPC security group

A red box highlights the 'Select an existing security group' radio button and the table below it.

6. Select **Review and Launch > Launch**.

7. For the key pair, you can reuse the previously generated key pair.

Select an existing key pair or create a new key pair

A key pair consists of a **public key** that AWS stores, and a **private key file** that you store. Together, they allow you to connect to your instance securely. For Windows AMIs, the private key file is required to obtain the password used to log into your instance. For Linux AMIs, the private key file allows you to securely SSH into your instance.

Note: The selected key pair will be added to the set of keys authorized for this instance. Learn more about [removing existing key pairs from a public AMI](#).

Choose an existing key pair

Select a key pair

Ic-keypair

I acknowledge that I have access to the selected private key file (Ic-keypair.pem), and that without this file, I won't be able to log into my instance.

Cancel Launch Instances

8. Select **Launch Instances**.

Launch Status

Your instances are now launching

The following instance launches have been initiated: i-0cbcf768f02edab2e [View launch log](#)

Get notified of estimated charges

Create [billing alerts](#) to get an email notification when estimated charges on your AWS bill exceed an amo

How to connect to your instances

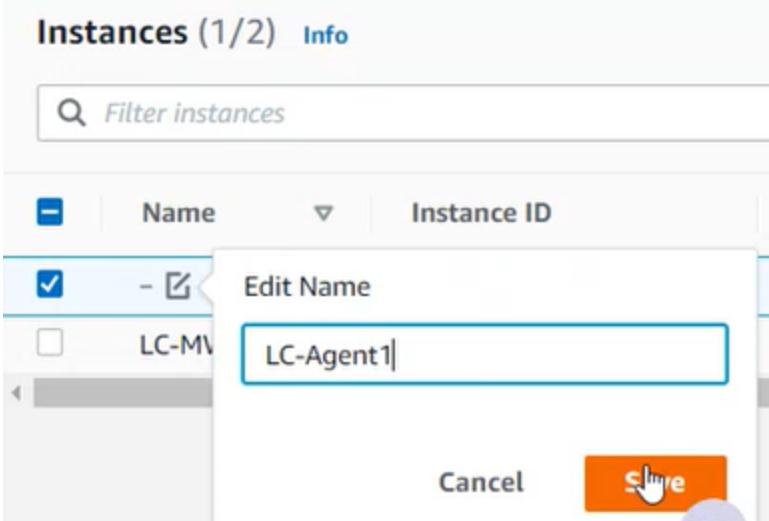
Your instances are launching, and it may take a few minutes until they are in the **running** state, when they will be ready to terminate your instances.

9. On the available instances, you should see two running instances:

- The one containing the Middleware.
- The new one, containing the Agent.

Define a name for the test agent instance (by default, there is no name).

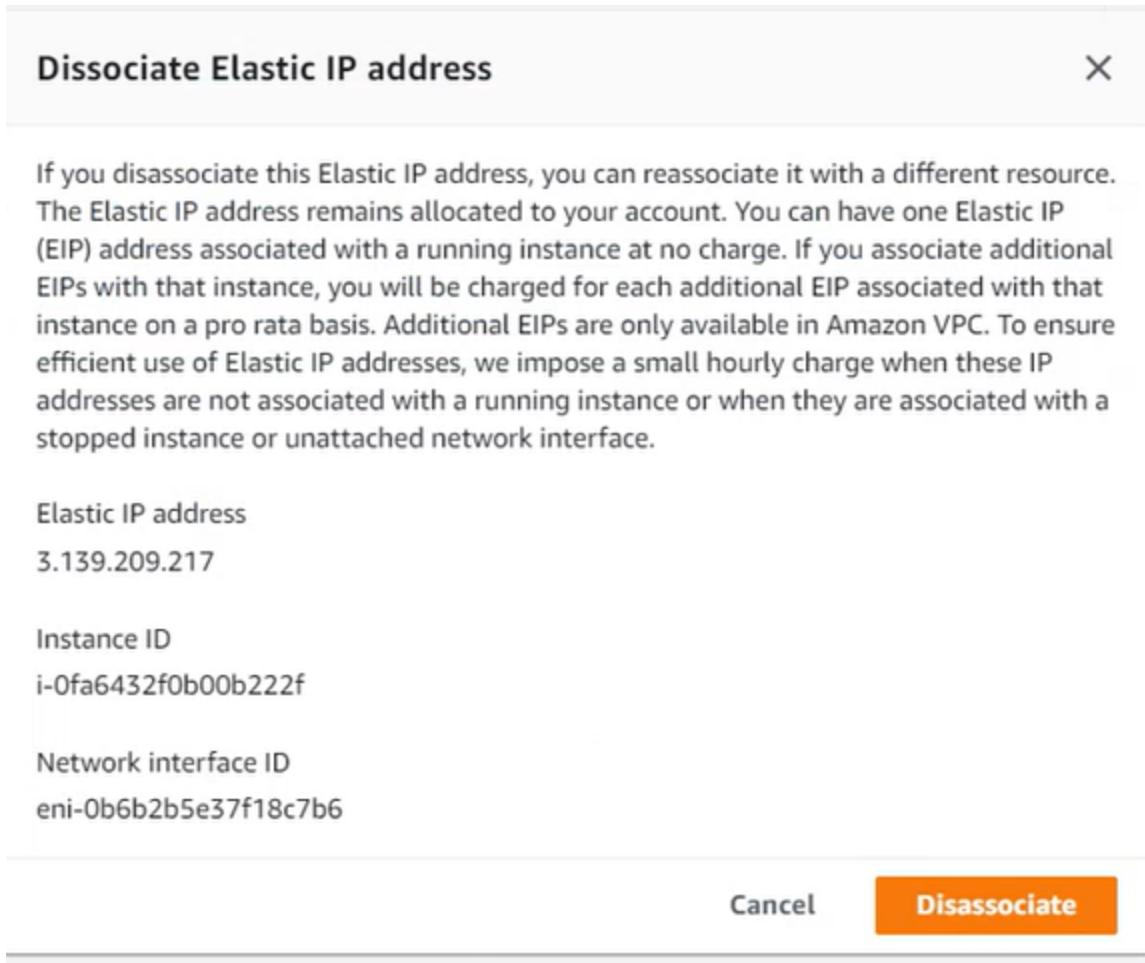
In this example we will name it **LC-Agent1**.



10. In order to access the agent, we need to assign an elastic IP.

There are two options here: assign a new one or reuse the previous one from Middleware. In this example we will reuse the previous one:

- Select **Elastic IP > Action > Disassociate.**



- The Elastic IP was disassociated and now should be reassociation to the Management interface of the test agent.

In the previous image deployment we associated the IP address to the Middleware instance, but here, since we have two network interfaces, we need to associate the Elastic IP address to the management network interface.

Select:

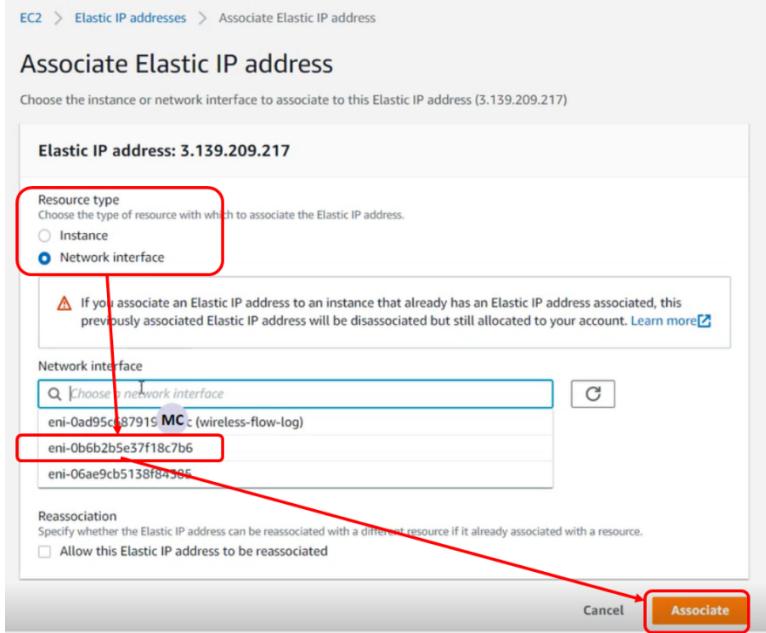
- Resource type: network interface.**

Network interface: the id that corresponds to the management subnet.

Subnets (2) [Info](#)

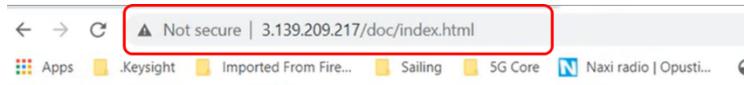
[C](#) [L](#)

Filter subnets						
	Name	Subnet ID	State	VPC	IPv4 CIDR	
<input type="checkbox"/>	mgmt-subnet	subnet-0a87408455ab56c3e	Available	vpc-0f83e58ca0488394d lo...	10.0.0.0/24	Edit
<input type="checkbox"/>	test-subnet	subnet-04267cc8ce65eb610	Available	vpc-0f83e58ca0488394d lo...	10.0.10.0/24	Edit



- **Associate.**

Now you can open a web browser and check if the agent Web UI interface is accessible on the elastic IP address:



5G Core Test Engine REST API DAS3

5G Core Test Engine REST API

[License](#)

› **Applications**

› **Traffic**

› **Capture**

11. Connect the test Agent to the Middleware.

This process is the standard one, as in standalone deployments:

- Using an SSH client we can connect to the agent using public key authentication:

```
ssh -i <private-key> loadcore@<Elastic_IP_address>
```

- Run `agent-setup.sh` script:

```
sudo ./agent-setup.sh
```

OR

```
sudo /home/ixia/agent-setup.sh
```

- For Middleware IP address, you will specify the private IP address that is assigned for the Middleware instance, from management subnet.
- For management interface you will select the agent management interface (for example, `eth0`).
- Do you want to allow this agent to be rebooted from the UI? [y/n]: **y**.

12. This completes test Agent deployment procedure.

You can repeat the above steps if multiple Agents should be deployed.

In this moment, the test setup can perform stateless UDP testing.

For application traffic, the agent instance type should be changed, and raw sockets should be configured (this is covered in the next chapter).

LoadCore Agent configuration for Application Traffic

Application traffic in AWS is done using ixStack over Raw Sockets.

In order to run Application traffic with LoadCore, AWS EC2 provides enhanced networking capabilities through two types of mechanisms:

1. Elastic Network Adapter (ENA) which uses `ena` driver
2. Intel 82599 VF interface which uses the Intel `ixgbevf` driver

For running Application traffic, ORAN-SIM CE supports the following instances types:

- c5 family which enables access to ENA
- m5 family which enables access to ENA
- c4 family which enables access to Intel 82599 VF interface (`ixgbevf` driver)

Both c5 and m5 can be used without any other changes on the Agent instances.

IMPORTANT Please make sure you enable the SRIOV option on each simulated 5G node in ORAN-SIM CE UI **Agent Assignment > Network Management** window.

C4 family will require a special parameter to be configured on Agent instances in order to take advantage of Intel 82599 VF interface. This parameter is only available using AWS CLI. Therefore, you will need to install AWS CLI on your computer.

For other information regarding the Intel 82599 VF interface, refer to:

<https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/sriov-networking.html>

AWS CLI Installation guidelines

The full details can be found on AWS support page:

<https://docs.aws.amazon.com/cli/latest/userguide/install-cliv2-windows.html>

Download and run the MSI installer:

<https://docs.aws.amazon.com/cli/latest/userguide/install-cliv2-windows.html>

You will need admin/elevated permission to install it. This is a straight forward process (**Next > Next > ..Finish**).

Use SSO to connect AWS CLI to your account

In order to use SSO to connect AWS CLI to your account, AWS SSO needs to be enabled on your account. For more details, refer to:

<https://docs.aws.amazon.com/singlesignon/latest/userguide/step1.html>

Open a CLI terminal and configure SSO, as follows:

1. **AWS configure SSO**
2. SSO start URL: <your SSO link> (e.g. **https://keysight.awsapps.com/start**)
You need to replace <your SSO link> with the SSO link used by your organization to connect to AWS.
3. SSO Region: <SSO instance region> (e.g. **us-east-1**)
You need to check the region where your AWS accounts belong to.
NOTE If an *Invalid grant provided* error is displayed, it usually means that you are using an incorrect SSO Region. For more details, refer to:
<https://github.com/aws/aws-cli/issues/5058>.
4. Press **Enter**. The browser will automatically open and drives you to AWS SSO:



5. Select **Sign to AWS CLI**.
6. On the terminal CLI you will see the available accounts. Select the one you are using:

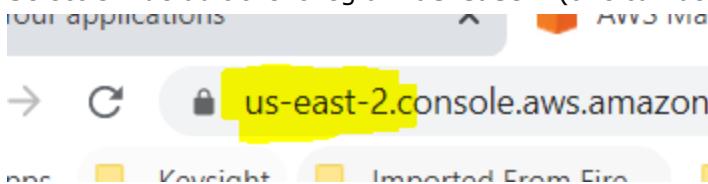
```
C:\ Command Prompt - aws configure sso
Microsoft Windows [Version 10.0.17763.1577]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\cipmatei>aws configure sso
SSO start URL [None]: https://keysight.awsapps.com/start#
SSO Region [None]: us-east-1
Attempting to automatically open the SSO authorization page in your default browser.
If the browser does not open or you wish to use a different device to authorize this request, open the following URL:
https://device.sso.us-east-1.amazonaws.com/

Then enter the code:

QPBL-QWPQ
There are 2 AWS accounts available to you.
  keysight-aws-sbx-calabasas, aws-sbx-calabasas.pdl-it-cloud@keysight.com (329217284442)
> keysight-aws-demo-loadcore, aws-demo-loadcore.pdl-it-cloud@keysight.com (672779868767)
```

7. Select CLI default client region: **us-east-2** (this can be seen in the browser link):



8. Set the output format to **.json**.
9. CLI profile name: press **Enter**.

```
C:\ Command Prompt
Microsoft Windows [Version 10.0.17763.1577]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\cipmatei>aws configure sso
SSO start URL [None]: https://keysight.awsapps.com/start#
SSO Region [None]: us-east-1
Attempting to automatically open the SSO authorization page in your default browser.
If the browser does not open or you wish to use a different device to authorize this request, open the following URL:
https://device.sso.us-east-1.amazonaws.com/

Then enter the code:

QPBL-QWPQ
There are 2 AWS accounts available to you.
Using the account ID 672779868767
The only role available to you is: AdministratorAccess
Using the role name "AdministratorAccess"
CLI default client Region [None]: us-east-2
CLI default output format [None]: json
CLI profile name [AdministratorAccess-672779868767]:
```

To use this profile, specify the profile name using --profile, as shown:

```
aws s3 ls --profile AdministratorAccess-672779868767
```

C:\Users\cipmatei>

Now you are logged on AWS using your CLI terminal.

Use Access key ID and secret access key to connect AWS CLI to your account

```
$ aws configure
AWS Access Key ID [None]: AKIAIOSFODNN7EXAMPLE <- your AWS Access Key ID
AWS Secret Access Key [None]: wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY <- your AWS
Secret Access Key
Default region name [None]: us-west-2
Default output format [None]: json
```

For details on how to get your **AWS Access Key ID** and **AWS Secret Access Key**, refer to the AWS documentation:

https://docs.aws.amazon.com/IAM/latest/UserGuide/id_credentials_access-keys.html

For more information on how AWS credentials work, refer to:

<https://docs.aws.amazon.com/general/latest/gr/aws-sec-cred-types.html>

To see how to create a new secret access key and for more details, refer to the AWS CLI documentation:

<https://docs.aws.amazon.com/cli/latest/userguide/cli-configure-quickstart.html>

Configure SRIOV support

Now we will configure the SRIOV support. Multiple details can be found on AWS documentation:

<https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/sriov-networking.html>

- Check if our test client instance has SRIOV support:

On CLI terminal type:

```
aws ec2 describe-instance-attribute --instance-id instance_id --attribute
sriovNetSupport
```

Replace the **instance_id** parameter with the instance id of the test agent.

Instances (1/3) Info		
<input type="button" value="Filter instances"/>		
	Name	Instance ID
<input checked="" type="checkbox"/>	LC-Agent1	i-0fa6432f0b00b222f

If you have multiple accounts, you'll need to specify the profile id in the above command. If you have only one account this can be skipped:

```
CLI default client region [None]: us-east-2
CLI default output format [None]: json
CLI profile name [AdministratorAccess-672779868767]:
To use this profile, specify the profile name using --profile, as shown:
aws s3 ls --profile AdministratorAccess-672779868767
C:\Users\cipmatei>aws ec2 describe-instance-attribute --profile AdministratorAccess-672779868767 --instance-id i-0fa6432
f0b00b222f --attribute sriovNetSupport
```

The output of the above command will display the support for SRIOV. If it is empty (like in the

picture below), it means the instance type used for the test agent does not have SRIOV and, in this case, we need to modify the instance attribute or the agent should be redeployed selecting a C4 instance type (or another one that has ENA support).

```
aws s3 ls --profile AdministratorAccess-672779868767
C:\Users\cipmatei>aws ec2 describe-instance-attribute --profile AdministratorAccess-672779868767 --instance-id i-0fa6432f0b00b222f --attribute sriovNetSupport
{
    "InstanceId": "i-0fa6432f0b00b222f",
    "SriovNetSupport": {}
}
```

Currently, the driver is **vif** and we need to do some changes and see **ixgbevf** and a **PCI address** (to be used to bind this to raw sockets).

<pre>[ec2-user ~]\$ ethtool -i eth0 driver: vif version: firmware-version: bus-info: vif-0 supports-statistics: yes supports-test: no supports-eeprom-access: no supports-register-dump: no supports-priv-flags: no</pre>	<pre>[ec2-user ~]\$ ethtool -i eth0 driver: ixgbevf version: 4.0.3 firmware-version: N/A bus-info: 0000:00:03.0 supports-statistics: yes supports-test: yes supports-eeprom-access: no supports-register-dump: yes supports-priv-flags: no</pre>
---	--

- We will now modify the instance attribute to support SRIOV.

Stop the test agent instance.

In CLI type the below command:

```
aws ec2 modify-instance-attribute --instance-id instance_id --sriov-net-support simple
```

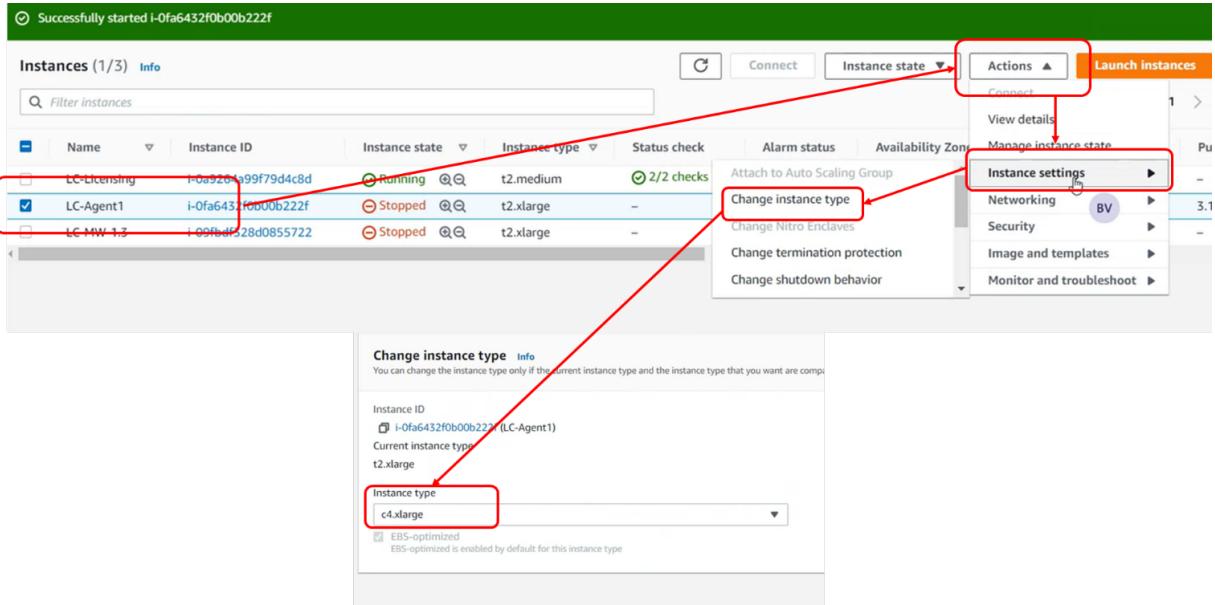
Here you will replace **instance_id** with the test agent instance id (see above). Also, add the profile id in the command (as above).

```
C:\Users\cipmatei>aws ec2 modify-instance-attribute --profile AdministratorAccess-672779868767 --instance-id i-0fa6432f0b00b222f --sriov-net-support simple
```

- Make sure you have an Elastic IP associated with the test agent.
- Stop the test agent instance and change the instance type.



- Select **c4.xlarge** type.



- Start the instance.

Now the test agent instance is properly configured, has SRIOV support.

You can check this using SSH on test agent and type:

- `ethtool -I eth0` (you should see the ixgbevf driver)

```
ixia@ip-10-0-0-158:~$ ethtool -I eth0
driver: ixgbevf
version: 4.1.0-k
firmware-version:
expansion-rom-version:
bus-info: 0000:00:03.0
supports-statistics: yes
supports-test: yes
supports-eeprom-access: no
supports-register-dump: yes
supports-priv-flags: no
ixia@ip-10-0-0-158:~$
```

- `lspci` (you will see the available interfaces)

```
ixia@ip-10-0-0-158:~$ lspci
00:00.0 Host bridge: Intel Corporation 440FX - 82441FX PMC [Natoma] (rev 02)
00:01.0 ISA bridge: Intel Corporation 82371SB PIIIX3 ISA [Natoma/Triton II]
00:01.1 IDE interface: Intel Corporation 82371SB PIIIX3 IDE [Natoma/Triton II]
00:01.3 Bridge: Intel Corporation 82371AB/EB/MB PIIIX4 ACPI (rev 01)
00:02.0 VGA compatible controller: Cirrus Logic GD 5446
00:03.0 Ethernet controller: Intel Corporation 82599 Ethernet Controller Virtual Function (rev 01)
00:04.0 Ethernet controller: Intel Corporation 82599 Ethernet Controller Virtual Function (rev 01)
00:1f.0 Unassigned class [ff801]: XenSource, Inc. Xen Platform Device (rev 01)
```

Starting with LoadCore 2.1 release, the SRIOV support is enabled per test interface. This can be found in **Agent Assignment > Network Management**. This will activate the usage of the vNIC MAC address for all protocols on that interface.

AGENTS ASSIGNMENT		NETWORK MANAGEMENT						
Order	Agent	Tags	Impairment Profile	Agent Interface	Network Stack	SRIoV	Traffic Capture	Entity
				Name	MAC			
1	10.73.50.65	IxStack: OFF (2) build: 492 (2)	None	ens192	00:0c:29:c0:8b:74	IxStack over Raw Sockets	ON	RAN
								NRF AUSF UDM/HSS PCF

Now the agent is able to run application traffic on eth1.

You can repeat this process for the second agent also you can add multiple interfaces to the test agent.

Add the test IP addresses to the AWS infrastructure

In AWS, in order to allow traffic between test IP addresses, these should be added in AWS infrastructure, on the test agent instance on test interface(s):

1. Go to **Instance > Networking > Manage IP addresses** > select **eth1** > **Assign new IP addresses**.
2. Add all the IP addresses that are used in the test.

The screenshot shows the AWS Instances page with three instances listed:

- LC-Licensing (Running, t2.medium, 2/2 checks)
- LC-Agent1 (Running, c4.xlarge, -)
- LC-MW-1.3 (Stopped, t2.xlarge, -)

A red box highlights the "Actions" dropdown menu for the LC-Agent1 instance. The "Networking" option is selected, and a sub-menu is open with "Manage IP addresses" highlighted. Another red box highlights the "Manage IP addresses" button in this sub-menu.

The "Manage IP addresses" dialog box is shown for the LC-Agent1 instance. It lists network interfaces:

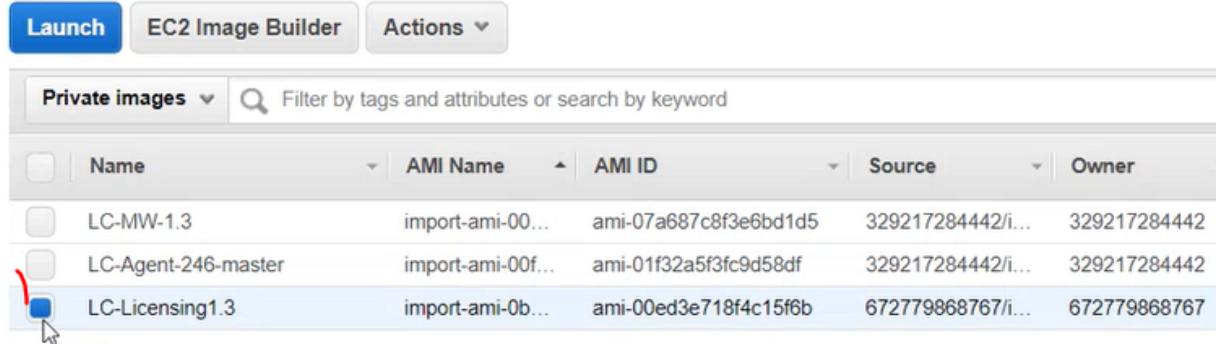
- eth0: eni-0b6b2b5e37f18fb6 - Primary network interface
- eth1: eni-06ae9cb513bf84385 - 10.0.10.0/24

 A red box highlights the "Assign new IP address" button at the bottom of the dialog.

License Server Installation

The installation procedure of the License Server requires the following steps:

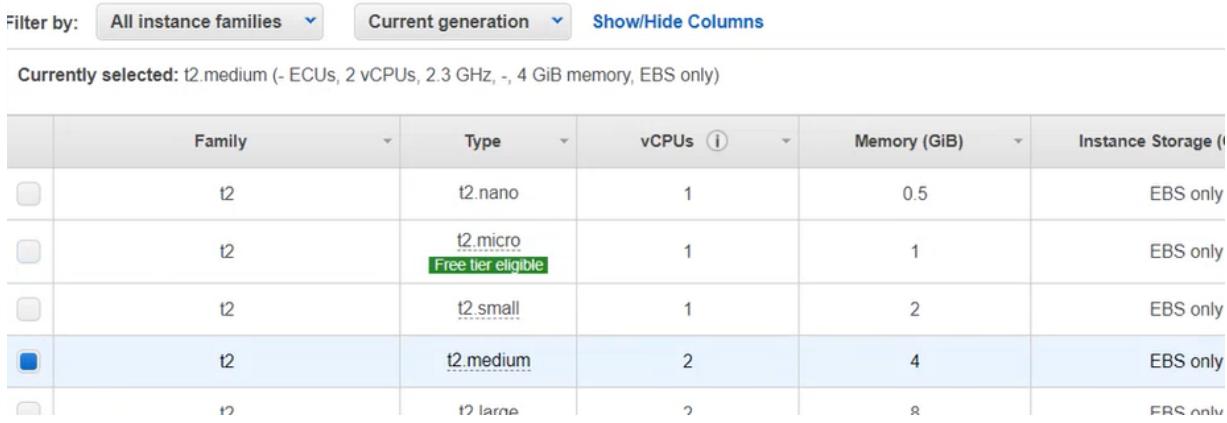
1. From the main console, select **Services > EC2 > Images > AMI**.
The browser will display the AMI images shared for your account.
Select the License Server image and select **Launch**.



	Name	AMI Name	AMI ID	Source	Owner
<input type="checkbox"/>	LC-MW-1.3	import-ami-00...	ami-07a687c8f3e6bd1d5	329217284442/i...	329217284442
<input type="checkbox"/>	LC-Agent-246-master	import-ami-00f...	ami-01f32a5f3fc9d58df	329217284442/i...	329217284442
<input checked="" type="checkbox"/>	LC-Licensing1.3	import-ami-0b...	ami-00ed3e718f4c15f6b	672779868767/i...	672779868767

2. Select **t2.medium** for instance type:

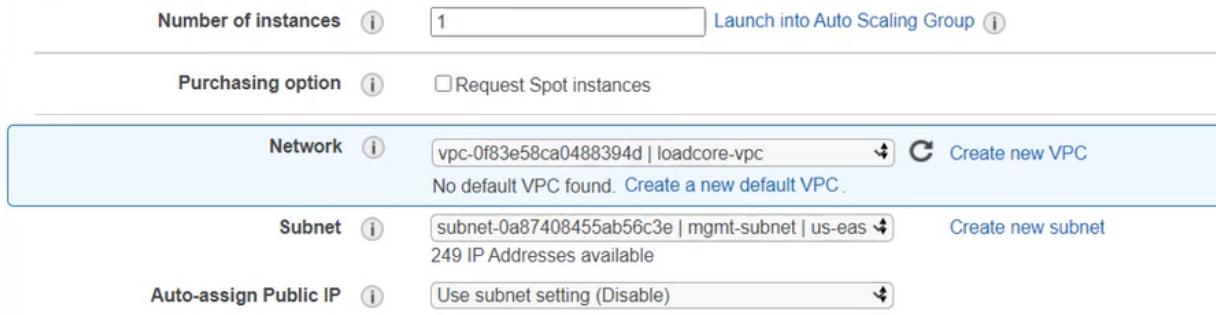
Amazon EC2 provides a wide selection of instance types optimized to fit different use cases. Instances are virtual servers that can run applications. They have the appropriate mix of resources for your applications. [Learn more](#) about instance types and how they can meet your computing needs.



Currently selected: t2.medium (- ECUs, 2 vCPUs, 2.3 GHz, -, 4 GiB memory, EBS only)					
	Family	Type	vCPUs	Memory (GiB)	Instance Storage (EBS only)
<input type="checkbox"/>	t2	t2.nano	1	0.5	EBS only
<input type="checkbox"/>	t2	t2.micro <small>Free tier eligible</small>	1	1	EBS only
<input type="checkbox"/>	t2	t2.small	1	2	EBS only
<input checked="" type="checkbox"/>	t2	t2.medium	2	4	EBS only
<input type="checkbox"/>	t2	t2.large	2	8	EBS only

3. In **Instance details**, the interface should belong to the management network.

Step 3: Configure Instance Details



Number of instances Launch into Auto Scaling Group [\(i\)](#)

Purchasing option [\(i\)](#) Request Spot instances

Network (i)	vpc-0f83e58ca0488394d loadcore-vpc	Create new VPC
No default VPC found. Create a new default VPC .		
Subnet (i)	subnet-0a87408455ab56c3e mgmt-subnet us-eas	Create new subnet
249 IP Addresses available		
Auto-assign Public IP (i)	Use subnet setting (Disable)	

4. For Security Group, select the one we previously defined:

Step 6: Configure Security Group

A security group is a set of firewall rules that control the traffic for your instance. On this page, you can allow unrestricted access to the HTTP and HTTPS ports. You can create a new security group or select

- Assign a security group:
- Create a **new** security group
 - Select an **existing** security group

- Leave the other parameters unchanged and launch the instance.

To install the licenses on the License Server, you need to access it using the Web UI.

To do this, you need to reassign the Elastic IP address or define a new Elastic IP and assign it to this server:

- Select **Elastic IP > Action > Disassociate**.

Name	Allocated IPv4 add...	Type	Allocation ID	Action
3.139.209.217	Public IP	eipalloc-05eb8b223d05e8983		<input style="background-color: #0070C0; color: white; border: 1px solid #0070C0; padding: 2px 10px; margin-right: 10px;" type="button" value="Associate Elastic IP address"/> <input style="border: 1px solid #0070C0; color: #0070C0; padding: 2px 10px;" type="button" value="Disassociate Elastic IP address"/>

Dissociate Elastic IP address

If you disassociate this Elastic IP address, you can reassociate it with a different resource. The Elastic IP address remains allocated to your account. You can have one Elastic IP (EIP) address associated with a running instance at no charge. If you associate additional EIPs with that instance, you will be charged for each additional EIP associated with that instance on a pro rata basis. Additional EIPs are only available in Amazon VPC. To ensure efficient use of Elastic IP addresses, we impose a small hourly charge when these IP addresses are not associated with a running instance or when they are associated with a stopped instance or unattached network interface.

Elastic IP address

3.139.209.217

Instance ID

i-0fa6432f0b00b222f

Network interface ID

eni-0b6b2b5e37f18c7b6

Cancel

Disassociate

- The Elastic IP was disassociated and now should be re-association to the Instance of the License Server.

Select the following:

- **Resource type: Instance.**
- **Instance id:** select the id of the License server instance.

Associate Elastic IP address

Choose the instance or network interface to associate to this Elastic IP address (3.139.209.217)

Elastic IP address: 3.139.209.217

Resource type
Choose the type of resource with which to associate the Elastic IP address.

Instance
 Network interface

⚠ If you associate an Elastic IP address to an instance that already has an Elastic IP address associated, this previously associated Elastic IP address will be disassociated but still allocated to your account. [Learn more](#)

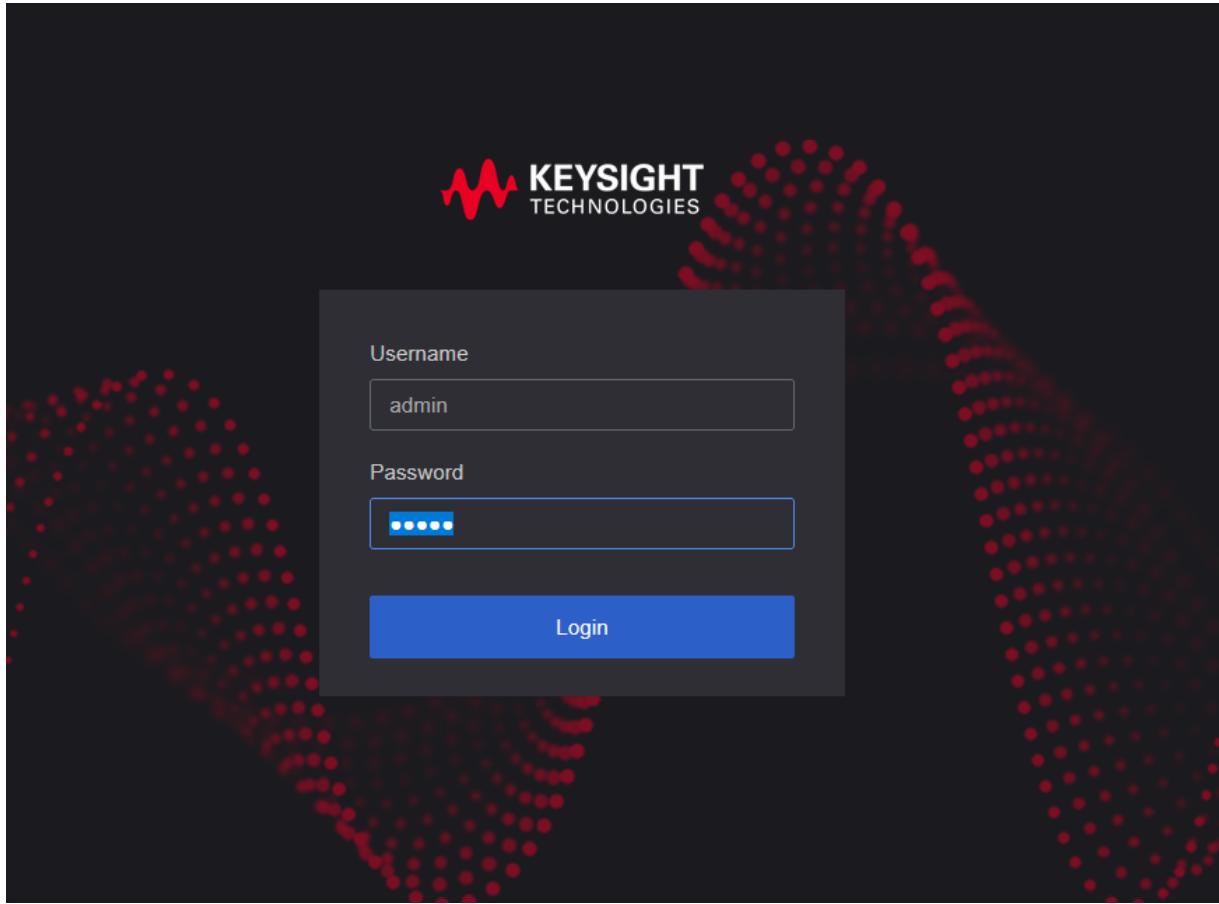
Instance
 X C

Private IP address
The private IP address with which to associate the Elastic IP address.

- Select **Associate**.

Now you can access the License Server UI and install the licenses:

1. On your browser, type the IP address that was assigned for the License Server.
2. Log in using the default username/password: **admin/admin**.



At this point, there are no licenses available on the newly installed server, therefore you must add the license codes you received (evaluation licenses can be obtained by sending an email to: Software-Eval-Request IX <software-eval-request.ix@keysight.com>.

For the licenses activation procedure and related actions, refer to [License Manager](#) section.

Software Upgrades

Middleware Upgrade

You can upgrade the Middleware software as follows:

1. After connecting to the ORAN-SIM CE setup, open the gear icon in the upper right to display the gear menu.
2. Select **Administration > Software Updates**.
3. Select **Browse** and use the opened window to find the upgrade .tar file on the disk.
4. Select **Start Update** to apply the patch and wait for the procedure to end.
5. Access the same menu and check the version of the setup, to make sure that the patch has been applied successfully.

Agent(s) Upgrade

You can upgrade the Agent(s) software as follows:

1. Connect to one of the ORAN-SIM CE agents.
2. Copy LoadCore-Agent-Update- < version >.tgz to /home/ixia.
3. Run the command:

```
curl -kX PUT https://< agent IP address > /api/v1/update --upload-file
/home/ixia/LoadCore-Agent-Update- < version >.tgz
```
4. Using this agent, you will be able to upgrade all agents including the agent that you are connected from.
5. Make sure that the upgrade was successful:

```
curl -kX GET http://< agent IP address > /api/v1/version
```

Expected response:

```
{"revision": "b02c33cb", "tag": "jenkins-lizard-dist-249", "timestamp": "2020-03-
20T21:02:13Z"}
```

Optionally, the agents can also be upgraded from Insomnia or any REST agent.

Repeat the steps presented above to deploy as many agents as required.

Troubleshooting

How to recover configuration files when ORAN-SIM CEUI becomes unresponsive

1. Open a SSH connection to Middleware instance using public key authentication.
2. `kubectl exec -it -n keysight-wap wap-db[TAB] /bin/bash [ENTER]`
3. `psql wapdb -U user`
4. `\dt+`
5. `\c wapdb`
6. `SELECT * FROM wireless_sessionconfigs;`
7. `SELECT session_id FROM wireless_sessionconfigs;`
8. `SELECT raw_config FROM wireless_sessionconfigs WHERE session_id='<session-id>';`

How to recover a session that got stuck in starting/stopping/running state

1. Open the REST API Browser from ORAN-SIM CE UI gear wheel menu (the upper right corner of the ORAN-SIM CE UI).
2. Go to **Sessions**.
3. Identify your session and click on **Sessions** button (Instance column).
4. Select **test** under selected session on the left side of the view.
5. Select **Edit** and go to status attribute. Change the status to **STOPPED** and select the commit button.
6. Return to ORAN-SIM CEUI and check the session status.

How to recover a ORAN-SIM CE Agent that does not respond when trying to run a test from ORAN-SIM CE UI

1. Reboot the ORAN-SIM CE Agent.
2. Connect to the ORAN-SIM CE Agent using SSH.
3. Run the `agent-setup.sh` script: `sudo ./agent_setup.sh`.
4. Provide the required information regarding the interfaces used in the testbed:
 - a. The IP address of the ORAN-SIM CE Middleware.
 - b. The management interface.
5. Allow the agent to be rebooted from the ORAN-SIM CE UI : [y].

Monitor the health of the application

Check that all pods are up and running

1. SSH to cluster console.
2. Run `kubectl get pods -A` command.
3. All pods should have running or completed status.

Check the available free space - the free % should be > 15%

1. SSH to cluster console.
2. Run `df -h` / or check events page in WebUI for errors/warnings regarding disk space.
3. The available free disk space % should be > 15%.

Date should be the same on MW and agents

1. Run `date` command on MW and agents. The MW and agents should have the same date/time.
2. If not:
 - check NTP status on MW:
 - SSH to cluster console
 - run:

```
kubectl exec -it -n keysight-wap wap-ntp-server-<id>-- /bin/bash -c "/usr/bin/ntpq -pn"
```
 - check NTP status on agents: `ntpq -pn` (ntp server should have MW IP)

Check agents status

1. Check agents status in gear menu > **Administration > Agent Management**.
2. All agents used in test should be online.

Backup and recovery

AWS provides tools that offers the possibility to backup the EBS volumes.

For more details, please refer to:

<https://aws.amazon.com/getting-started/hands-on/amazon-ebs-backup-and-restore-using-aws-backup/>

AWS Security Best Practices

IAM Service

AWS provides a set of security guidelines to help secure your resources. For more details, please refer to:

- <https://docs.aws.amazon.com/IAM/latest/UserGuide/best-practices.html>

KVM Deployment

This section describes the steps needed to deploy ORAN-SIM CE on KVM.

Prerequisites

For a complete and correct functioning setup, make sure you have downloaded and installed the packages on your test environment:

- **Wireshark** capable to decode PFCP messages and IEs (at least 2.5.2).
This will be used to analyze the traffic captures.
- **Hypervisor** with available resources to deploy the virtual machine(s) hosting the Middleware, the Test Agents and License Server.
The examples below were done using VMware ESXi.
- **ORAN-SIM CE images** (three images: Middleware, Agent and License server). License Server image is optional, since it can be collocated with MW, but it is recommended to be installed on a separate VM. The images can be downloaded from KSM: <https://ksm.software.keysight.com>

IMPORTANT IP connectivity between VMs must to be ensured.

- You will need to use this machine to run ORAN-SIM CE tests. **ILU (Windows or Linux) cannot be used to run ORAN-SIM CE tests.**
- **Valid licenses** for License server. For deploying full 5G core and run Control plane and User plane traffic, the following licenses will be required:
 - Control plane licenses:
 - ORAN-SIM CE interface license simulation (**P89033A** x 11 pcs).
This license will enable Control plane testing. One license is needed for each simulated interface.
 - 5GCore Performance enabler on VM: 1M UEs and 10k TPS for VM (**P89034A** x 1 pcs).
 - User plane licenses:
 - User Plane Flow-based license (N3 and N6). Multiple QTY are needed if multiple flows are active simultaneously. Includes three Application Traffic Flows (TCP/UDP) and 10Gbps throughput capacity (**P89037A** x 2 pcs). The recommendation is to use this type of license as this will be suggested for all new customers.
 - As an alternative for the above license you can also use Tier-4 license (**P89030A** or **P89031A** x 2 pcs).

IMPORTANT These license types will enable User plane traffic and are not needed if ONLY control plane traffic is needed for future tests.

- Minimum supported resolution for ORAN-SIM CE UI is 1920x1080 (Full HD).

Hardware Requirements

By default, the VM for Middleware will reserve the following compute resources when installing the OVA:

- 8 x vCPUs
- 16 GB RAM

- 256 GB SSD

The test agent will reserve the following compute resources when installing the OVA:

- 4 x vCPUs
 - 4 GB RAM **out of which 1GB is reserved for HUGE MEM(IxStack over DPDK/Raw)**
- IMPORTANT** This value is for control plane only. If you are running app traffic the recommendation is to allocate minimum 16 GB RAM.
-
- 20 GB SSD

Running application traffic will require increasing agent resources. The recommendation for each agent will be in this case:

- 8 x vCPUs
- 32 GB RAM
- 20 GB SSD

Licensing server default resources

- 2 x vCPUs
- 8 GB RAM
- 100 GB SSD

Supported NICs in tests with IxStack over DPDK/Raw(TCP based traffic)

The list of supported NICs in tests with IxStack over DPDK/Raw(TCP based traffic):

- Intel X710 10G
- Intel XXV710 25G
- Intel XL710 40G
- Intel E810 25G
- Intel E810 100G
- Mellanox ConnectX-4/5 25G
- Mellanox ConnectX-4/5 100G
- Mellanox ConnectX-6 Dx 100G
- KVM Virtual NIC (virtio)

Supported drivers list:

- mlx4_core
- mlx5_core
- ixgbe
- ixgbefvf
- i40e
- i40evvf
- ice

- iavf
- Virtio

Enable Virtualization

Virtualization needs to be enabled from the hypervisor BIOS settings:

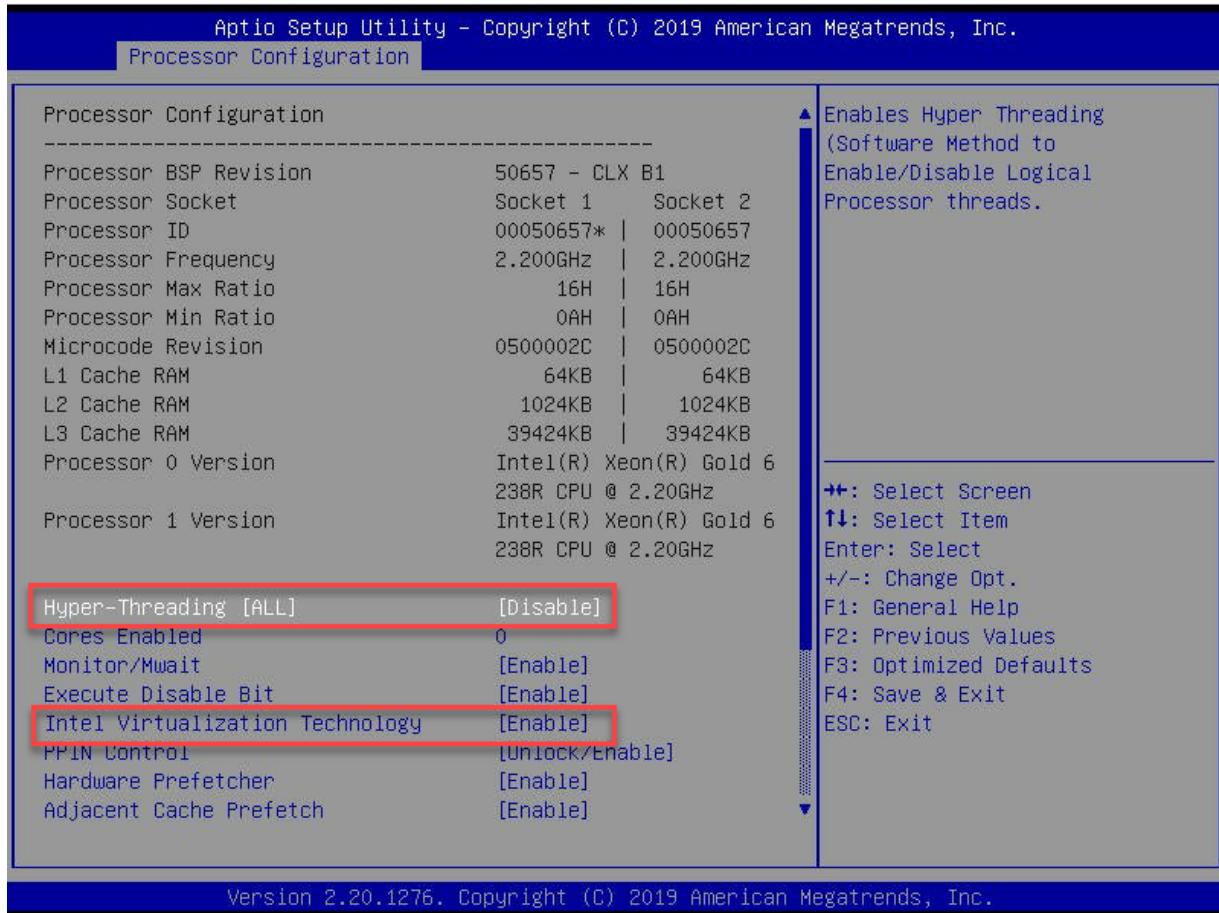
1. Go to **Processor Configuration** in order to enable Intel Virtualization technology.

NOTE

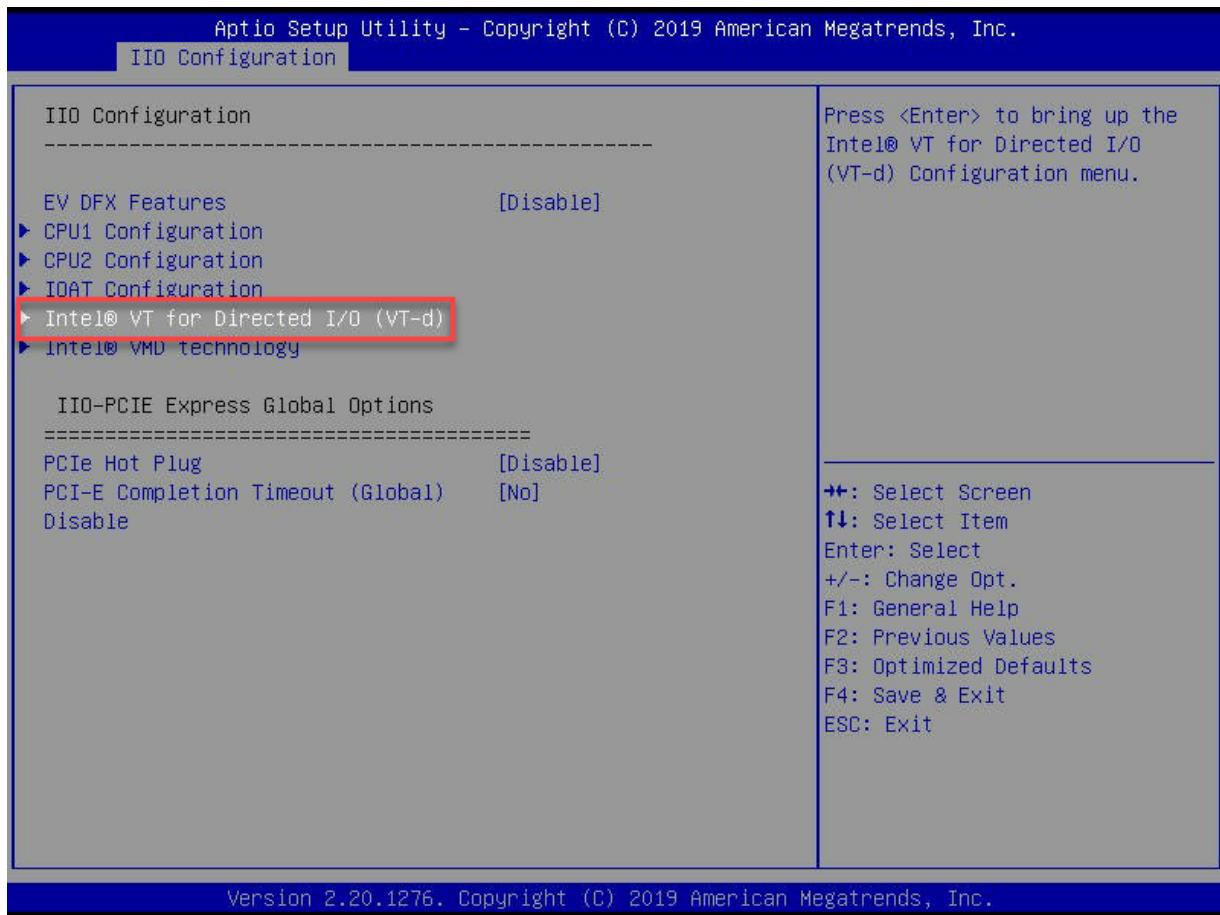
These settings will appear different in BIOS if the hypervisor has an AMD CPU.

NOTE

It is recommended to disable Hyper-threading as it can improve the VM performance.



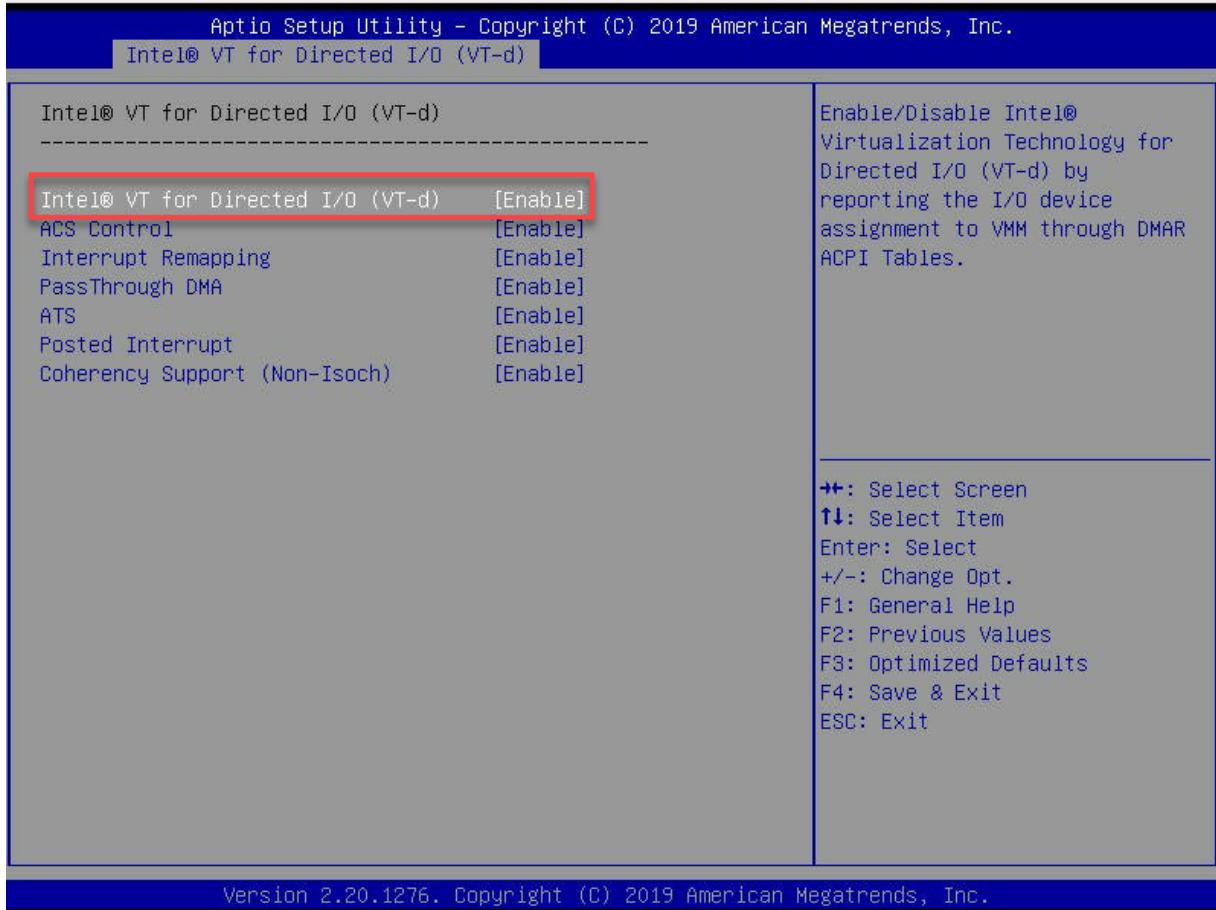
2. From Chipset Configuration, select **North Bridge > IIO Configuration**, select **Intel VT for Directed I/O (VT-d)** and press **Enter**.



3. Enable **Intel VT for Directed I/O (VT-d)**. This should automatically enable all the other settings as well.

NOTE

In some configurations, it might display **Intel VT-x**. Also, these settings will be different in case the hypervisor has an AMD CPU.



- After the BIOS settings have been saved, the hypervisor needs to be powered off and on (rebooting is not sufficient to apply the changes).

Install Linux Distribution

This section provides the steps to install RockyLinux (recommended version 9.1). You can use it to install other Linux distributions, for example CentOS or Ubuntu (recommended version 20.04).

- Select a .iso file as shown below, or use the custom Rocky Linux image provided with the eLSU. For example:

..		
CHECKSUM	23-Mar-2023 21:08	1214
README	15-Dec-2022 04:23	1747
Rocky-9.1-20221214.1-x86_64-dvd.iso	14-Dec-2022 23:48	8906080256
Rocky-9.1-20221214.1-x86_64-dvd.iso.CHECKSUM	03-Feb-2023 09:31	168
Rocky-9.1-20221214.1-x86_64-dvd.iso.manifest	14-Dec-2022 23:48	406566
Rocky-9.1-20221215.1-x86_64-minimal.iso	15-Dec-2022 04:25	1489108992
Rocky-9.1-20221215.1-x86_64-minimal.iso.CHECKSUM	03-Feb-2023 09:31	176
Rocky-9.1-20221215.1-x86_64-minimal.iso.manifest	15-Dec-2022 04:25	34103
Rocky-9.1-x86_64-boot.iso	19-Nov-2022 03:31	843055104
Rocky-9.1-x86_64-boot.iso.CHECKSUM	03-Feb-2023 09:31	147
Rocky-9.1-x86_64-boot.iso.manifest	19-Nov-2022 03:31	559
Rocky-9.1-x86_64-boot.torrent	24-Nov-2022 21:11	16740
Rocky-9.1-x86_64-dvd.iso	24-Nov-2022 03:03	9008185344
Rocky-9.1-x86_64-dvd.iso.CHECKSUM	03-Feb-2023 09:31	146
Rocky-9.1-x86_64-dvd.iso.manifest	24-Nov-2022 03:03	406084
Rocky-9.1-x86_64-dvd.torrent	24-Nov-2022 21:11	11381
Rocky-9.1-x86_64-minimal.iso	24-Nov-2022 03:06	1592590336
Rocky-9.1-x86_64-minimal.iso.CHECKSUM	03-Feb-2023 09:31	154
Rocky-9.1-x86_64-minimal.iso.manifest	24-Nov-2022 03:06	34103
Rocky-9.1-x86_64-minimal.torrent	24-Nov-2022 21:11	15855
Rocky-x86_64-boot.iso	19-Nov-2022 03:31	843055104
Rocky-x86_64-boot.iso.CHECKSUM	03-Feb-2023 09:31	139
Rocky-x86_64-boot.iso.manifest	19-Nov-2022 03:31	559
Rocky-x86_64-dvd.iso	14-Dec-2022 23:48	8906080256
Rocky-x86_64-dvd.iso.CHECKSUM	03-Feb-2023 09:31	138
Rocky-x86_64-dvd.iso.manifest	14-Dec-2022 23:48	406566
Rocky-x86_64-minimal.iso	15-Dec-2022 04:25	1489108992
Rocky-x86_64-minimal.iso.CHECKSUM	03-Feb-2023 09:31	146
Rocky-x86_64-minimal.iso.manifest	15-Dec-2022 04:25	34103

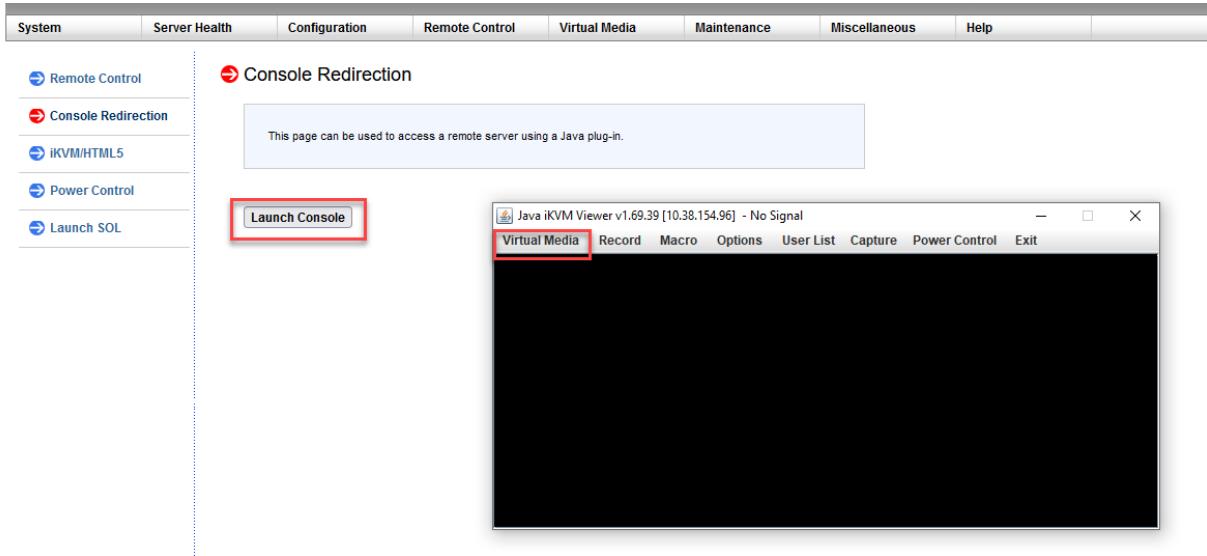
2. After download, go to the IPMI browser page, to Remote Control, and select **Console Redirection:**

NOTE

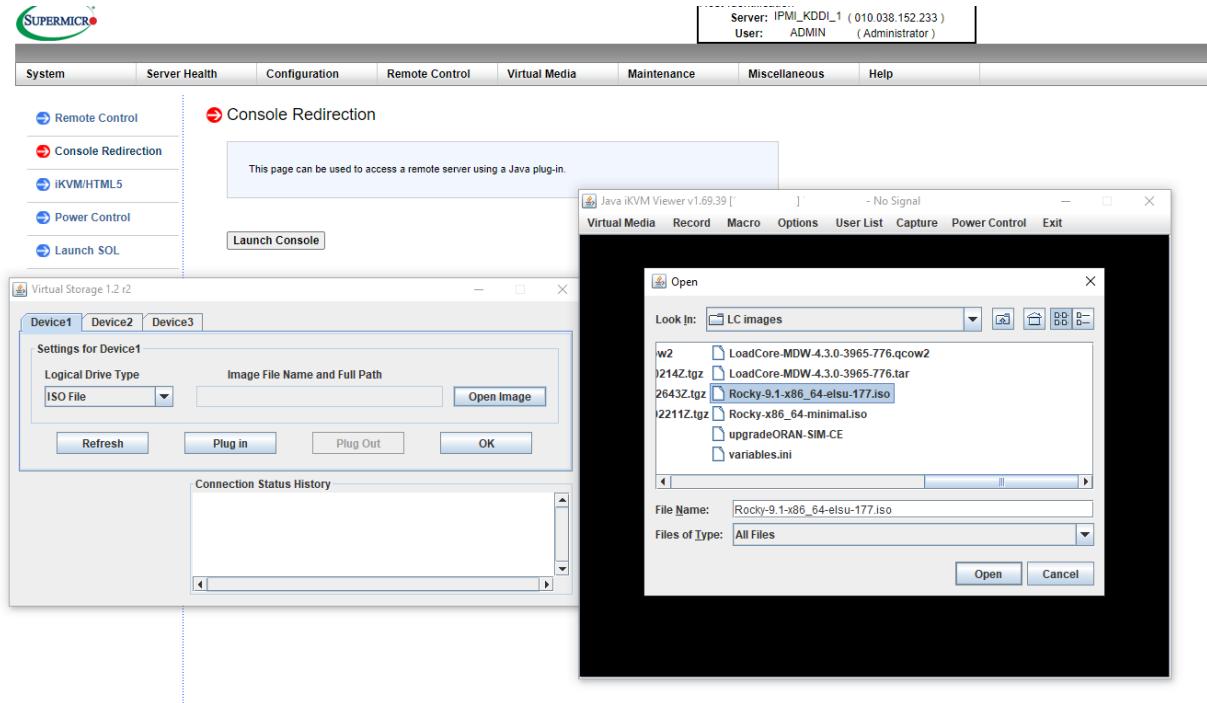
This step may differ depending on the server manufacturer.

The screenshot shows the SUPERMICRO IPMI browser interface. At the top right, there is a 'Host Identification' box with the server details: Server: 010.038.154.096, User: ADMIN (Administrator). Below this is a navigation menu with tabs: System, Server Health, Configuration, Remote Control, Virtual Media, Maintenance, Miscellaneous, and Help. The 'Remote Control' tab is selected. On the left, there is a sidebar with links: Remote Control, Console Redirection (which is highlighted with a red box), IKVM/HTML5, Power Control, and Launch SOL. The main content area is titled 'Remote Control' and contains the sub-instruction: 'Use these pages to perform various remote operations on servers, such as remote access servers.' It also lists several options: Console Redirection: Launch the redirection console via Java viewers; IKVM/HTML5: Launch the IKVM/HTML5 and manage the server remotely; Power Control: See the server power state and perform power control functions; and Launch SOL: Launch the SOL console.

3. Select **Launch Console**, continue through the Java menus until the new window is displayed, and then select **Virtual Media**.



4. Select **Virtual Storage**, set **Device type** as **ISO File** and select the .iso file downloaded earlier.



After these steps, it will be possible to install and boot from the .iso image.

Install and prepare KVM

Rocky Linux

In /etc/default/grub add `intel_iommu=on iommu=pt pci=realloc` at the line mentioned below. For AMD CPUs, it will be `amd_iommu=on`. These settings are needed for KVM device passthrough.

```
Centos 1 Centos 2
GNU nano 2.3.1
File: /etc/default/grub

GRUB_TIMEOUT=5
GRUB_DISTRIBUTOR="$(sed 's, release .*\.,g' /etc/system-release)"
GRUB_DEFAULT=saved
GRUB_DISABLE_SUBMENU=true
GRUB_TERMINAL_OUTPUT="console"
GRUB_CMDLINE_LINUX="crashkernel=auto spectre_v2=retpoline rd.lvm.lv=centos/root rd.lvm.lv=centos/swap rhgb quiet intel_iommu=on iommu=pt pci=realloc"
GRUB_DISABLE_RECOVERY="true"
```

Then do the following command to change the grub file. A reboot will be needed.

```
grub2-mkconfig -o /boot/grub2/grub.cfg
```

NOTE

You can check if the grub settings have taken effect using the `cat /proc/cmdline` command. If you do not see the new parameters here, you can add them with the following command (reboot after):

```
sudo grubby --update-kernel=ALL --args="intel_iommu=on iommu=pt pci=realloc"
```

Make sure that the CPU has the virtualization parameter enabled (it should return *VT-d* or *VT-x*):

```
lscpu | grep Virt
```

Or, the following should return *vmx*:

```
cat /proc/cpuinfo | egrep -i "vmx|svm"
```

Use the following commands to install and check KVM:

```
dnf update
dnf install qemu-kvm libvirt virt-manager virt-install
systemctl enable --now libvirtd
systemctl status libvirtd
lsmod | grep -i kvm
```

NOTE

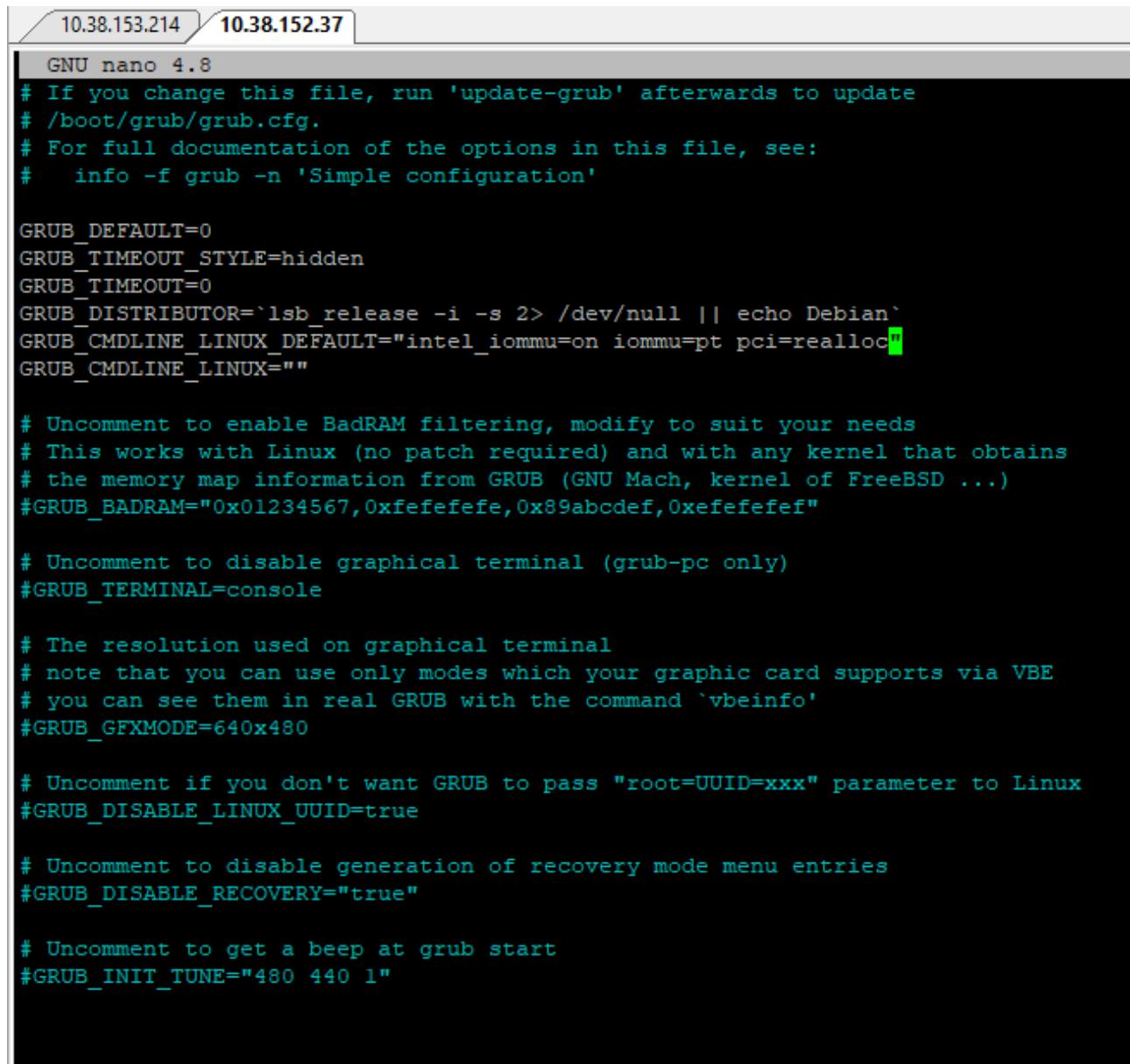
Sometimes it is needed to add the (root) user to the `kvm`, `qemu` and/or `libvirt` groups. To do this run the following commands (replace root with other needed user):

```
usermod -a -G libvirt root
usermod -a -G kvm root
usermod -a -G qemu root
groups root
```

Sometimes adding the user and the group accordingly in `/etc/libvirt/qemu.conf` is also required.

Ubuntu

In `/etc/default/grub` add `intel_iommu=on iommu=pt pci=realloc` at the line mentioned below. For AMD CPUs, it will be `amd_iommu=on`. These settings are required for KVM device passthrough.



```

GNU nano 4.8
# If you change this file, run 'update-grub' afterwards to update
# /boot/grub/grub.cfg.
# For full documentation of the options in this file, see:
#   info -f grub -n 'Simple configuration'

GRUB_DEFAULT=0
GRUB_TIMEOUT_STYLE=hidden
GRUB_TIMEOUT=0
GRUB_DISTRIBUTOR=`lsb_release -i -s 2> /dev/null || echo Debian`
GRUB_CMDLINE_LINUX_DEFAULT="intel_iommu=on iommu=pt pci=realloc"
GRUB_CMDLINE_LINUX=""

# Uncomment to enable BadRAM filtering, modify to suit your needs
# This works with Linux (no patch required) and with any kernel that obtains
# the memory map information from GRUB (GNU Mach, kernel of FreeBSD ...)
#GRUB_BADRAM="0x01234567,0xfefefefe,0x89abcdef,0xefefefef"

# Uncomment to disable graphical terminal (grub-pc only)
#GRUB_TERMINAL=console

# The resolution used on graphical terminal
# note that you can use only modes which your graphic card supports via VBE
# you can see them in real GRUB with the command `vbeinfo'
#GRUB_GFXMODE=640x480

# Uncomment if you don't want GRUB to pass "root=UUID=xxx" parameter to Linux
#GRUB_DISABLE_LINUX_UUID=true

# Uncomment to disable generation of recovery mode menu entries
#GRUB_DISABLE_RECOVERY="true"

# Uncomment to get a beep at grub start
#GRUB_INIT_TUNE="480 440 1"

```

Then do the following command to change the grub file. A reboot will be required.

```
grub-mkconfig -o /boot/grub/grub.cfg
```

Make sure that the CPU has the virtualization parameter enabled (it should return *VT-d* or *VT-x*):

```
lscpu | grep Virt
```

Or, the following should return *vmx*:

```
cat /proc/cpuinfo | egrep -i "vmx|svm"
```

Use the following commands to install and check KVM:

```
apt update
apt install -y qemu qemu-kvm libvirt-daemon libvirt-clients bridge-utils virt-manager
systemctl enable --now libvirtd
```

```
systemctl status libvиртd
lsmod | grep -I kvm
```

NOTE

Sometimes it is needed to add the `(root)` user to the `kvm`, `qemu` and/or `libvirt` groups. To do this run the following commands (replace `root` with other needed user):

```
usermod -a -G libvirt root
usermod -a -G kvm root
usermod -a -G qemu root
groups root
```

Install Gnome and XRDP

Rocky Linux

Use the following commands to verify if it is set to `graphical.target`, and if not, set it as default:

```
systemctl get-default
systemctl isolate graphical.target
systemctl set-default graphical.target
```

Use the following commands to install and check Gnome:

```
dnf group install "Server with GUI"
gnome-shell --version
```

Use the following commands to install and check XRDP:

```
dnf install epel-release
dnf install xrdp
systemctl enable xrdp.service
systemctl start xrdp.service
systemctl status xrdp.service
```

Make sure port 3389 is added in the firewall:

```
firewall-cmd --add-port=3389/tcp --permanent
firewall-cmd --reload
```

Ubuntu

Use the following commands to check if it is set to `graphical.target`, and if not, set it as default:

```
systemctl get-default
systemctl isolate graphical.target
systemctl set-default graphical.target
```

Use the following commands to install and check Gnome:

```
apt install ubuntu-gnome-desktop
gnome-shell --version
```

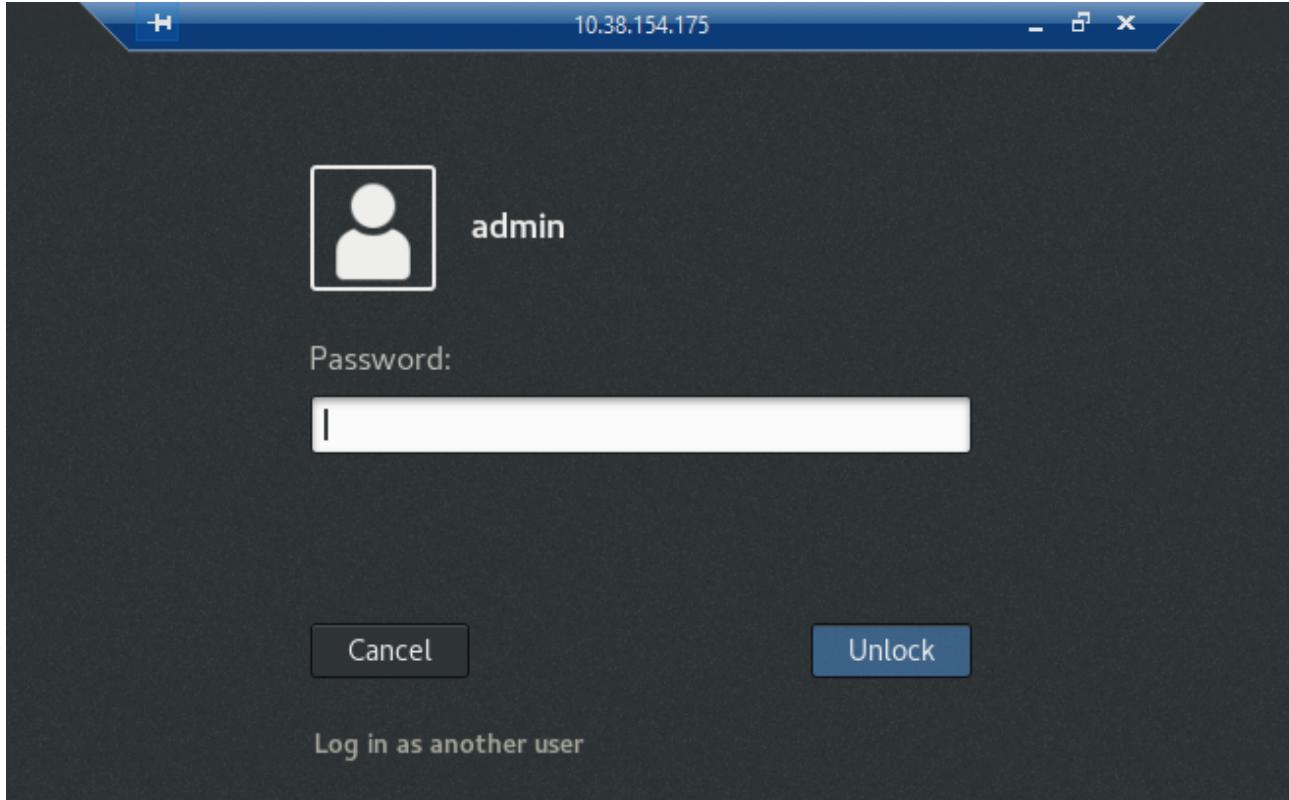
Use the following commands to install and check XRDP:

```
apt install xrdp
systemctl enable xrdp.service
systemctl start xrdp.service
systemctl status xrdp.service
```

Make sure port 3389 is added in the firewall:

```
ufw allow 3389/tcp
```

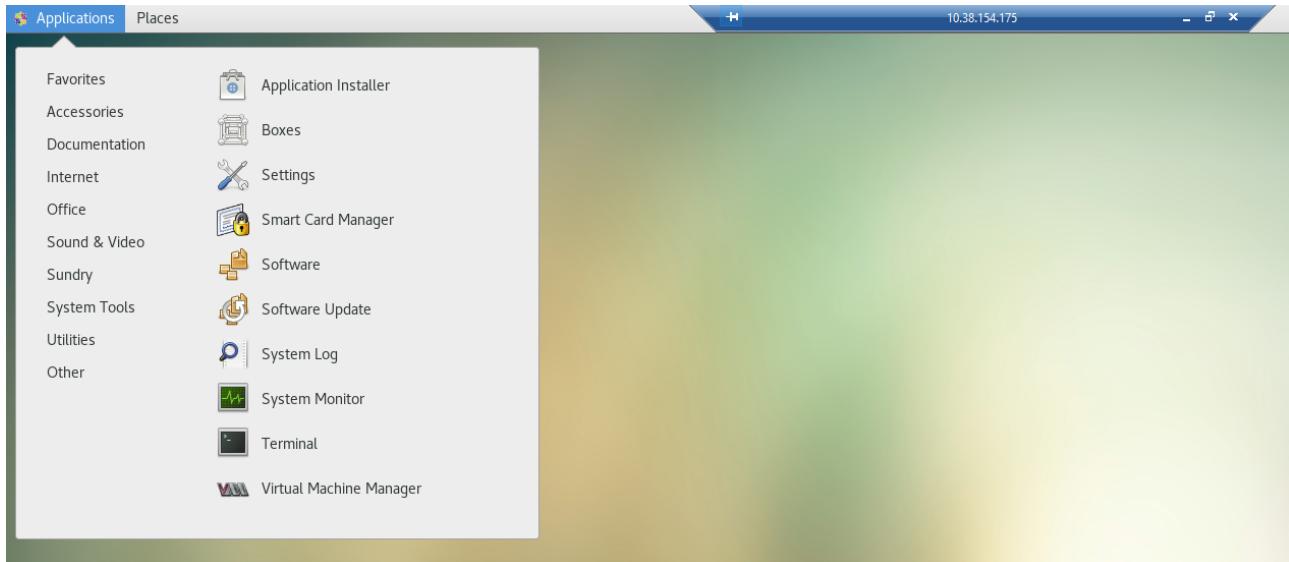
Now it should be possible to connect to the hypervisor with a Remote Desktop application:



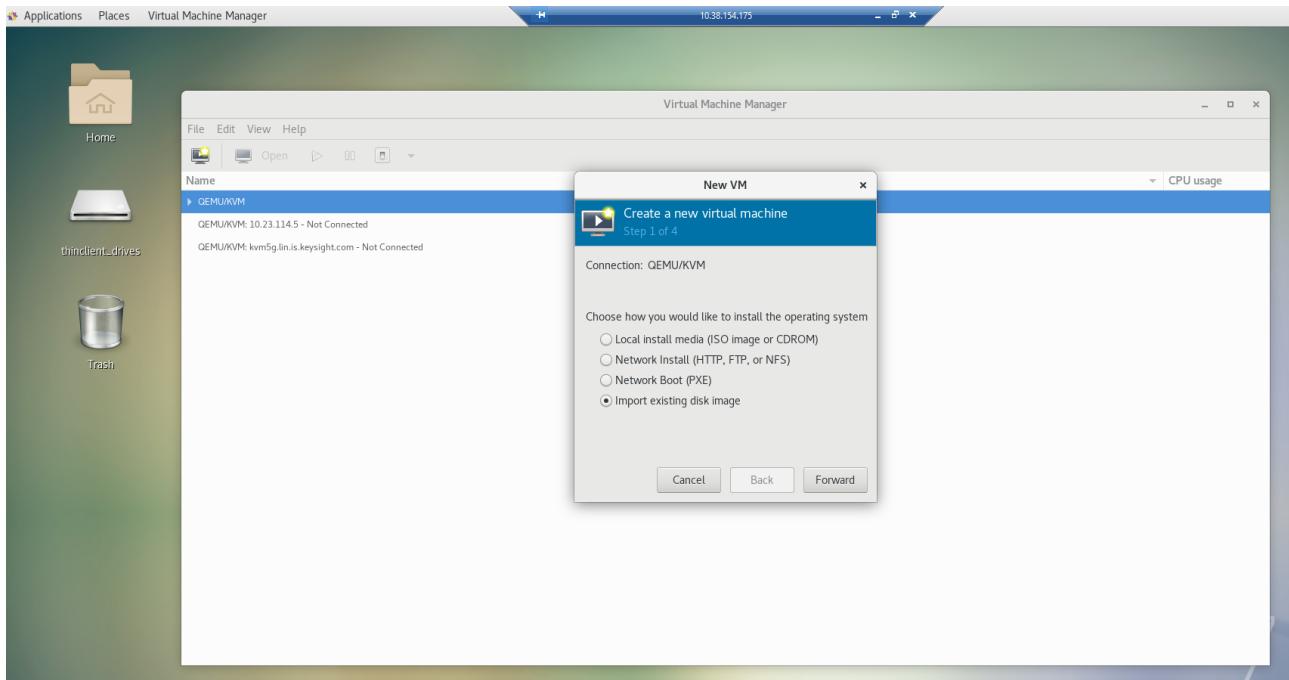
Install LoadCore VMs

Upload the needed QCOW images to the hypervisor through WinSCP, Moba, VNC or any other application that can use FTP.

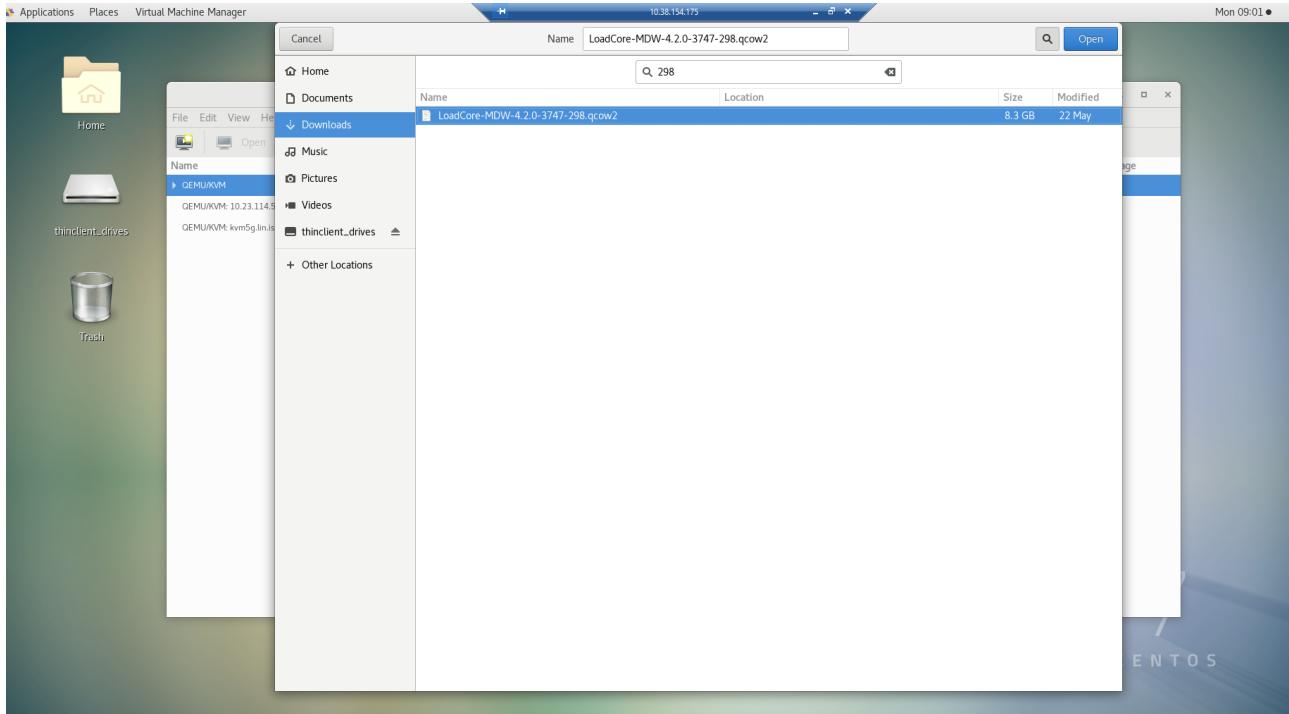
Go to the **Applications** button> **System tools** and then open **Virtual Machine Manager**:



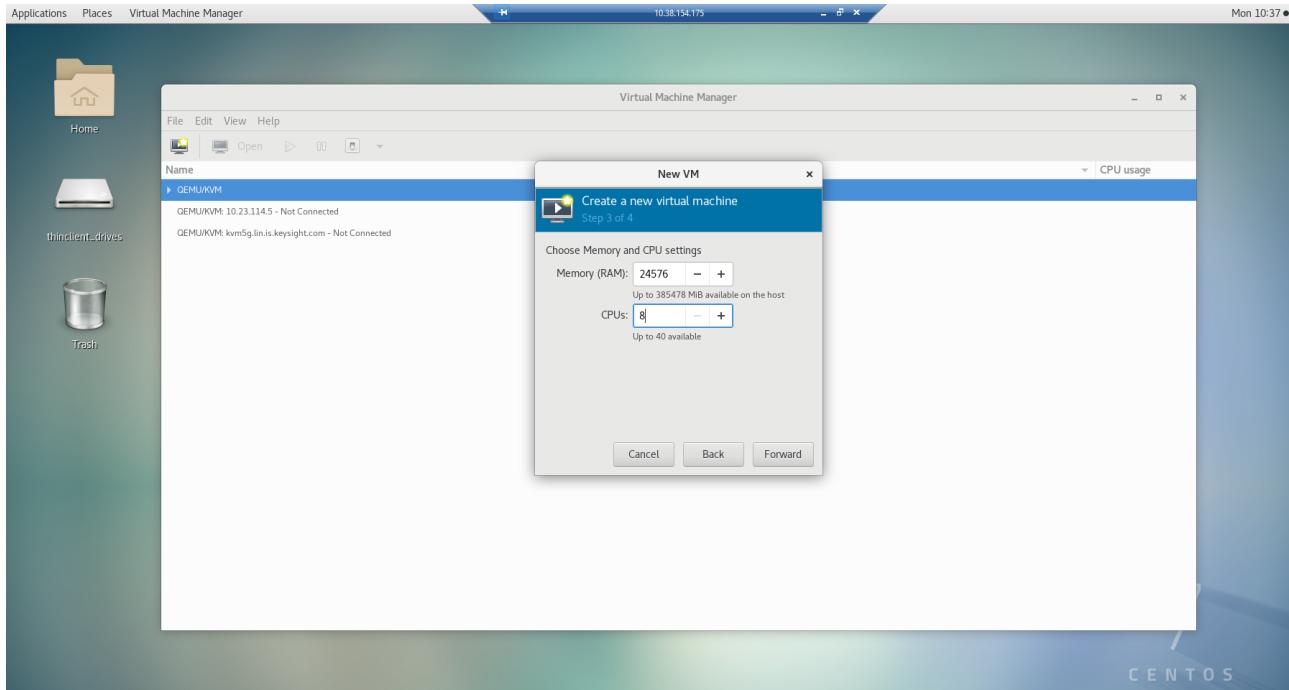
Select the new VM button (upper left) and select the **Import existing disk image** option:



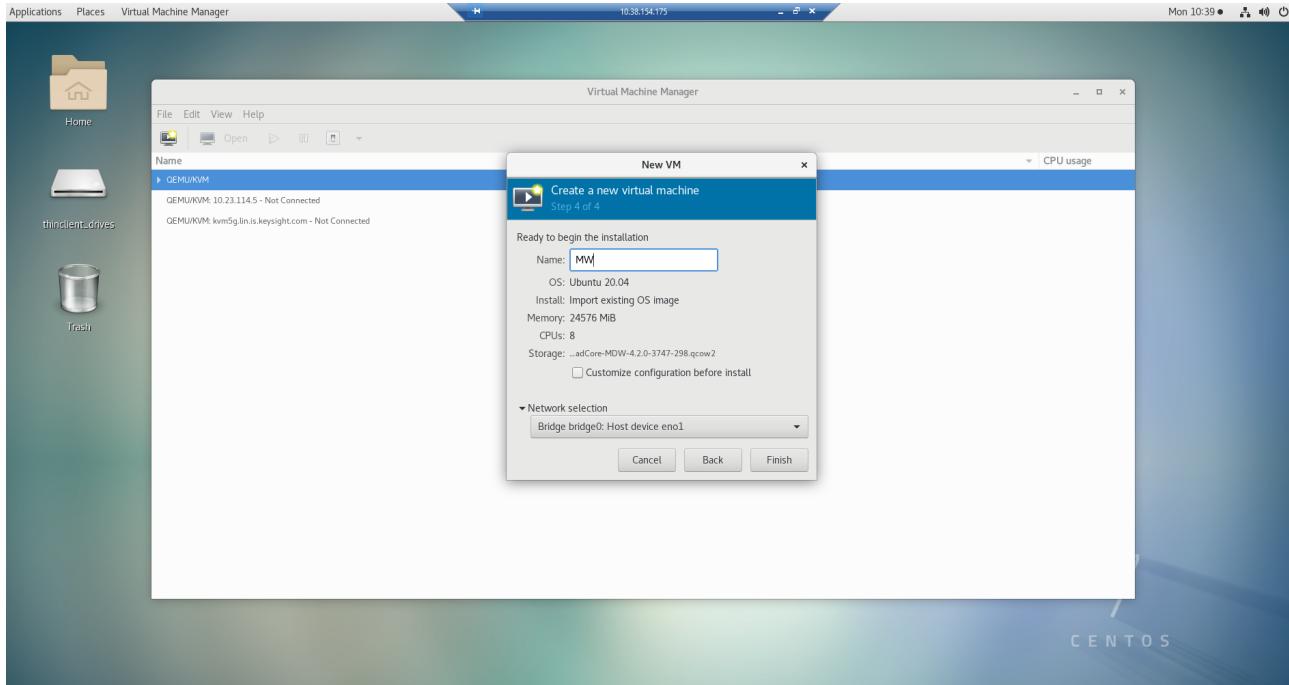
Select the image to be loaded:



Select the appropriate resources:



Provide the VM name and select a management interface:



Alternatively the VMs can also be deployed from the hypervisor command line, with commands like the following:

```
virt-install --name LoadCore-MW --os-type=Linux --os-variant=ubuntu22.04 --memory=24576
--vcpus=8 --disk=/home/keysight/Desktop/qcow2_files/ LoadCore-MDW-4.2.0-3747-298.qcow2 -
--network bridge=bridge0,model=e1000 --import --noautoconsole
```

or

```
sudo virt-install --import --name loadcore-agent-1 \
    --memory 32768 --vcpus 8 --cpu host-passthrough \ <- 32GB ram and 8 CPUs
recomended for agent VMs
    --disk loadcore-agent-2.qcow2,format=qcow2,bus=virtio \ <- provide disk image
    --network type=direct,source=eno1,source_mode=bridge,model=e1000e \ <- configures
management network as directly connected to host's network
    --os-variant=ubuntu22.04 \
    --host-device=pci_0000_d8_00_1 \ <- enable pci passthrough for test NIC
    --noautoconsole
```

To connect from the hypervisor to the VM:

```
virsh console LoadCore-MW
```

IMPORTANT

The recommended order for booting up the VMs is the following:

- first, the License Server, if a dedicated one has been deployed (this is the VM that uses the least amount of resources)
- next, the MW
- last, after a few minutes, start the agents one by one.

This order is also according to dependencies/communication between the VMs.

Add virtual bridge

This step is optional, but recommended to use if there is only one interface for management assigned on the hypervisor.

Rocky Linux

First, create the bridge with the following command (replace `br0` with the name of the bridge you want to give):

```
nmcli con add type bridge ifname br0
```

Assign a slave interface to the bridge (replace `enp6s0` with the desired interface):

```
nmcli con add type bridge-slave ifname enp6s0 master br0
```

Assign a static IP address and a gateway to the bridge (DHCP can also be used):

```
nmcli con mod bridge-br0 ipv4.addresses 192.168.1.100/24 ipv4.gateway 192.168.1.1
connection.autoconnect true
```

Bring down and delete the old connection on `enp6s0`:

```
nmcli con down enp6s0
nmcli con delete enp6s0
```

Bring the bridge up:

```
nmcli con up br0
```

You can also check the device and connection status with:

```
nmcli dev status
nmcli con show
```

NOTE In some setups you may need to disable spanning tree, by executing the following command:

```
nmcli connection modify bridge-br0 bridge.stp no
```

Ubuntu

First install `bridge-utils`:

```
apt install bridge-utils -y
```

Open the `.yaml` file found in `/etc/netplan` (it can be `00-installer-config.yaml`, `network.yaml`, `01-network-manager-all.yaml`). Add the bridge lines as in the example below for static IP:

```
bridges:
  br0:
    interfaces: [ ens3 ]
    dhcp4: false
    addresses: [ 10.38.152.37/22 ]
    routes:
      - to: default
        via: 10.38.152.1
```

```

10.38.152.37
GNU nano 4.8
# This is the network config written by 'subiquity'
network:
ethernets:
ens3:
    dhcp4: false
# add configuration for bridge interface
bridges:
br0:
    interfaces: [ens3]
    addresses: [10.38.152.37/22]
    # gateway4 is deprecated, use routes instead
    routes:
        - to: default
            via: 10.38.152.1
            metric: 100
            on-link: true
    mtu: 1500
    nameservers:
        addresses: [8.8.8.8]
    parameters:
        stp: true
        forward-delay: 4
    dhcp4: false
    dhcp6: false
version: 2

```

For DHCP you can just set the `dhcp4` parameter to true and comment or remove the static ip address:

```

bridges:
br0:
    interfaces: [ ens3 ]
    dhcp4: true

```

Then try and apply the netplan:

```

netplan try
netplan apply

```

Azure Cloud Deployment

The requirements for deploying ORAN-SIM CE appliances in Azure cloud are:

1. The existence of a resource group.
 - a. To create a resource group, select **Resource Groups** from the Azure portal.
 - b. Select **Add** and enter the property values.
 - c. Type a name and select a location.
 - d. Select **Review + create** to review the values and then select **Create**.
2. The existence of a storage account named *keysight*.
 - a. On the Azure portal, select **Resource Groups**.
 - b. Select the created resource group.
 - c. On the resource group window, select **+ Add**.
 - d. In the list of resources, type **Storage account**. On the storage account window, select **Create**.
 - e. Enter the *keysight* name for your storage account and select the location that should be the same as the resource group location.
 - f. Select **Review + create** to review the storage account settings and then select **Create**.
3. The existence of a container named *keysight* in the *keysight* storage account
 - a. On the Azure portal, select **Resource Groups**.
 - b. Select the created resource group.
 - c. On the resource group window, select the *keysight* storage account.
 - d. In the left menu for storage account, scroll to the Blob service section and select **Containers**.
 - e. Select the **+ Container** button.
 - f. Type the *keysight* name for the new container.
 - g. Select **Create**.
4. The existence of vhds in the *keysight* container.
 - a. In the Azure portal, navigate to the container you created and select the *keysight* container.
 - b. Select the **Upload** button to open the upload blade and browse your local file system to find the mw vhd with the prefix *LoadCore-MW*. Select the **Upload** button to upload the blob.
 - c. The previous point apply for the agent vhd with the prefix *LoadCore-Agent* and the licensing vhd with the prefix *licensing*.
5. The existence of templates in Azure portal.
 - a. To add templates, select **Templates** from the Azure portal.
 - b. On the Templates window, select **+ Add**.
 - c. Type a name for the first template, add a description and then select **OK**.
 - d. Add the template content and then select **OK**.

- e. Select **Add**.
- f. The previous steps apply also for the rest of templates.

OpenStack Deployment

This section describes the steps needed to deploy ORAN-SIM CE on OpenStack.

Prerequisites

For a complete and correct functioning setup, make sure you have downloaded and installed the packages on your test environment:

- **Wireshark** capable to decode PFCP messages and IEs (at least 2.5.2).
This will be used to analyze the traffic captures.
- **Hypervisor** with available resources to deploy the virtual machine(s) hosting the Middleware, the Test Agents and License Server.
The examples below were done using VMware ESXi.
- **ORAN-SIM CE images** (three images: Middleware, Agent and License server). License Server image is optional, since it can be collocated with MW, but it is recommended to be installed on a separate VM. The images can be downloaded from KSM: <https://ksm.software.keysight.com>

IMPORTANT IP connectivity between VMs must to be ensured.

- You will need to use this machine to run ORAN-SIM CE tests. **ILU (Windows or Linux) cannot be used to run ORAN-SIM CE tests.**
- **Valid licenses** for License server. For deploying full 5G core and run Control plane and User plane traffic, the following licenses will be required:
 - Control plane licenses:
 - ORAN-SIM CE interface license simulation (**P89033A** x 11 pcs).
This license will enable Control plane testing. One license is needed for each simulated interface.
 - 5GCore Performance enabler on VM: 1M UEs and 10k TPS for VM (**P89034A** x 1 pcs).
 - User plane licenses:
 - User Plane Flow-based license (N3 and N6). Multiple QTY are needed if multiple flows are active simultaneously. Includes three Application Traffic Flows (TCP/UDP) and 10Gbps throughput capacity (**P89037A** x 2 pcs). The recommendation is to use this type of license as this will be suggested for all new customers.
 - As an alternative for the above license you can also use Tier-4 license (**P89030A** or **P89031A** x 2 pcs).

IMPORTANT These license types will enable User plane traffic and are not needed if ONLY control plane traffic is needed for future tests.

- Minimum supported resolution for ORAN-SIM CE UI is 1920x1080 (Full HD).

Hardware Requirements

By default, the VM for Middleware will reserve the following compute resources when installing the OVA:

- 8 x vCPUs
- 16 GB RAM

- 256 GB SSD

The test agent will reserve the following compute resources when installing the OVA:

- 4 x vCPUs
 - 4 GB RAM **out of which 1GB is reserved for HUGE MEM(IxStack over DPDK/Raw)**
- IMPORTANT** This value is for control plane only. If you are running app traffic the recommendation is to allocate minimum 16 GB RAM.
-
- 20 GB SSD

Running application traffic will require increasing agent resources. The recommendation for each agent will be in this case:

- 8 x vCPUs
- 32 GB RAM
- 20 GB SSD

Licensing server default resources

- 2 x vCPUs
- 8 GB RAM
- 100 GB SSD

Supported NICs in tests with IxStack over DPDK/Raw(TCP based traffic)

The list of supported NICs in tests with IxStack over DPDK/Raw(TCP based traffic):

- Intel X710 10G
- Intel XXV710 25G
- Intel XL710 40G
- Intel E810 25G
- Intel E810 100G
- Mellanox ConnectX-4/5 25G
- Mellanox ConnectX-4/5 100G
- Mellanox ConnectX-6 Dx 100G
- KVM Virtual NIC (virtio)

Supported drivers list:

- mlx4_core
- mlx5_core
- ixgbe
- ixgbefvf
- i40e
- i40evvf
- ice

- iavf
- Virtio

Middleware installation

The installation procedure of the Middleware requires the following steps:

1. In OpenStack, navigate the left menu to **Admin > Compute > Images** section and select **Create Image**. Input an appropriate image name, browse and select the **MW qcow2** file, select the QCOW2 format and finalize by clicking on **Create Image** button.

The screenshot shows the OpenStack Admin interface. On the left, the navigation bar includes 'Project', 'Admin', 'Compute', 'Host Aggregates', 'Instances', 'Flavors', 'Images', 'Network', and 'System'. Under 'Compute', there are sections for 'Overview', 'Hypervisors', 'Host Aggregates', 'Instances', 'Flavors', and 'Images'. The 'Images' section shows a list of existing images: cirros, cloupeak-image, LC Agent 4.2.0.5, LC Agent 4.3.0.6, LC MW 4.0.0.36, LC MW 4.2.0.37, LC MW 4.3.0.39, LC MW 4.3.0.39, and NicuATT. The main window displays the 'Create Image' dialog. It has tabs for 'Image Details' and 'Metadata'. Under 'Image Details', the 'Image Name' is set to 'Middleware', 'Image Description' is empty, 'Image Source' is 'File' (with a 'Browse' button pointing to 'LoadCore-MDW-4.3.0-396'), 'Format' is 'QCOW2 - QEMU Emulator', and 'Image Requirements' show 'Kernel' and 'Architecture' both set to 'Choose an image'. Under 'Image Sharing', 'Visibility' is 'Public' and 'Protected' is 'No'. At the bottom right of the dialog is a 'Create Image' button. To the right of the dialog, a list of images is shown with columns for 'Name', 'Status', 'Visibility', 'Protected', 'Disk Format', and 'Size'. The new image 'Middleware' is listed with a size of 12.13 MB.

2. Navigate to **Admin > Compute > Flavors** section and select **Create Flavor**. Input an appropriate flavor name and choose the required resources to be assigned (in this case 8 vCPUs, 20 GB RAM, and 256 GB storage), and press **Create Flavor** to confirm.

The screenshot shows the OpenStack Admin interface. The left navigation bar is identical to the previous screenshot. The main window shows the 'Create Flavor' dialog under the 'Flavors' section. The 'Flavor Information' tab is active, showing fields for 'Name' (set to 'MW 4.3'), 'ID' (set to 'auto'), 'vCPUs' (set to '8'), 'RAM (MB)' (set to '20480'), 'Root Disk (GB)' (set to '256'), 'Ephemeral Disk (GB)' (set to '0'), and 'Swap Disk (MB)' (set to '0'). Below these fields, there is a table with columns 'Name', 'vCPUs', 'RAM (GB)', 'Root Disk (GB)', 'Ephemeral Disk (GB)', 'Swap Disk (MB)', and 'Actions'. The table lists several existing flavors, such as 'compute' (2 vCPUs, 24GB RAM, 0GB disk), 'flavor12cores32Gpinned' (12 vCPUs, 24GB RAM, 0GB disk), 'flavor18cores32Gpinned' (18 vCPUs, 24GB RAM, 0GB disk), 'flavor8cores32Gpinned' (8 vCPUs, 24GB RAM, 0GB disk), 'flavor9cores32Gpinned' (9 vCPUs, 24GB RAM, 0GB disk), 'LC Agent Generic' (4 vCPUs, 24GB RAM, 0GB disk), 'LC Agent Regular' (4 vCPUs, 24GB RAM, 0GB disk), 'LC Agent TPUT' (16 vCPUs, 24GB RAM, 0GB disk), 'MW 2.2' (4 vCPUs, 24GB RAM, 0GB disk), 'MW 3.1' (8 vCPUs, 24GB RAM, 0GB disk), 'MW 4.0' (8 vCPUs, 24GB RAM, 0GB disk), 'MW 4.2' (8 vCPUs, 24GB RAM, 0GB disk), and 'Nicu_Ubuntu' (12 vCPUs, 32GB RAM, 100GB disk). At the bottom right of the dialog is a 'Create Flavor' button.

3. If not already created, it is recommended to create a management network to be used for communication between middleware, agents and license server. To do this, navigate to **Admin > Networks** section and select **Create Network**. Input an appropriate name, select the project for which the network will be created, and choose a network address. Click **Next** to confirm.

4. Navigate to **Project > Compute > Instances** section and click **Launch Instance**.

5. In the **Launch Instance** dialog (these are mandatory configurations marked by asterisk):

- select **Details** section to input an appropriate *name* to this instance

Launch Instance

Details

Please provide the initial hostname for the instance, the availability zone where it will be deployed, and the instance count. Increase the Count to create multiple instances with the same settings.

Instance Name * LC_MW

Description

Availability Zone nova

Total Instances (15 Max)

Count * 1

33%

4 Current Usage
1 Added
10 Remaining

< Back | Next > | **Launch Instance**

- select **Source** section and choose the newly created *image* as boot source

Launch Instance

Source

Instance source is the template used to create an instance. You can use an image, a snapshot of an instance (image snapshot), a volume or a volume snapshot (if enabled). You can also choose to use persistent storage by creating a new volume.

Select Boot Source Image

Allocated

Name	Updated	Size	Type	Visibility
LC MW 4.3.0-3965-681	12/21/23 12:28 PM	11.31 GB	qcow2	Public

Available (10)

Select one

Click here for filters or full text search.

Name	Updated	Size	Type	Visibility
cirros	11/3/20 8:35 PM	12.13 MB	qcow2	Public
cloudpeak-image-3.10.0.30	11/17/20 6:32 PM	1.09 GB	qcow2	Public
LC Agent 4.2.0.5	8/21/23 12:44 PM	841.63 MB	qcow2	Public
LC Agent 4.3.0.6	12/21/23 12:22 PM	1.13 GB	qcow2	Public
LC MW 4.0.0-3637-269	12/20/22 5:22 PM	10.53 GB	qcow2	Public
LC MW 4.2.0-3747-298	5/11/23 11:54 AM	8.25 GB	qcow2	Public

- select the **Flavor** section to add the newly created *flavor* that allocates the resources

Launch Instance

Allocated						
Name	VCPUS	RAM	Total Disk	Root Disk	Ephemeral Disk	Public
» MW 4.3	8	20 GB	256 GB	256 GB	0 GB	Yes

▼ Available ⓘ Select one

Name	VCPUS	RAM	Total Disk	Root Disk	Ephemeral Disk	Public
» tiny	1	1 GB	1 GB	1 GB	0 GB	Yes
» compute	2	4 GB	15 GB	15 GB	0 GB	Yes
» LC Agent Generic	4	4 GB	20 GB	20 GB	0 GB	Yes
» SLUM	2	8 GB	256 GB	256 GB	0 GB	Yes
» LC Agent Regular	4	8 GB	30 GB	30 GB	0 GB	Yes
» MW 3.1	8	12 GB	256 GB	256 GB	0 GB	Yes
» MW 2.2	4	12 GB	256 GB	256 GB	0 GB	Yes
» MW 4.0	8	16 GB	256 GB	256 GB	0 GB	Yes
» MW 4.2	8	24 GB	256 GB	256 GB	0 GB	Yes

- select the **Network** section and add the new *network* as communication channel.

Launch Instance

Allocated ⓘ Select networks from those listed below.						
Network	Subnets Associated	Shared	Admin State	Status		
» 1 Internal1	Internal1-Subnet	No	Up	Active		

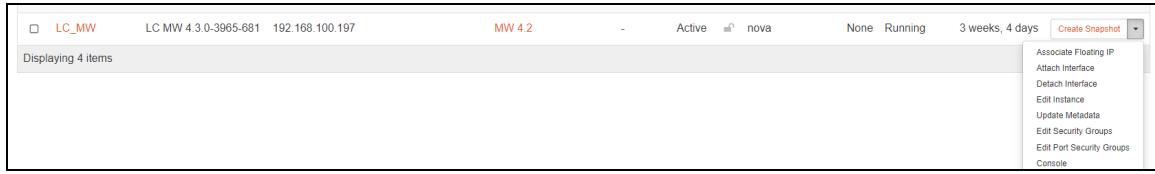
▼ Available ⓘ Select at least one network

Network	Subnets Associated	Shared	Admin State	Status		
» Internal2	Internal2	No	Up	Active		
» Test2	Test2-Subnet	No	Up	Active		
» Test	Test-Subnet	No	Up	Active		
» External	External-Subnet	Yes	Up	Active		

* Cancel < Back Next > **Launch Instance**

Confirm the configuration by pressing the **Launch Instance** button.

- Optional Step: After the Middleware instance has been deployed, assign a floating IP so you can access it from an external network:
 - from the **Project > Compute > Instances** section, go to the allocated image and, from the drop-down menu at the end of the row select **Associate Floating IP**.



- b. in the **Manage Floating IP Association** dialog, select an *IP address* from the drop-down list, or create one by clicking the **+** button.
- c. click **Associate** to conclude this step.

Manage Floating IP Associations

IP Address *
10.38.218.202 **+**

Select the IP address you wish to associate with the selected instance or port.

Port to be associated *
LC_MW: 192.168.100.197

Cancel Associate

Agent installation and configuration

Agent installation follows similar steps to Middleware.

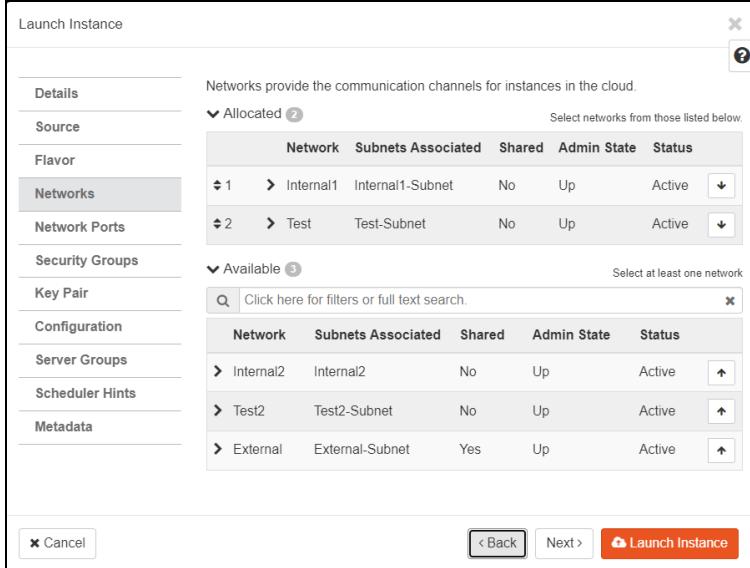
1. In OpenStack, navigate the left menu to **Admin > Compute > Images** section and select **Create Image**. Input an appropriate agent name, such as *LC Agent 4.3.0.6*, then browse and select the LC agent image file, select the QCOW2 format and finalize by clicking on **Create Image** button.
2. Navigate to **Admin > Compute > Flavors** section and select **Create Flavor**. Input an appropriate flavor name, such as *LC_Agent Generic*, and choose the required resources to be assigned, and press **Create Flavor** to confirm.
3. Agents require at least one management interface for communication with middleware, and at least a test interface, that will be used to communicate to either another LC agent or a DUT. Navigate to **Admin > Networks** section and select **Create Network**, then name it as *Test*; select the project for which the network will be created, and choose a network address. Click **Next** to confirm.
4. Navigate to **Project > Compute > Instances** section and click **Launch Instance**.
 - select **Details** section to input an appropriate *name* to this agent instance, such as *LC_Agent_1*.
 - select **Source** section and choose the created agent image

The screenshot shows a 'Select Boot Source' dialog. On the left, a sidebar lists options like Details, Source, Flavor*, Networks*, etc. The 'Source' section is selected. The main area displays two tables: 'Allocated' and 'Available'. The 'Allocated' table has one entry: 'LC Agent 4.3.0.6' (1.13 GB, qcow2, Public). The 'Available' table lists several images: cirros (12.13 MB, qcow2, Public), cloudpeak-image-3.10.0.30 (1.09 GB, qcow2, Public), LC Agent 4.2.0.5 (841.63 MB, qcow2, Public), LC MW 4.2.0-3747-298 (8.25 GB, qcow2, Public), LC MW 4.3.0-3965-755 (10.66 GB, qcow2, Public), and LoadCore-MDW-4.4.0-4.310-487 (10.88 GB, qcow2, Public).

- select the **Flavor** section to add the agent's resource. Note that the agent flavor can be different according to the agent purpose. For example, if it is used for Application Traffic, then pinned CPUs and PCI passthrough may be required, or if used only for simulating Control Plane procedures, it can have lower resources.

The screenshot shows a 'Launch Instance' dialog. The 'Flavor' section is selected in the sidebar. The main area displays two tables: 'Allocated' and 'Available'. The 'Allocated' table has one entry: 'LC Agent Generic' (4 VCPUS, 4 GB RAM, 20 GB Total Disk, 20 GB Root Disk, 0 GB Ephemeral Disk, Yes Public). The 'Available' table lists three flavors: 'tiny' (1 VCPUS, 1 GB RAM, 1 GB Total Disk, 1 GB Root Disk, 0 GB Ephemeral Disk, Yes Public), 'compute' (2 VCPUS, 4 GB RAM, 15 GB Total Disk, 15 GB Root Disk, 0 GB Ephemeral Disk, Yes Public), and 'cyber-age nt-worker-' (4 VCPUS, 8 GB RAM, 256 GB Total Disk, 256 GB Root Disk, 0 GB Ephemeral Disk, Yes Public).

- select the **Network** section and add the two network types.



5. Confirm the configuration by pressing the **Launch Instance** button.
6. To register the agent to the Middleware, connect via SSH (user/password are *ixia/ixia*), and run `sudo /home/ixia/agent-setup.sh` command. Input the MW IP (either the internal IP or the floating IP), and answer with *y/n* the questions that follow.

```

18/06/2024 11:05:36 /home/mobaxterm ssh ixia@10.38.2.82
Ubuntu 22.04 LTS
X11 forwarding request failed on channel 0
Welcome to Ubuntu 22.04 LTS (GNU/Linux 5.15.0-88-generic x86_64)

 * Documentation: https://help.ubuntu.com
 * Management: https://landscape.canonical.com
 * Support: https://ubuntu.com/advantage
Last login: Mon Jun 17 11:18:43 2024 from 10.20.132.215
ixia@lc-agent-1:~$ sudo ./agent-setup.sh
[sudo] password for ixia:

Enter the IP address or hostname of the middleware: 10.38.2.86

Selected interface ens3 with address 192.168.100.94 as management interface
Would you like to change the management interface? [y/n]: n

Do you want to allow this agent to be rebooted from the UI? [y/n]: y

Would you like to change the hostname to 5GCTE-fa-16-3e-28-6e-6b? [y/n]: n

```

7. To make sure that this step was successful, check on the Middleware user interface: click on the **Settings** (⚙️) button on the upper right corner, and select **Agent Management**, where the agent you just registered should be displayed.

Agent IP	Owner	Status	Tags	Hostname	Version	Type	Traffic Agent Info		Test NICs			NTP Settings		Advanced System		
							Name	Gateway	MTU	IPs	Active Server	Status	OS Name	Kernel Versi		
192.168.100.94		Stopped	hostname: lc... (1) txStack: OFF (1) build: pipeline... (1)	lc-agent-1			ens4	ens5p0	1450	1500	Inactive	Inactive	Ubuntu 22.04 LTS	Linux 5.15.0 generic		

- Once the Agent has been deployed, if a test subnet has been used, it is also required to allow traffic to flow through it. Back in OpenStack, go to **Project > Compute > Instances** and select the Agent instance, then go to the **Interfaces** tab.

Name	Network	Fixed IPs	MAC Address	Status	Admin State	Actions
(d654990e-7c8f)	Internal1	• 192.168.100.94	fa:16:3e:28:6e:6b	Active	UP	<button>Edit Security Groups</button>
(da7844d5-4867)	Test	• 192.168.200.244	fa:16:3e:09:3a:3f	Active	UP	<button>Edit Security Groups</button>

- Under the **Name** column, click the *Test* interface to open it for editing. You will be redirected to **Project > Network > Networks > Test**.

IP Address or CIDR	MAC Address	Actions
	No items to display.	

- Select the **Allowed Address Pairs** tab, and press the **+Add Allowed Address Pair** button. In the dialog, set the IP address range on which traffic is allowed through the interface (20.0.0.0/8 is the default IP range used in LC tests, 0.0.0.0/0 will allow all traffic, or you can use another range), and click **Submit**.

Add Allowed Address Pair

IP Address or CIDR *

Description:
Add an allowed address pair for this port. This will allow multiple MAC/IP address (range) pairs to pass through this port.

MAC Address

- Optional Step:** After the Agent instance has been deployed, assign a floating IP so you can access it from an external network:

- from the **Project > Compute > Instances** section, go to the allocated image and, from the drop-down menu at the end of the row select **Associate Floating IP**.



- in the **Manage Floating IP Association** dialog, select an *IP address* from the drop-down list, or create one by clicking the **+** button.
- click **Associate** to conclude this step.

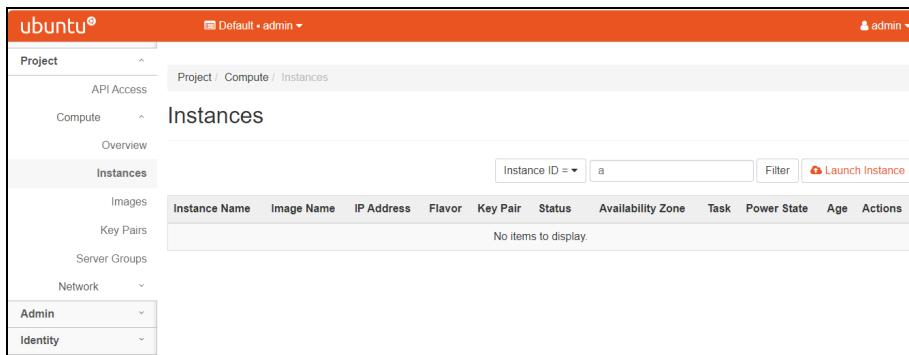
IP Address *	Select the IP address you wish to associate with the selected instance or port.
10.38.218.202	
Port to be associated *	LC_MW: 192.168.100.197

Cancel **Associate**

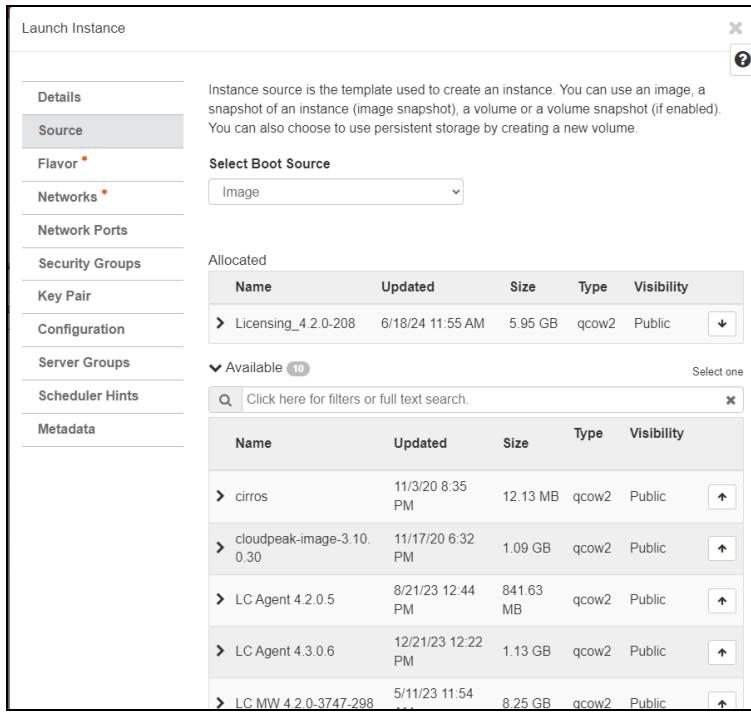
License Server installation

The installation procedure of the license server requires the following steps:

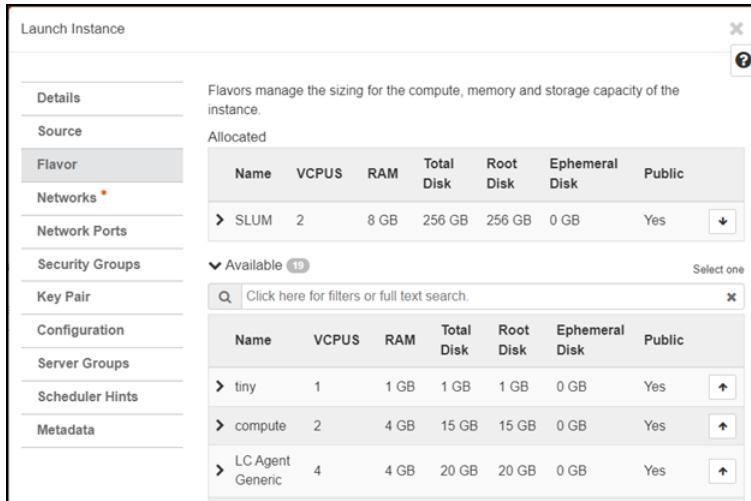
- In OpenStack, navigate the left menu to **Admin > Compute > Images** section and select **Create Image**. Input an appropriate license server name, then browse and select the server image file, select the QCOW2 format and finalize by clicking on **Create Image** button.
- Navigate to **Admin > Compute > Flavors** section and select **Create Flavor**. Input an appropriate flavor name, such as *SLUM*, and choose the required resources to be assigned, and press **Create Flavor** to confirm.
- Navigate to **Project > Compute > Instances** section and click **Launch Instance**.



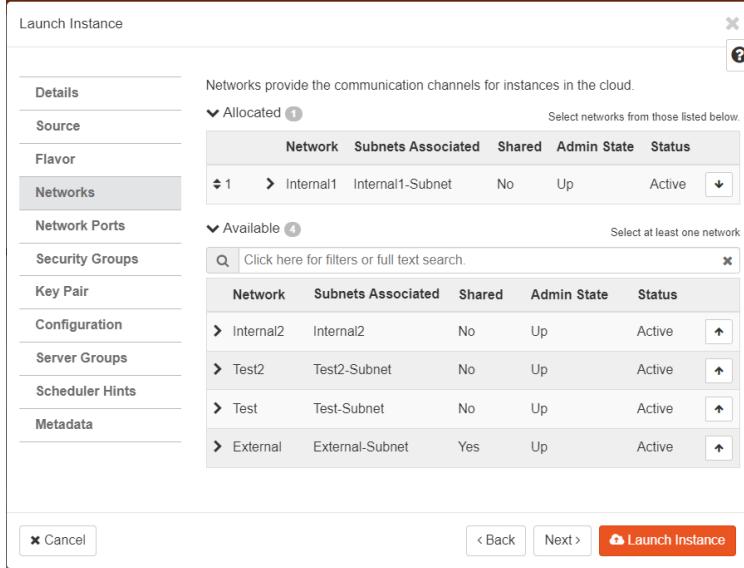
- In the **Launch Instance** dialog (these are mandatory configurations marked by asterisk):
 - select **Details** section to input an appropriate *name* to this instance
 - select **Source** section and choose the newly created license server *image* as boot source



- select the **Flavor** section to add the newly created flavor that allocates the resources



- select the **Network** section and choose the same management subnet that was previously added for MW and agent. This will be used for communication between License Server and MW



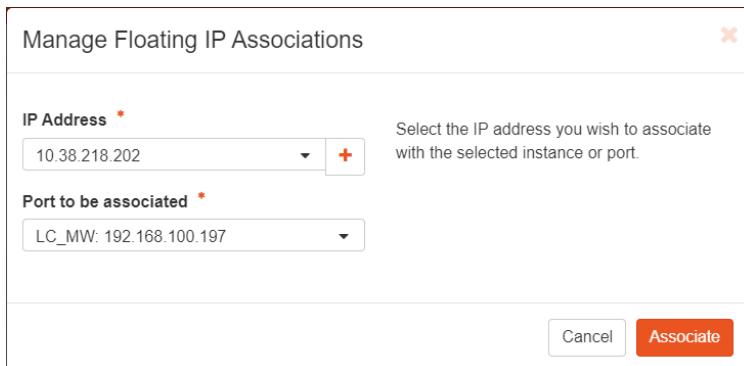
Confirm the configuration by pressing the **Launch Instance** button.

5. **Optional Step:** After the license server instance has been deployed, assign a floating IP so you can access it from an external network:

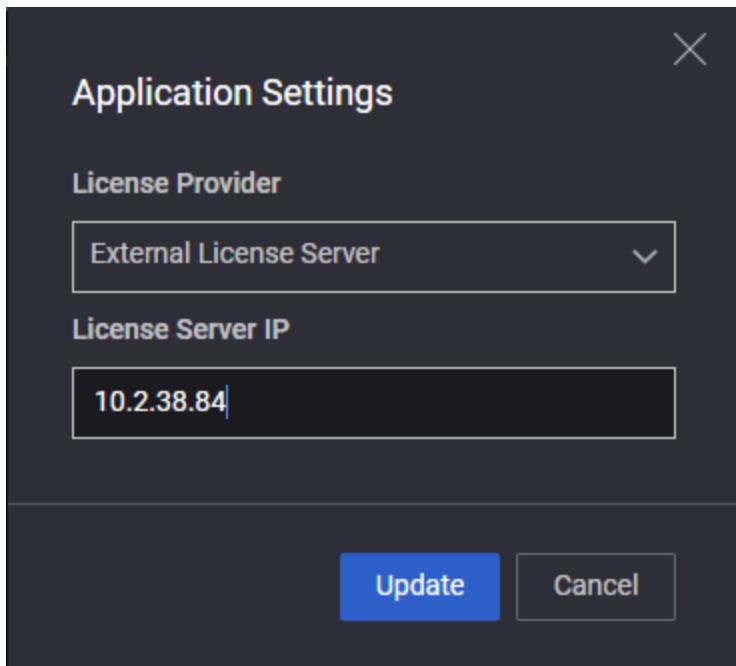
- from the **Project > Compute > Instances** section, go to the allocated image and, from the drop-down menu at the end of the row select **Associate Floating IP**.



- in the **Manage Floating IP Association** dialog, select an *IP address* from the drop-down list, or create one by clicking the **+** button.
- click **Associate** to conclude this step.



- To finalize, go to the Middleware user interface, click on the **Settings** (⚙) button on the upper right corner, and select **Application Settings**. In the dialog, select **External License Server** and input the management IP (either internal or floating).



PCI Passthrough and CPU Pinning

PCI Passthrough and CPU pinning are used to obtain maximum performance out of the compute nodes' resources. These settings are recommended when simulating Application Traffic.

PCI Passthrough

- Find the PCI of the interface that will be used for passthrough, vendorID and product ID. To do so, connect via SSH to the compute node, and issue the following command:

```
lspci -nnn
cristi@sa-os-compute1:~$ lspci -nnn | grep Mellanox
d8:00.0 Ethernet controller [0200]: Mellanox Technologies MT27800 Family [ConnectX-5] [15b3:1017]
d8:00.1 Ethernet controller [0200]: Mellanox Technologies MT27800 Family [ConnectX-5] [15b3:1017]
cristi@sa-os-compute1:~$
```

- With the information obtained, go to `/etc/nova/nova.conf` file and in the `[pci]` section add the device address to the `passthrough_whitelist`. Alternatively:
 - specify multiple PCI devices using `vendor_id` and `product_id`
 - add a PCI alias.

For example:

```
vi /etc/nova/nova.conf
[pci]
alias = { "vendor_id": "15b3", "product_id": "1017", "device_type": "type-PF",
"name": "mlxcx5" passthrough_whitelist = [...,{ "vendor_id": "15b3", "product_
id": "1017"}] #OR passthrough_whitelist = {"address": "0000:d8:00.0"}
```

- Restart the compute service with the following command:

```
systemctl restart nova-compute.service
```

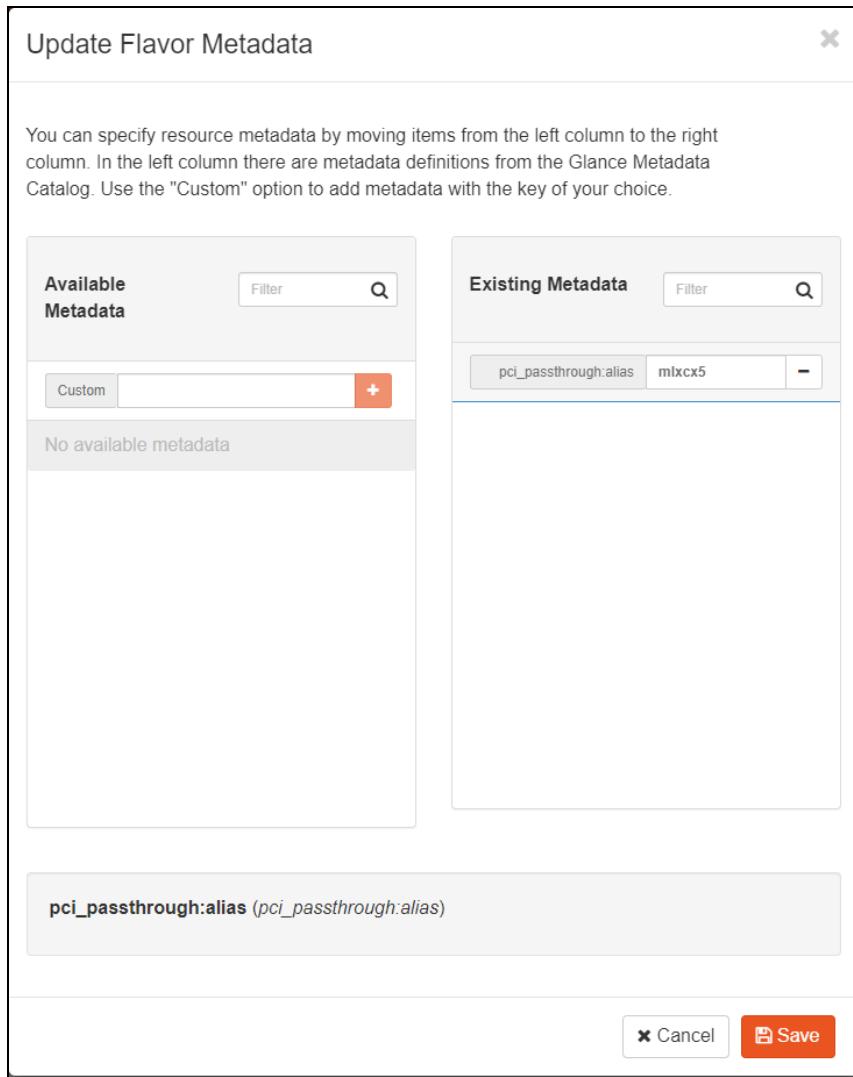
4. Connect via SSH to the controller node, and configure the same alias in the same file, under [pci]:

```
vi /etc/nova/nova.conf
[pci]
alias = { "vendor_id": "15b3", "product_id": "1017", "device_type": "type-PF",
"name": "mlxcx5" }
```

5. Restart the nova-api.service on the controller:

```
systemctl restart nova-api.service
```

6. In OpenStack, add the following metadata (property) to an existing flavor: go to the **Flavors** screen, click **Update Metadata**, and use `pci_passthrough:alias` and the alias from the earlier step:



By using a flavor that is configured with direct PCI passthrough, the deployed instance will automatically have a test interface with PCI-PT.

CPU Pinning

In case the application traffic will be simulated, it is recommended to disable hyperthreading and enable CPU pinning on the agents:

1. Add the following metadata to the flavor, which means that the VM will have the hyperthreading disabled (thread policy), and that it will take the specified number of CPUs from one NUMA node.

Available Metadata	Existing Metadata
<input type="button" value="Custom"/> +	hw:numa_nodes 1
	hw_cpu_policy dedicated
	hw_cpu_thread_policy isolate

Click each item to get its description here.

IMPORTANT

Make sure that the number of CPUs set on the flavor is smaller than the number of CPUs in a NUMA node. This information can be verified via SSH connect to the compute node, issuing the `lscpu` command.

Note that, for optimal performance when simulating application traffic, the above metadata can also be combined with the [PCI Passthrough](#).

HEAT Templates

An alternative method to deploy a VM is by using a Heat template. This requires installation of OpenStack Orchestration service, and download the LC templates, found at the following link: [oran-sim-ce/Openstack/Open RAN SIM CE 2.0/Heat Templates at main · Keysight/oran-sim-ce · GitHub](https://github.com/Keysight/oran-sim-ce/tree/main/Openstack/Open RAN SIM CE 2.0/Heat Templates at main · Keysight/oran-sim-ce · GitHub)

1. In OpenStack, go to **Project > Orchestration > Stacks** and select **+Launch Stack**:

2. In the **Select Template** dialog, make sure to select the appropriate Heat template for the instance you want to deploy. Click **Next** to continue.

Select Template

Template Source *

File

Description:

A template is used to automate the deployment of infrastructure, services, and applications.
Use one of the available template source options to specify the template to be used in creating this stack.

Template File

Choose File LoadCore_HeatTemplate_Agent2.yaml

Environment Source

File

Environment File

Choose File LoadCore_HeatTemp...bles_Agent2.yaml

Cancel Next

3. In **Launch Stack** dialog, select the parameters that will be used for the stack and instance

creation, such as network and VM name.

The screenshot shows the 'Launch Stack' dialog box. It includes fields for Stack Name (example), Creation Timeout (minutes) (60), Rollback On Failure (checked), Password for user "admin" (*****), Internal Management Network (Internal), Agent Flavor (LoadCoreAgent-nonAppTraffic), Agent Image Name (LoadCoreAgent-310), Agent VM Name (LCAgent3), and LoadCore Test Network (LC Test Network). At the bottom are 'Cancel' and 'Launch' buttons.

If the Orchestration menu is not present in the OpenStack UI, you can deploy with Heat templates from command line:

1. Upload the YAML files to the controller and then do a SSH connection.
2. Deploy the MW with a command such as:

```
openstack stack create -t LoadCore_HeatTemplate_MW1.yaml --parameter LoadCore_MW_Name=LC_MW --parameter "LoadCore_MW_Image_Name=LC MW 4.3.0-3965-681" --parameter "LoadCore_MW_Flavor=MW 4.2" --parameter Internal_Management_Network=Internal1_MWStack
```

3. Deploy the agent with a command such as:

```
openstack stack create -t LoadCore_HeatTemplate_Agent2.yaml --parameter LoadCore_Agent_Name=LC_Agent_1 --parameter "LoadCore_Agent_Image_Name=LC Agent 4.3.0.6" --parameter LoadCore_Agent_Flavor=flavor8cores32Gpinned --parameter Internal_Management_Network=Internal1 --parameter Test_Network=Test_AgentStack1
```

4. Check the existing stacks with:

```
openstack stack list
```

Appendix A Enable PCI Passthrough for KVM deployments

PASSTHROUGH MODE ON HOST LINUX

Add the host NIC directly (passthrough) to the VM machine using the following procedure:

- **On HOST machine:**

1. Enable passthrough for PCI devices on the **host** machine by adding `iommu=1` to the `/etc/default/grub` file on the `GRUB_CMDLINE_LINUX_DEFAULT` line:

```
GRUB_CMDLINE_LINUX_DEFAULT="quiet splash iommu=1 intel_iommu=on"
```

2. Update grub:

```
sudo update-grub
```

3. Reboot the host machine.

4. Map the host's CPU cores to the VM machines to match NUMA node0 CPU(s) assigned to the Network interface:
 - `lscpu` to get CPUs configuration (for example, NUMA node0 CPU(s): 0-17,36-53)
 - Map CPUs using the command:

```
virsh: for i in {0..15}; do sudo virsh vcpupin --config TL150 $i $i; done
```

In the example above TL150 is the VM name obtained with `virsh list -all`. The **VM Id** from the same list could be used instead of name.

Refer also to `virsh vcpupin --help`.

5. Ensure performance mode for each CPU (default could be **powersave** mode):

```
sudo echo performance >/sys/devices/system/cpu/cpu$i/cpufreq/scaling_governor
```

Or script for all targeted CPUs:

```
for i in {0..15}; sudo echo
performance>/sys/devices/system/cpu/cpu$i/cpufreq/scaling_governor ; done
```

6. Verify and modify the CPU speed:

```
/sys/devices/system/cpu/cpu0/cpufreq/cpuinfo_cur_freq
/sys/devices/system/cpu/cpu0/cpufreq/scaling_max_freq
```

NOTE

For **virsh** commands refer to
https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux/5/html/virtualization/ch33s08.

- **On VM:**

1. On the VM add a new hardware PCI selecting the PCI address of targeted host network interface (find it using `ethtool -i interface_name` on host machine). The VM will see directly that Interface NIC (see the same MAC on VM). In the same time the host machine will lose that network interface (not seen any more on `ip -a addr`).
2. Depending on the Network Interface Type (Intel, Mellanox, VMWare -vmxnet3 driver) and the number of cores configured on the agent you will need to configure the values for RAM and the huge pages number. The **minimum** requirements for these values can be

calculated using this online calculator: <https://loadcore.htmlsave.net/>. You can add an extra 500MB-1GB to the minimum RAM value.

To configure huge pages number on the agent use the following steps:

- a. `sudo nano /boot/grub/grub.cfg`
- b. `hugepagesz=2M hugepages=xyz ro quiet`

where the huge pages value is the one computed by the above calculator

- c. reboot the agent to enforce the changes

After following the above steps, the agent can now be used in Application Data scenarios..

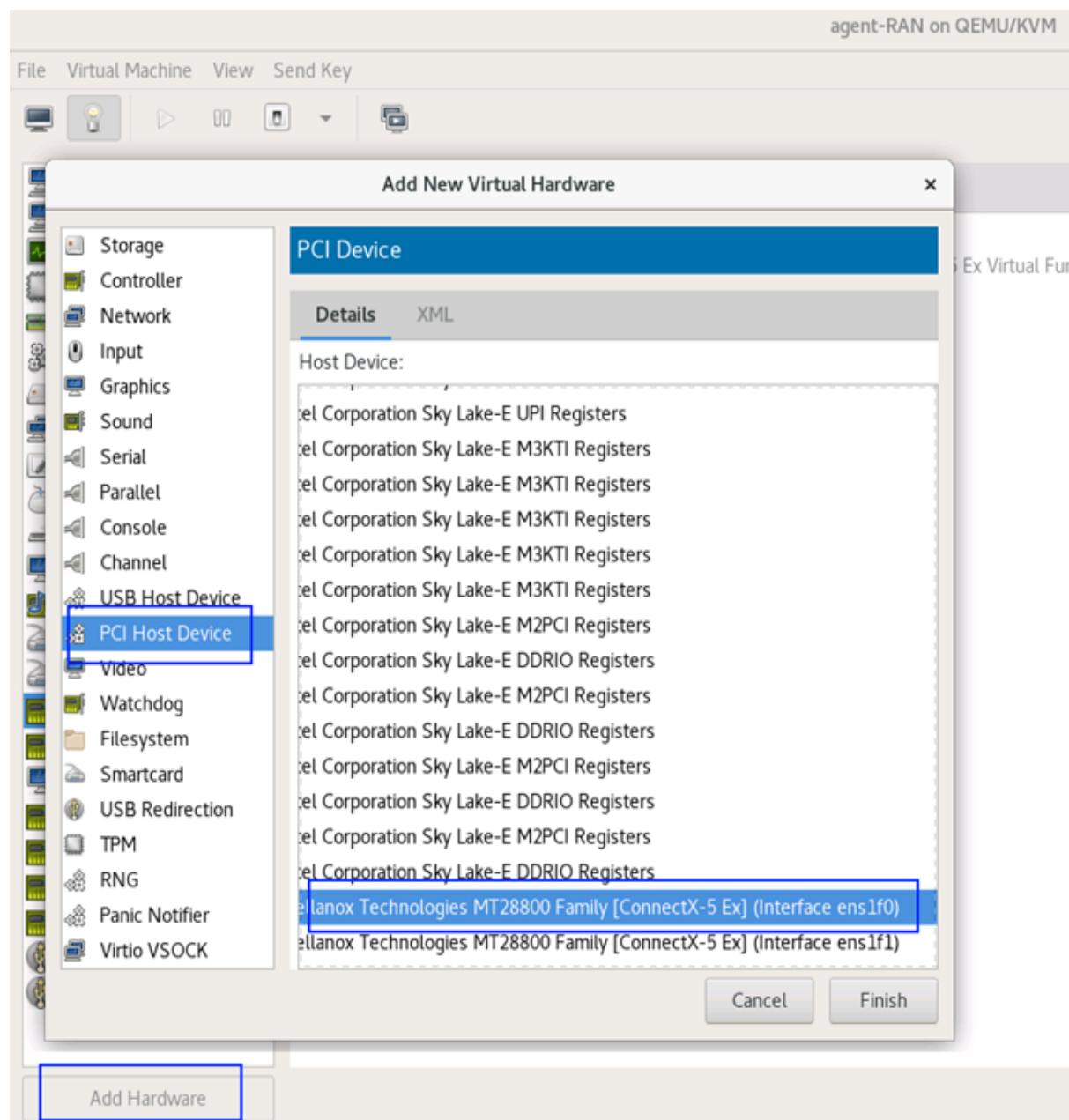
NOTE

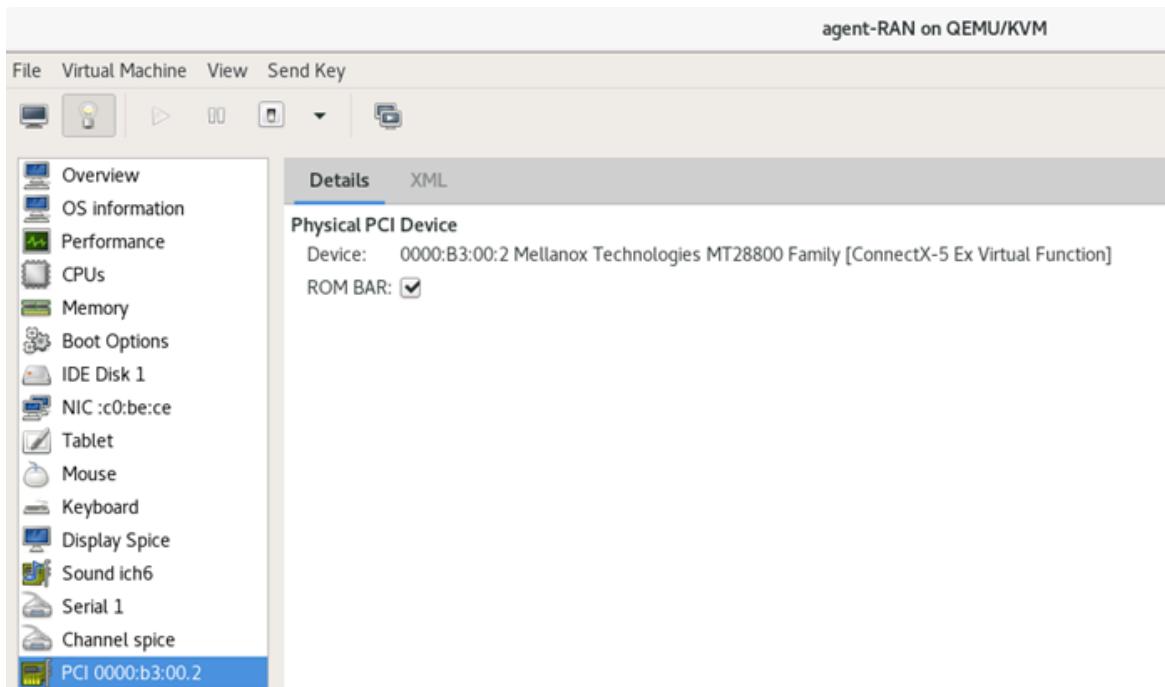
The maximum value for the huge pages number can be 8192. If the requirements surpasses this value, we recommend increasing the number of agents.

KVM VM PASSTHROUGH MODE

Dedicated physical Network Interface using Passthrough Source mode for selected physical interface.

First a **PCI Host Device** must be added and after that the corresponding **Device** (corresponding to that NIC). In this way the interface will have the NIC's driver.





To passthrough a PCI network card from the hypervisor CLI to the agent VM, first do the next command, which will show all the network cards, and their PCI information:

```
lshw -c network -businfo
```

Centos 2

```
[root@dhcp-10-38-154-175 ~]# lshw -c network -businfo
  Bus info          Device      Class      Description
  ======          ======      ======      ======
pci@0000:18:00.0  eno1        network    Intel XL710 for 40GbE QSFP+
pci@0000:18:00.1  eno2        network    Intel XL710 for 40GbE QSFP+
pci@0000:18:00.2  eno3        network    Intel XL710 for 40GbE QSFP+
pci@0000:18:00.3  eno4        network    Intel XL710 for 40GbE QSFP+
pci@0000:3c:00.0  enp60s0f0   network    Intel XL710 for 40GbE QSFP+
pci@0000:3c:00.1  enp60s0f1   network    Intel XL710 for 40GbE QSFP+
pci@0000:5e:00.0  enp94s0f0   network    Intel XL710 for 10GbE SFP+
pci@0000:5e:00.1  enp94s0f1   network    Intel XL710 for 10GbE SFP+
pci@0000:af:00.0  enp175s0f0  network    Intel XL710 for 10GbE SFP+
pci@0000:af:00.1  enp175s0f1  network    Intel XL710 for 10GbE SFP+
pci@0000:d8:00.0  enp216s0f0  network    Intel XL710 for 40GbE QSFP+
pci@0000:d8:00.1  enp216s0f1  network    Intel XL710 for 40GbE QSFP+
virbr0-nic        network    Ethernet interface
virbr0            network    Ethernet interface
virbr0            network    Ethernet interface
bridge1           network    Ethernet interface
bridge2           network    Ethernet interface
bridge0           network    Ethernet interface
virbr0            network    Ethernet interface
```

From this output choose the card that you want, for example device *enp60s0f1*, which is *Intel XL710* port and add it to the agent:

```
virsh attach-device LC_Agent pci_0000_3c_00_1.xml
```

The *.xml* of the PCI can also be checked with :

```
virsh nodedev-dumpxml pci_0000_3c_00_1
```

Alternatively, you can also edit the *.xml* file of the VM:

```
virsh edit LC_Agent
```

Add the lines in the `<devices>` section:

```
<hostdev mode='subsystem' type='pci' managed='yes'>
<source>
  <address domain='0x000' bus='0x3c' slot='0x00' function='0x1' />
</source>
</hostdev>
```

Appendix B Deploying Open RAN SIM CE with static IP Addresses

Middleware

After the Middleware VM has been installed (the normal procedure installation for ESXi or KVM) you can log on the VM console for the deployed machine (for example, the console from ESXi hypervisor).

You need to log in with console credentials. Logging in with console means log in as **console** first (no password required) and then log in as **admin** with password **admin** (all lowercase letters). This will give you access to a predefined menu from where you can configure the networking settings.

The IP address can be set with the command `kcos networking ip set` like in the following example:

```
kcos networking ip set ens32 10.38.50.100/24 10.38.50.1
```

`ens32` can be replaced with the interface you want to use for the management, `10.38.50.100/24` is the IP and subnet of the Middleware and `10.38.50.1` is the gateway's IP.

NOTE The gateway is mandatory and IPv6 can also be used.

NTP is highly recommended to be configured in static IP environments. The default NTP for Middleware is `ntp.ubuntu.com`. If you are using a local or another NTP server it is best to change it with `kcos date-time ntp-servers set` (it should also be the same as the one set in ESX), for example:

```
kcos date-time ntp-servers set 10.38.50.50
```

The `kcos` commands also allow the configuration of other settings, including DNS, and has good help menu, with examples, that can be found with `-h` parameter (at the end of the command).

IMPORTANT Do not assign IP addresses from `10.32.0.XXX` range as it is used by the internal cluster and will create conflicts.

Agents

After the agent VM has been installed (the normal procedure for ESXi or KVM) you can log on the VM console for the deployed machine (for example, the console from ESXi hypervisor) with username **ixia** and password **ixia** (all lowercase letters).

The IP can be changed by modifying the `netplan`:

```
sudo nano /etc/netplan/network.yaml
```

By default, it will display the following:

```
GNU nano 2.9.3                               /etc/netplan/network.yaml

# Run 'sudo netplan apply' to apply changes.

network:
  version: 2
  renderer: networkd
  ethernets:
    management-e1000:
      match:
        driver: e1000
      dhcp4: yes
      dhcp6: yes
      dhcp-identifier: mac
      #addresses: [192.168.1.2/24]
      #gateway4: 192.168.1.1
      #nameservers:
      #  # addresses: [1.1.1.1, 8.8.8.8]
    management-e1000e:
      match:
        driver: e1000e
      dhcp4: yes
      dhcp6: yes
      dhcp-identifier: mac
      #addresses: [192.168.1.2/24]
      #gateway4: 192.168.1.1
      #nameservers:
      #  # addresses: [1.1.1.1, 8.8.8.8]
    ens160:
      #dhcp4: yes
      #dhcp6: yes
      #dhcp-identifier: mac
      #addresses: [172.16.1.1/16]
      #gateway4: 172.16.0.1

^G Get Help   ^O Write Out   ^W Where Is   ^X Cut Text   ^J Justify   ^C Cur Pos   M-U Undo   M-A Mark Text   M-J To Bracket   ^B Back
^X Exit   ^R Read File   ^\ Replace   ^U Uncut Text   ^T To Spell   ^G Go To Line   M-E Redo   M-6 Copy Text   M-W WhereIs Next   ^F Forward
```

DHCP must be disabled and an IP address and gateway must be assigned to the interface:

```
GNU nano 2.9.3                               /etc/netplan/network.yaml                               Modified

# Run 'sudo netplan apply' to apply changes.

network:
  version: 2
  renderer: networkd
  ethernets:
    management-e1000:
      match:
        driver: e1000
      dhcp4: no
      dhcp6: no
      dhcp-identifier: mac
      addresses: [10.38.50.101/24]
      gateway4: 10.38.50.1
      #nameservers:
      #  # addresses: [1.1.1.1, 8.8.8.8]
    management-e1000e:
      match:
        driver: e1000e
      dhcp4: no
      dhcp6: no
      dhcp-identifier: mac
      #addresses: [192.168.1.2/24]
      #gateway4: 192.168.1.1
      #nameservers:
      #  # addresses: [1.1.1.1, 8.8.8.8]
    ens160:
      #dhcp4: yes
      #dhcp6: yes
      #dhcp-identifier: mac
      #addresses: [172.16.1.1/16]
      #gateway4: 172.16.0.1

^G Get Help   ^O Write Out   ^W Where Is   ^X Cut Text   ^J Justify   ^C Cur Pos   M-U Undo   M-A Mark Text   M-J To Bracket   M-▲ Previous
^X Exit   ^R Read File   ^\ Replace   ^U Uncut Text   ^T To Spell   ^G Go To Line   M-E Redo   M-6 Copy Text   M-W WhereIs Next   M-▼ Next
```

After this, save the changes to the `.yaml` file and do:

```
sudo netplan apply
```

If you are unsure of the changes you can also do `sudo netplan try` (before `apply`) so it can be checked that the changes are valid before applying.

Now, you can do the script to bind the agent to the Middleware, same as in the normal deploy, with:

```
sudo ./agent-setup.sh
```

NOTE

Start the NTP service on the agents (usually done when `agent-setup.sh` is run) only after setting the clock/NTP server on the Middleware. Setting the clock on the Middleware after the ntp service started on the agents can lead to it panicking (agent side) on big adjustments on sync. Restarting the ntp agent side (`sudo systemctl restart ntp`) should fix this.

Appendix C Ports used in ORAN-SIM CE communication

The following are ports used by Open RAN SIM CE that need to be kept open in the network:

Port Number	Used for...
22	SSH service
80	connecting to the browser UI
123	NTP communication between MW and agents
443	ingress, for rest api commands/to connect to webserver
7443	communication between MW and license server
9022	SSH to connect as root
30422	NATS communication between MW and agents
31123	per-UE stats communication between MW and agents
32100	EULA (EULA can also be accepted through console)

Appendix D CPU Pinning

To make sure that CPU pinning is done correctly, first the number of NUMA nodes has to be checked. Also it is recommended to have hyperthreading disabled. This can be done with `lscpu`, and in the example below there are 2 NUMA nodes and 1 Thread per core (hyperthreading disabled).

It is best that all the CPUs that will be pinned on one VM belong to the same NUMA node. In the case above the 1st NUMA node has CPUs 0-19 and the 2nd NUMA node has CPUs 20-39.

IMPORTANT Host aggregates should be used to separate pinned instances from unpinned instances as the latter will not respect the resourcing requirements of the former. This means that, for maximum performance and vCPU separation, all VMs will have CPU pinning, including MW, license server, etc.

Once it has been established which CPUs will be assigned to the VM, it can be done with the `virsh vcpupin` command. In the example below a `for` loop has been used to assign the first 8 CPUs:

```
for i in {0..7}; do virsh vcpupin --config LC_Agent $i $i; done
```

After this has been done it can be checked from the XML of the VM, and it will look like:

```
<vcpu placement='static'>8</vcpu>
<cputune>
  <vcpuin vcpu='0' cpuset='0' />
  <vcpuin vcpu='1' cpuset='1' />
  <vcpuin vcpu='2' cpuset='2' />
  <vcpuin vcpu='3' cpuset='3' />
  <vcpuin vcpu='4' cpuset='4' />
  <vcpuin vcpu='5' cpuset='5' />
  <vcpuin vcpu='6' cpuset='6' />
  <vcpuin vcpu='7' cpuset='7' />
</cputune>
```

On the 2nd agent the next 8 CPUs can be assigned, as follows:

```
for i in {8..15}; do virsh vcpupin --config LC_Agent_2 $((i - 8)) $i; done
```

And it will look like:

```
<vcpu placement='static'>8</vcpu>
<cputune>
<vcpuin vcpu='0' cpuset='8'/>
<vcpuin vcpu='1' cpuset='9'/>
<vcpuin vcpu='2' cpuset='10'/>
<vcpuin vcpu='3' cpuset='11'/>
<vcpuin vcpu='4' cpuset='12'/>
<vcpuin vcpu='5' cpuset='13'/>
<vcpuin vcpu='6' cpuset='14'/>
<vcpuin vcpu='7' cpuset='15'/>
</cputune>
```

The XML can also be changed directly.

To revert the CPUs that were pinned to a certain VM, either delete the lines from the XML file, or simply assign access to all the CPUs, in this case 0-39:

```
for i in {0..7}; do virsh vcpuin --config LC_Agent $i 0-39; done
```

Appendix E Configure SRI-OV with Network Manager

- After you have chosen an appropriate interface to use for single-root input/output virtualization (SRI-OV), you can configure the number of VFs that will be created from it (in this case four of them):

```
sudo nmcli con modify ens1f0np0 sriov.total-vfs 4 sriov.autoprobe-drivers true
```

- Modify the the VFs and add a different MAC address to each:

```
sudo nmcli con modify ens1f1np1 sriov.vfs '0 mac=01:64:02:00:05:01 trust=true, 1
mac=01:64:02:01:06:02 trust=true, 2 mac=01:64:02:02:07:03 trust=true, 3
mac=01:64:02:03:08:04 trust=true'
```

- Do a reboot.

- To check that the setting has taken effect, use the following command:

```
sudo nmcli con show ens1f0np0 | grep -i sriov
```

- The output should look as follows:

```
sriov.total-vfs: 4
sriov.vfs: 0 mac=01:64:02:00:05:01 trust=true, 1 mac=01:64:02:01:06:02 trust=true, 2
mac=01:64:02:02:07:03 trust=true, 3 mac=01:64:02:03:08:04 trust=true
sriov.autoprobe-drivers: 1 (true)
```

- Check if the VFs appear and their PCI number using the following command:

```
sudo lshw -c network -businfo
```

You should now be able to use passthrough and assign the VFs to the agent VMs.

NOTE

It is possible to experience the VFs to appear fluctuating in the output of the nmcli connection. This occurs because the VFs do not have an IP connection (DHCP is enabled by default) or because the port on which they are created does not have a physical connection yet. This situation can be ignored since it is only important to use the VFs with PCI passthrough on the VMs, and assign the IPs during a test.

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CHAPTER 3**ORAN-SIM CE Deployment on Containers**

This section contains the following topics:

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Amazon AWS EKS Deployment

This section describes the steps need for ORAN-SIM CE deployment in AWS EKS.

The deployment procedure requires a ORAN-SIM CE tool named `loadcore-kube-setup` to upload the images and install the product.

How to get an authentication token to be able to push the images into ECR

In order to push the images into the Registry, you will need a token. This procedure uses the AWS account provided by Keysight to authenticate on AWS by using the `aws cli` tool.

To install the `aws cli` tool, please refer to

<https://docs.aws.amazon.com/cli/latest/userguide/getting-started-install.html>.

To log into AWS using `aws cli`, please refer to the [Use SSO to connect AWS CLI to your account](#) section.

After the authentication is successful, you can use the following command to get the authentication token:

```
aws ecr get-login-password --region us-east-1
```

AWS Docs:

- <https://docs.aws.amazon.com/AmazonECR/latest/userguide/getting-started-cli.html>
- <https://docs.aws.amazon.com/cli/latest/userguide/cli-configure-sso.html>
- <https://docs.aws.amazon.com/cli/latest/userguide/cli-configure-quickstart.html>

How to push ORAN-SIM CE container images into AWS EKS

This step can be done from a Linux machine.

Before pushing the images, you need to create a repository for each ORAN-SIM CE image. There is no support for this in `loadcore-kube-setup` tool until now, so it needs to be done manually by using a bash command.

https://docs.amazonaws.cn/en_us/AmazonECR/latest/userguide/repository-create.html

<https://awscli.amazonaws.com/v2/documentation/api/latest/reference/ecr/create-repository.html>

After creating all the repositories, we can use the `loadcore-kube-setup` tool to upload the images.

Download the ORAN-SIM CE k8s build and extract it.

Modify the `load-core.yaml` file as follows:

```
privateRegistry:
  name: <the-name-of-ECR-registry>
  storePrivateImages: true
  auth:
    user: AWS
    password: <the-token-from-step-1>
```

After modifying the `load-core.yaml` file, you can upload the images by using the following command:

```
./loadcore-kube-setup upload-images
```

How to install ORAN-SIM CE Middleware in EKS

In case the EKS cluster exists, you will need to have the `kubeconfig` file on the same machine where you are running `loadcore-kube-setup` tool because it will use it to create all the resources needed by ORAN-SIM CE.

In case you do not have any cluster created, you can use the following links:

- <https://docs.aws.amazon.com/eks/latest/userguide/create-cluster.html>
- <https://docs.aws.amazon.com/eks/latest/userguide/create-managed-node-group.html>

The requirements for the EKS cluster workers are as follows:

- they need use Ubuntu as operating system because the SCTP module is not available on Amazon images.
- the instance type should have at least 8 vCPUs and 32 GB RAM.

To create the `kubeconfig` file, please refer to

<https://docs.aws.amazon.com/eks/latest/userguide/create-kubeconfig.html>.

After generating the `kubeconfig` file, make sure to add the path to it into `load-core.yaml` file on `kubeConfigPath` attribute. The default path is `~/.kube/config`.

Before installing the ORAN-SIM CE Middleware, make sure that you have access to the EKS cluster by using any `kubectl` command: `kubectl get nodes` or `kubectl get pods -A`.

You will need to modify the storage class inside the `load-core.yaml` file (in this case `gp2`).

```
storage:
  class: gp2
```

The environment attribute inside `load-core.yaml` file should be set to: `environment: onPremise` .

After verifying the access to the EKS cluster, use the following command to install the Middleware:

```
./loadcore-kube-setup install-mw
```

NOTE The installation will take at least 10 minutes depending on workers instance type.

Use the following command to get the public IP address of the ORAN-SIM CE UI:

```
kubectl get svc -n kcos-framework kcos-ingress-v1-ingress-nginx-controller -o json | jq '.status.loadBalancer.ingress[0].ip'
```

or

`kubectl get svc -A` and search on External IP column

How to install ORAN-SIM CE Agents on EKS

To run tests in ORAN-SIM CE , the Agents use `multus` CNI for separating the management traffic from test traffic.

The `multus` CNI needs to be installed on the EKS cluster before deploying the ORAN-SIM CE Agents:

- Install `multus` CNI using the following command:

```
kubectl apply -f https://raw.githubusercontent.com/amazon-vpc-cni-k8s/master/config/multus/v3.7.2-eksbuild.1/aws-k8s-multus.yaml
```

- Check the multus installation by using the command:

```
kubectl get pods -n kube-system
```

Each node should have one pod called `kube-multus-ds`.

Some changes need to be done in the `load-core.yaml` file regarding the additional testing interface for the agents. You can use the following config example. The master attribute from below can vary on each environment. This is the name of the worker interface. The type attribute can be `ipvlan` or `macvlan`.

```
config: |
  {
    "cniVersion": "0.3.1",
    "type": "ipvlan",
    "master": "ens7",
```

```

    "mode": "12",
    "ipam": {
      "type": "host-local",
      "subnet": "10.0.100.0/24",
      "rangeStart": "10.0.100.205",
      "rangeEnd": "10.0.100.215"
    }
}

```

Multus CNI examples:

- <https://github.com/k8snetworkplumbingwg/multus-cni/tree/master/examples>.

In case you need multiple agents, you can play with the replica attribute from the file (`replicas: 1`).

After changing the configuration, you can use the following command to install the agents:

```
./loadcore-kube-setup install-agent
```

Using the default configuration, the tests will work only if the agents are deployed on the same worker.

In case you need a more complex scenario, AWS released a guide on how to use `multus` in EKS:

- <https://aws.amazon.com/blogs/containers/amazon-eks-now-supports-multus-cni/>

How to uninstall ORAN-SIM CE components

To uninstall agents:

```
./loadcore-kube-setup uninstall-agent
```

To uninstall Middleware:

```
./loadcore-kube-setup uninstall-mw
```

OpenShift Deployment

The configuration required to set up a ORAN-SIM CE Agent in OpenShift:

1. After connecting to the proxy, export the `KUBECONFIG` env var:

```
%> export KUBECONFIG=~/ocp-install/auth/kubeconfig
```

For this environment, it was added to the `.bashrc` file.

2. Login user the `kubeadmin` user:

```
%> oc login -u kubeadmin -p BGwxz-k9GNo-hYoED-Tqp6z https://api.lab.ocp.lan:6443
```

3. Make sure that SCTP is enabled on the workers. For this, execute:

```
%> oc create -f load-sctp-module.yaml
```

More details about this topic here:

<https://docs.openshift.com/containerplatform/4.5/networking/using-sctp.html>

4. Create an OpenShift project named `loadcore-root`. The command used is:

```
%> oc new-project loadcore-root --description="LoadCore project" --display-name="loadcore-root"
```

5. Configure OpenShift to allow running containers under root and gave full privileges to the containers:

```
%> oc adm policy add-scc-to-user anyuid -z default -n `oc project -q` --as=system:admin
%> oc adm policy add-scc-to-user privileged -z default -n `oc project -q` --as=system:admin
```

6. Next, add a default route to the internal image registry and get the registry path into the REGISTRY variable:

```
%> oc patch configs.imageregistry.operator.openshift.io/cluster --patch '{"spec": {"defaultRoute":true}}' --type=merge
%> oc adm policy add-scc-to-user privileged -z default -n `oc project -q` --as=system:admin
%> echo $REGISTRY
default-route-openshift-image-registry.apps.lab.ocp.lan
```

7. Log in to the internal image registry using podman:

```
%> podman login --tls-verify=false -u unused -p $(oc whoami -t) ${REGISTRY}
```

8. Load the ORAN-SIM CE agent image using podman:

```
%> podman load -i LoadCore-Agent-Docker-0.1-15f7cb3ba-20201202T161108Z.tar.gz
```

9. See the loaded image:

```
%> podman images
...
localhost/loadcore-agent 0.1-15f7cb3ba ca0aa01b2c11 6 days ago 608 MB
```

10. Tag the ORAN-SIM CE image using the same image ID returned by podman images:

```
%> podman tag ca0aa01b2c11 ${REGISTRY}/loadcore-root/loadcore-agent:0.1-15f7cb3ba
```

11. Push the ORAN-SIM CE image to the internal image registry:

```
%> podman push --tls-verify=false ${REGISTRY}/loadcore-root/loadcore-agent:0.1-15f7cb3ba
```

12. Now, configure an extra interface to be used as test interface. Multus is already configured on OpenShift.

Here, a multus network named loadcore-root-network is added.

```
%> oc edit networks.operator.openshift.io cluster
```

Then, add the following:

```
spec:
  additionalNetworks:
    - name: loadcore-root-network
      namespace: loadcore-root
      type: Raw
      rawCNIConfig: '{"cniVersion": "0.3.1", "name": "ixia-network", "type": "bridge", "master": "eth0", "ipam": { "type": "whereabouts", "range": "192.168.1.0/24", "exclude": ["192.168.1.0/32", "192.168.1.1/32", "192.168.1.254/32"]}}'
```

13. Get the ORAN-SIM CE image tag inside the registry:

```
%> oc describe is loadcore-agent
```

Observe the image registry tag, it is something like this:

```
image-registry.openshift-image-registry.svc:5000/loadcore-root/loadcore-
agent@sha256:718cb38c0c4dd9d71e09a5b05d9edfe462f2ca3c5fe9b0c30e5a1e6f6d83d3fa
```

14. Edit the `loadcore-agent-deployment-loadcore-root.yaml` and specify the above image registry tag:

```
...
spec:
  containers:
    - name: loadcore-agent
      loadimage: YOUR-IMAGE-REGISTRY-TAG
...

```

Also, specify the IP address of your middleware in the container `args` section.

15. Apply the ORAN-SIM CE agent deployment:

```
%> oc apply -f loadcore-agent-deployment-loadcore-root.yaml
```

16. Take a look at the started ORAN-SIM CE pods:

```
%> oc get pods
```

17. Get a shell inside a ORAN-SIM CEagent pod:

```
%> oc exec -it loadcore-agent-65bdc89cf8-58sxt -- bash
```

18. Verify the IP interfaces:

```
%> ip a
```

You should see a `net1` interface, added by multus.

19. Get the list of running processes:

```
%> ps aux
```

Among other processes, you should see the `5GTestEngineService` (`lizard`) and the `portmanager` running.

Supported NICs in tests with IxStack over DPDK/Raw(TCP based traffic):

- Intel X710 10G
- Intel XXV710 25G
- Intel XL710 40G
- Intel E810 25G
- Intel E810 100G
- Mellanox ConnectX-4/5 25G
- Mellanox ConnectX-4/5 100G
- Mellanox ConnectX-6 Dx 100G

ORAN-SIM CE Deployment on k8s

The following procedure describes the steps needed in order to deploy ORAN-SIM CE on k8s:

1. Install `helm` and `helmfile` in `~` directory and make sure they have 755 permissions.
2. Make sure you have `multus` deployed.

In case you do not have it installed, use:

```
kubectl apply -f https://raw.githubusercontent.com/intel/multus-cni/master/deployments/multus-daemonset.yaml
```

NOTE

Alternatively, you can upload and install both the kubernetes cluster along with `multus` with the `kube-install.py` script; replace the user and the interface with the corresponding ones from the setup:

```
sudo python3 kubeinstall.py --setup-system --user=ixia --net-interface=ens3 --config=config.json
```

3. Create a folder for MW and copy the `.tar` file in that folder. (`.tar` file name is e.g: `LoadCore-MDW-3.0.0-3304-184-AGENT-3.0.0-640`).

- a. untar the `.tar` file:

```
tar -xvf LoadCore-MDW-3.0.0-3304-184-AGENT-3.0.0-640
```

- b. In that directory you will find a file named `load-core.yaml`. In that file you will find all the configurations you will need to add/modify in order to deploy ORAN-SIM CE.

NOTE

By default, `load-core.yaml` comes as a *LoadBalancer*. This means that your ORAN-SIM CE application will be reachable at port **443**. However, it can be easier to configure it as *NodePort*, and the application will be later accessible on port **30443**.

4. In case you have a private registry, after you added everything in `load-core.yaml`, you will need to push the images into the registry.

```
./loadcore-kube-setup upload-images
```

If you do not have a private registry, you will have to change the status (*true* to *false*) in `load-core.yaml`, `storePrivateImages` and `storePublicImages` as in the following example:

```
privateRegistry:
  name: <REGISTRY-URL>
  storePrivateImages: false
  storePublicImages: false
  auth:
    user: <REGISTRY-USER>
    password: <REGISTRY-PASSWORD>
  pullSecret:
    name: load-core-secret
    create: true
    pushTag: ""
```

5. In `load-core.yaml` you need to specify the storage class. If `kubeinstall.py` script was used, by default will be `local-path`:

```
persistence:
  storage:
    # It is mandatory to specify a storage class to be used by the volumes
    provisioner
```

```

# (for storing data in the cluster).
# Also, the size of the provisioned volumes can be tweaked.
class: local-path
volumesCapacity:
  testResults: 64Gi
  elasticsearch: 16Gi
  postgresql: 8Gi

```

You can also query it with the following command:

```
kubectl get storageclass -A
```

- In case there is no specific worker node to be used for licensing, the appropriate line can be uncommented in `load-core.yaml`:

```

# worker: <WORKER-NAME>
# Alternatively, the worker can be omitted and a random worker may be used.
useRandomWorker: true

```

- In order to install the MW, use the following command:

```
./loadcore-kube-setup install-mw
```

- Before deploying the agent, you need to use an appropriate interface. It is recommended to use one that is separate from management. Default is set to be the "whereabouts" type, but it can be changed to `ipvlan` as in the following example from `load-core.yaml` (replace interface and IPs as appropriate):

```

config: |
  {
    "cniVersion": "0.3.1",
    "type": "ipvlan",
    "master": "ens8",
    "mode": "l2",
    "ipam":
      {
        "type": "host-local",
        "subnet": "20.0.0.0/8",
        "rangeStart": "20.0.0.2",
        "rangeEnd": "20.255.255.254"
      }
  }

```

- To install the agent, use the following command:

```
./loadcore-kube-setup install-agent
```

NOTE

In `load-core.yaml` you will find a `replicas` parameter. By default is set to 2. This means two agents will be deployed. If you need more agents, you will need to change this value.

- In order to uninstall the agent, use the following command:

```
./loadcore-kube-setup uninstall-agent
```

11. In order to uninstall ORAN-SIM CE , use the following command:

```
./loadcore-kube-setup uninstall-mw
```

IMPORTANT

You need to first deploy the MW and after to deploy the agents. When uninstalling, first you need to uninstall the agent and, after that, uninstall the middleware.

NOTE

If you need to deploy ORAN-SIM CE on Google Anthos, change the environment value from `load-core.yaml` into **gke** (you do not need to use commas).

ORAN-SIM CE Deployment on GKE Anthos

The following procedure describes the steps needed in order to deploy ORAN-SIM CE on GKE Anthos:

1. Create an Anthos Sample Deployment cluster.
2. Go to **Kubernetes Engine** and select the Anthos cluster previously created. Go to **Networking** and enable **Network Policy**.
3. Connect to Cloud Shell and run:

```
gcloud services enable containerregistry.googleapis.com
```

In this case, `eu.gcr.io` container registry will be created. For more details, refer to:
<https://cloud.google.com/container-registry/docs/overview>

In `load-core.yaml`, which will appear after you do step 5, you have to type at `privateRegistry/name: {hostname}/{project-id}` as per <https://cloud.google.com/container-registry/docs/overview>.

After you push your first image to your `privateRegistry`, in Cloud Storage you will find your artifactory created where all your images will be held.

Steps to push an image:

- `docker pull hello-world`
- `docker tag hello-world:latest eu.gcr.io/{project-id}/hello-world:ABC`
- `docker push eu.gcr.io/{project-id}/hello-world:ABC`

4. Go to **Cloud Storage** and create a bucket where you will upload your ORAN-SIM CE `tar.gz` image.
5. Connect to Cloud Shell and download the ORAN-SIM CE `tar.gz` images as follows:
 - a. `cd /root`

We are going to root directory as this is the only one who has enough space. Be careful that after some time this directory is refreshed automatically.

- b. Download the ORAN-SIM CE image to `/root` directory using:

```
gsutil cp gs://{{bucket name}}/{{image name}}
```

For example:

```
gsutil cp gs://anthos-sample-bucket/LoadCore-MDW-3.0.0-3304-184-AGENT-3.0.0-640
```

- c. Untar ORAN-SIM CE images using:

```
tar -xvf LoadCore-xxx
```

- d. In the ~ directory, create a dir for your ORAN-SIM CE . In this case, a mw3.0 folder was created.

Move all the files excluding images.tar to your created folder.

- e. Generate a new key for your private registry with the following command (as per <https://cloud.google.com/iam/docs/creating-managing-service-account-keys#iam-service-account-keys-create-console>):

```
gcloud iam service-accounts keys create our_key --iam-account="your iam-account"
```

The information from the file our_key has to be copied into load-core.yaml at privateRegistry/auth/password.

In load-core.yaml you also have the kubeConfigPath. Change this path to your current .kube path.

- f. Upload the containers to your private registry:

- cd /root
- sudo ~/mw3.0/loadcore-kube-setup upload-images -c ~/mw3.0/load-core.yaml

6. Install helm and helmfile in ~directory and make sure they have 755 permissions.

7. Add your path to bashrc.

For example:

```
export PATH=/home/{}/mw3.0:$PATH
```

8. Go to **Kubernetes Engine** and select your cluster. Go to **Nodes** and create a new pool of nodes.

In this case, there were created 2 nodes, with Image Type = Ubuntu with Docker, series E2 and machine type = e2-standard-8.

9. Install the MW:

```
./loadcore-kube-setup install-mw
```

After the installation is completed, in order to find the ORAN-SIM CE IP (which will be the ingress ip) you have to:

```
kubectl get svc -A -o wide | grep kcos-framework-v1-ingress ->
```

Take the 2nd IP which is the External IP. This IP will be put in load-core.yaml at the management IP to which the agent will connect.

10. In order to find out the management interface and add it in the load-core.yaml, you have to go to **Compute Engine > VM Instances** and connect via SSH (there is a ssh button in the right of each node). If you take the output of ip a you will see that the management interface of each node is ens4. This means that in load-core.yaml, you will have to specify **ens4**.

11. Install the agent:

- a. Install multus :

```
kubectl apply -f "multus-for-gke.yaml"
```

- b. ./loadcore-kube-setup install-agent

NOTE

In load-core.yaml you will find a replicas parameter. By default is set to 2. This means 2 agents will be deployed. If you need more agents you will need to change this value.

12. Uninstall the agent:

```
./loadcore-kube-setup uninstall-agent
```

13. Uninstall the MW:

```
./loadcore-kube-setup uninstall-mw
```

IMPORTANT

You need to first deploy the MW and after to deploy the agents. When uninstalling, first you need to uninstall the agent and after that uninstall the middleware.

NOTE

For Anthos, the environment value from `load-core.yaml` has to be **gke** (without commas).

NOTE

To disable the container registry:

```
gcloud services disable containerregistry.googleapis.com --force
```

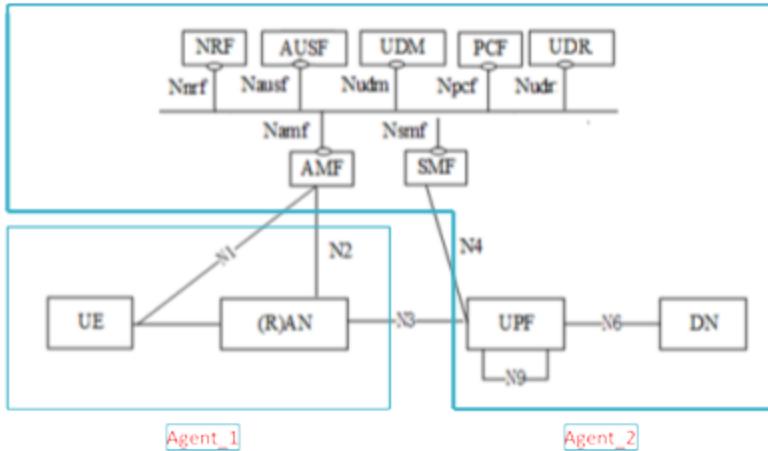
NOTE

Anthos cluster already has LoadBalancer installed. This means that you will need to set in `load-core.yaml` at type of the cluster **LoadBalancer**.

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CHAPTER 4**Test Case #1: gNB and 5G Core simulation in B2B scenario**

The purpose of this test is to emulate the entire 5G network, in a back-to-back topology. LoadCore will be used to simulate UEs and gNBs on one agent and the rest of 5G core elements will be simulated by the second agent. In a real environment, any of these agents can be replaced with a real DUT.



The topology involves two entities:

- One agent (located on VM machine agent_1), simulating the UEs and gNB
- One agent (located on VM machine agent_2), simulating the rest of 5G core elements (NRF, AUSF, UDM, PCF, UDR, AMF, SMF and DN)

A typical test will validate the following aspects on the network:

- Successful UE attach, create security context and PDN session establishment.
- Validate the core network is able to support huge number of UEs.
- Various types and volumes of traffic passing from UEs to DN.
- Extended QoS is assigned per UE, per flow, and per Uplink and Downlink directions.

Test Configuration

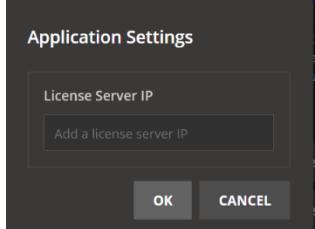
Two options are available for configuring the first LoadCore test:

- Load the Full Core topology from Repository and configure each network element with proper IP addresses, plus traffic flows. This is the option will be described below.
- Load a predefined test configuration that matches the current deployment.

License server configuration

To configure the license server:

1. Select the wheel icon on the top right corner of the Dashboard page. The general settings menu appears.
2. Select **Application settings**. The Application Settings window appears.
3. Add the IP address in the License Server IP field.

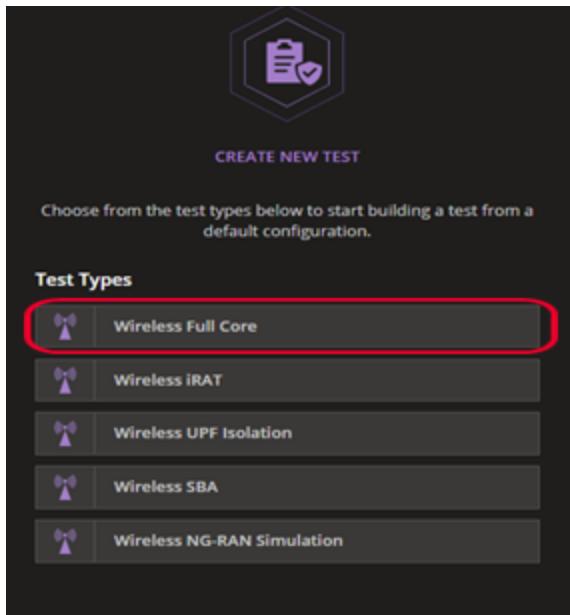


Is this setup the license server IP is: 10.73.53.17 (the IP address the license server got during the VM deployment).

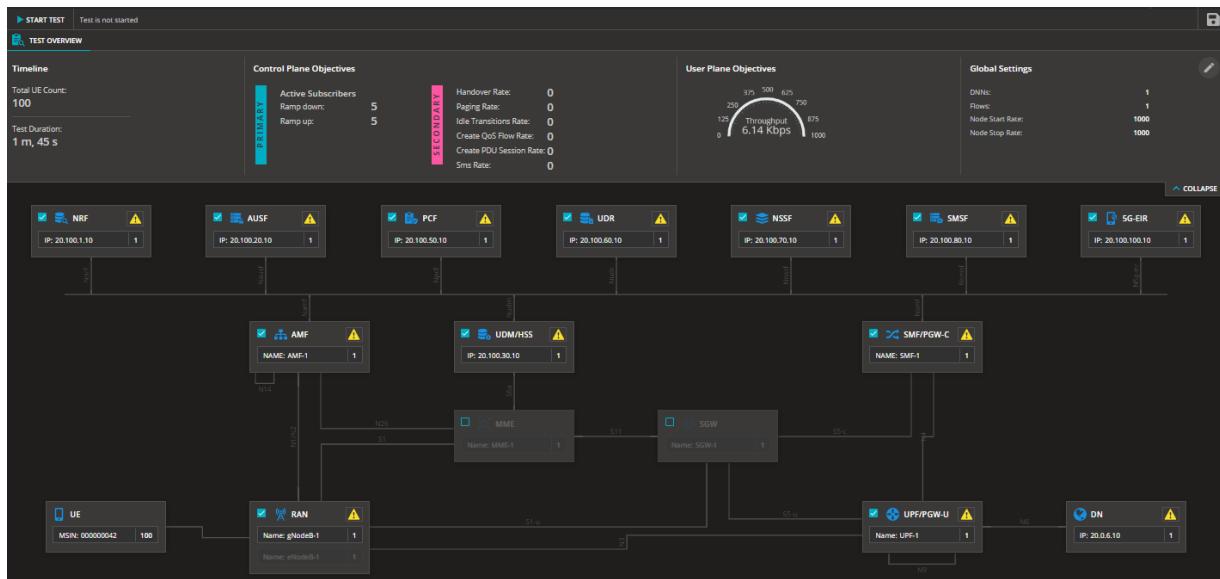
Configure the test from scratch

To configure the test using this method, do the following:

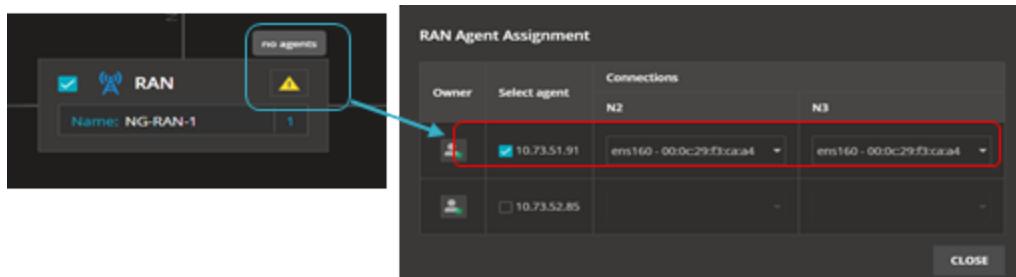
1. Connect to LoadCore UI using the IP that was assigned to Middleware (in this setup is 10.73.53.201)
2. On the Dashboard page, under the Create New Test section, select **Wireless Full Core**.



This creates a new session with Full Core topology, that is already configured with some parameters. The IP addresses assigned to the nodes must be changed in order to match the VM deployment.



- Select the yellow warning sign on the nodes and assign an agent to simulate it. In the drop-down list, there are the IP address of the agents that were previously defined:



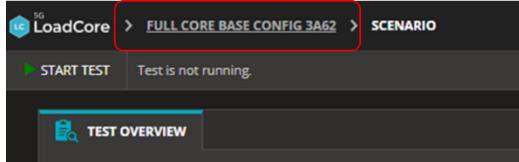
- Agent 1** has: 10.73.50.65 and will be assigned for emulating the gNB
- Agent 2** has: 10.73.48.241 and will be assigned to the rest of the nodes

This screenshot shows the 'AGENTS ASSIGNMENT' interface. On the left, a sidebar lists various network nodes. The 'RAN' node is selected and highlighted with a red box. In the main area, the 'RAN Agent Assignment' table shows one agent assigned to the RAN node. The agent listed is '10.73.50.65'.

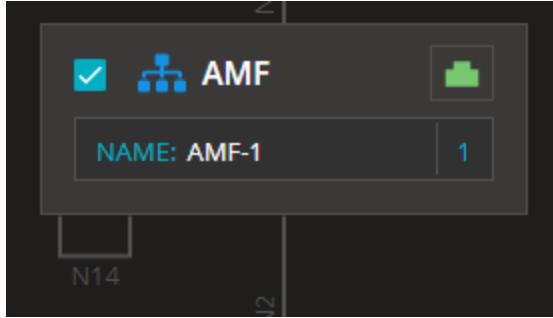
Owner	Select Agent	Tags	Connections								
RAN	<input checked="" type="checkbox"/> 10.73.50.65		<table border="1"> <tr> <td>N2</td> <td>N3</td> <td>Passthrough Device</td> <td>S1</td> </tr> <tr> <td>ens192 - 00:0c:29:c0:8b:74</td> <td>ens160 - 00:0c:29:c0:8b:6a</td> <td>None</td> <td>ens192 - 00:0c:29:c0:8b:74</td> </tr> </table>	N2	N3	Passthrough Device	S1	ens192 - 00:0c:29:c0:8b:74	ens160 - 00:0c:29:c0:8b:6a	None	ens192 - 00:0c:29:c0:8b:74
N2	N3	Passthrough Device	S1								
ens192 - 00:0c:29:c0:8b:74	ens160 - 00:0c:29:c0:8b:6a	None	ens192 - 00:0c:29:c0:8b:74								

IMPORTANT

There is no **Back** button implemented in this release. In order to go back to previous screen, you need to click on session name, as shown below.



At the end of this operation all nodes should have a green icon for the agents assignment.



You can see the complete agent assignment by using Network Management tab. This can be opened by selecting any green icon and, then, select the **Network Management** tab.

AGENTS ASSIGNMENT			NETWORK MANAGEMENT									
			Agents assigned to the selected node									
Order	Agent	Tags	Impairment Profile	Agent Interface		Network Stack		SRIoV	Traffic Capture	Entity		
1	10.73.50.65	IxStack ON (2) DPDK (2) build: 492 (2)	None	Name	MAC	Mixed	Linux Stack	Off	Off	RAN	NRF AUSF UDM/HSS	
				ens192	00:0c:29:c0:8b:74	Linux Stack	IxStack over DPDK	On	On	RAN	PCF UDR NSSF SMSF	
2	10.73.48.241	IxStack ON (2) DPDK (2) build: 492 (2)	None	ens192	00:0c:29:07:57:a7	Linux Stack	IxStack over DPDK	Off	Off	NRF AUSF UDM/HSS	5G-EIR AMF SMF/PGW-C	
				ens160	00:0c:29:07:57:9d	IxStack over DPDK	Linux Stack	On	On	UPF/PGW-U	UPF/PGW-U	

From here you can also enable traffic capture or configure different stacks to be used on a specific test interface (for example, application traffic can run only over IxStack Raw Sockets or IxStack over DPDK/Raw).

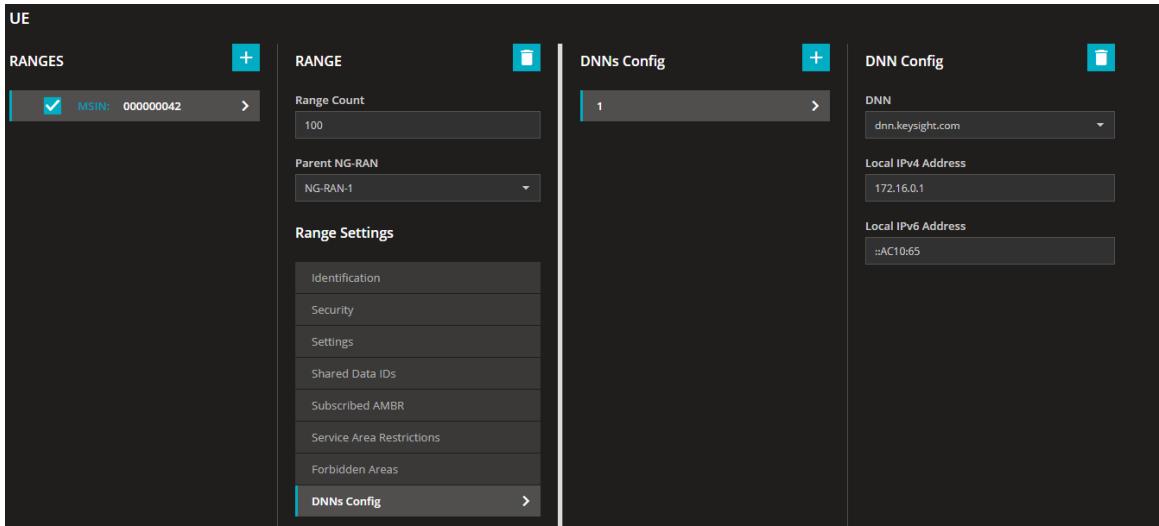
The default **Wireless Full Core** topology comes with predefined IP configuration. These parameters are listed below. You can run a basic test with this IP assignment. To do this, after assigning the agents, start the test.

When the test starts, the LoadCore application will configure these IP addresses on the deployed nodes (no need for manual configuration with `yaml` file, like in the previous LoadCore release).

The IP allocation is done as follows:

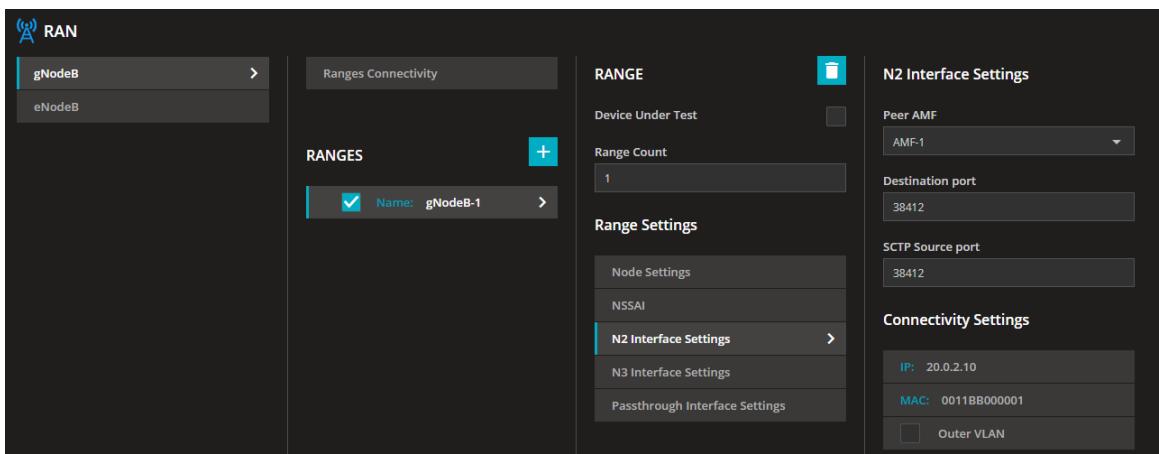
- **UE configuration**

- DNNs config: UE IP Address: **172.16.0.1**. The IP address is per DNN.



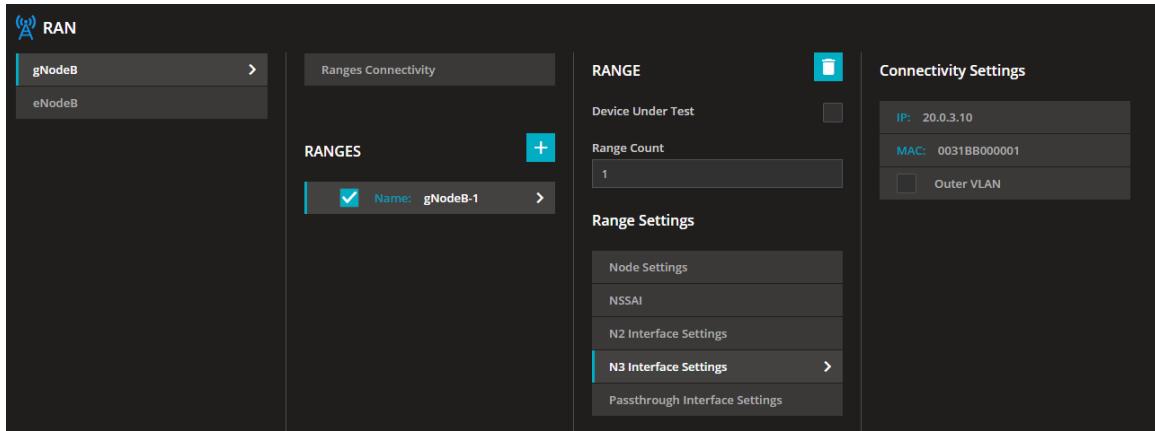
- **RAN configuration:**

- N2 Interface settings
 - IP address: **20.0.2.10**
 - Peer AMF: **AMF-1**



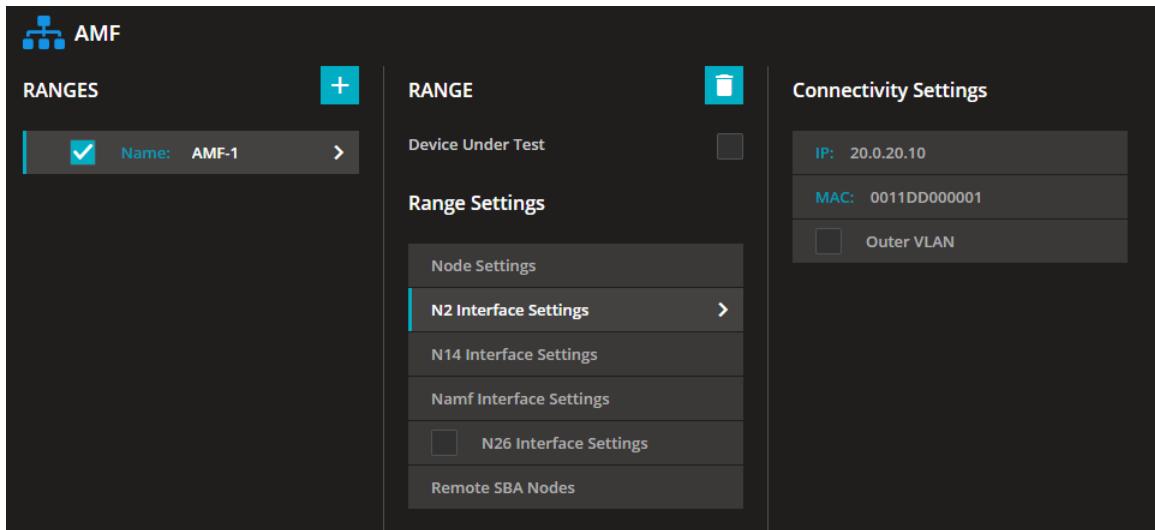
- N3 Interface settings:

- IP address: **20.0.3.10**

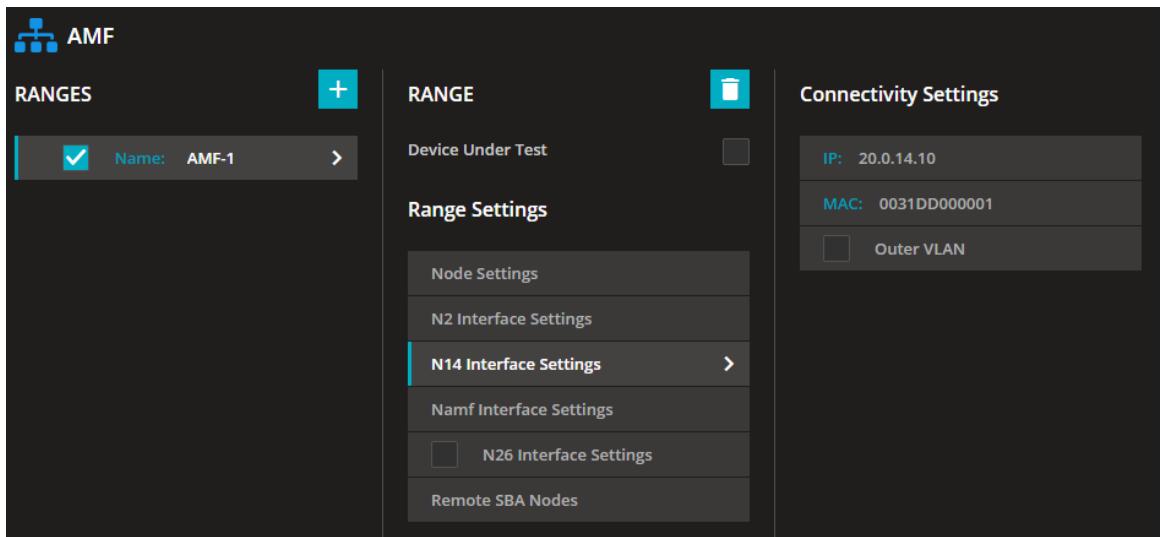


- **AMF configuration:**

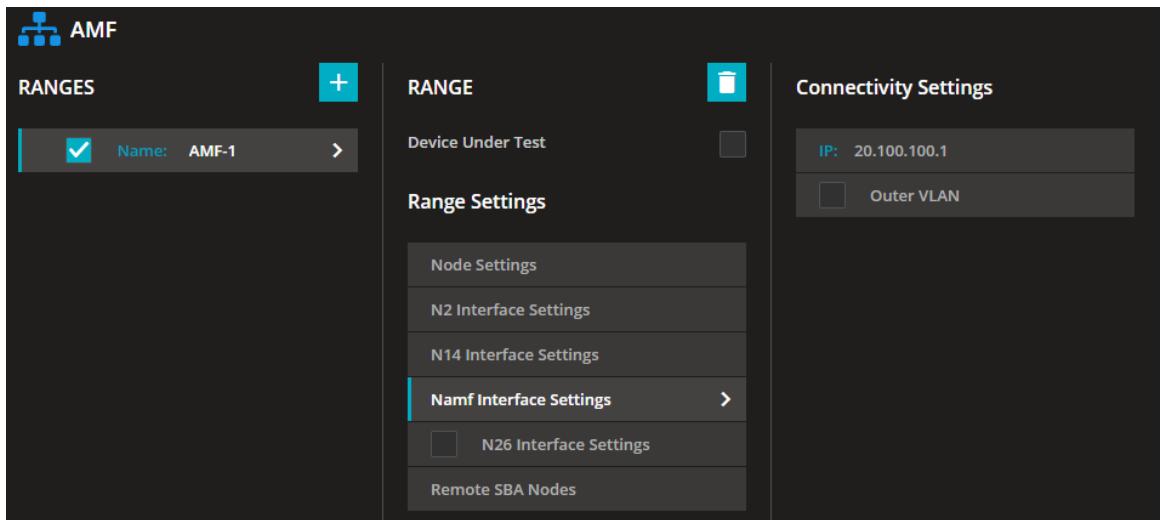
- N2 Interface settings
 - IP address: **20.0.20.10**



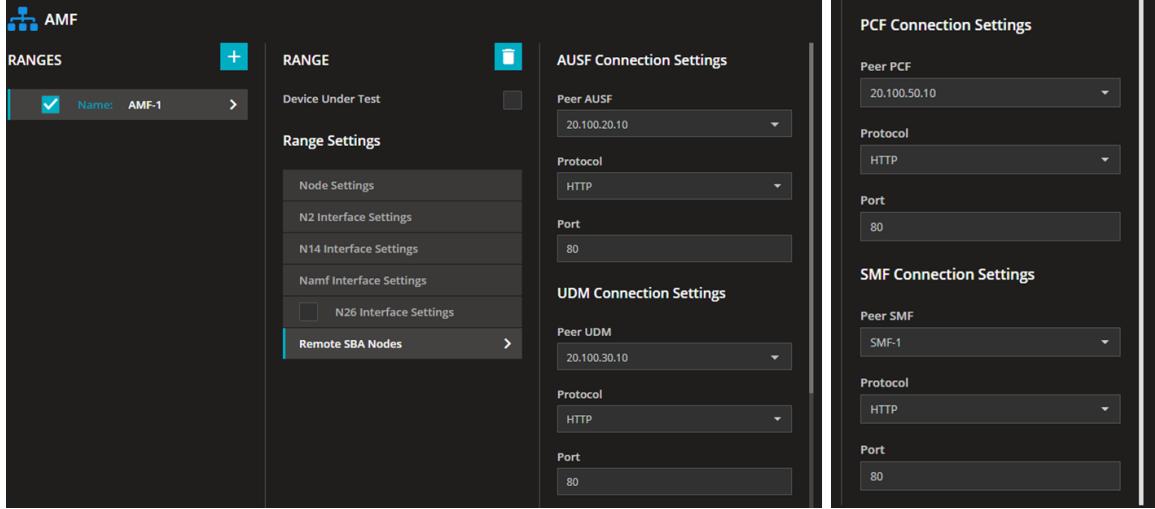
- N14 Interface settings
 - Local IP address: **20.0.14.10**



- Namf Interface settings
 - IP address: **20.100.100.1**

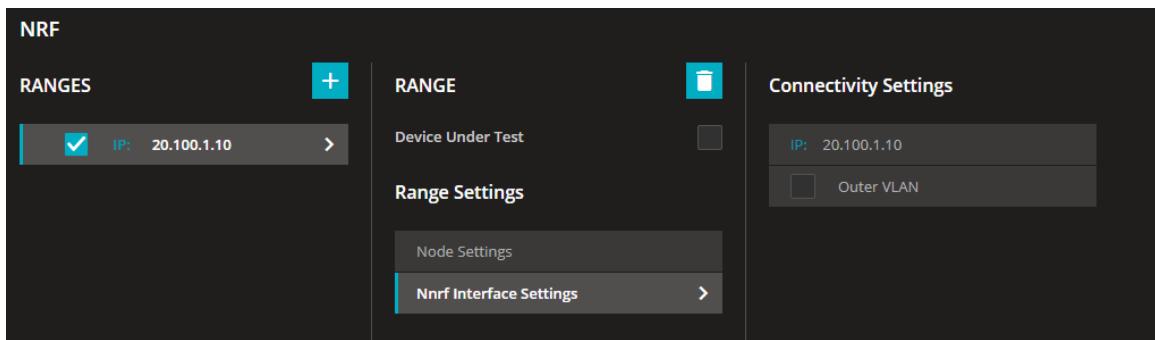


- Remote SBA nodes:
 - AUSF Connection Settings
 - IP address: **20.100.20.10**
 - UDM Connection Settings
 - IP address: **20.100.10.10**
 - PCF Connection Settings
 - IP address: **20.100.30.10**
 - SMF Connection Settings:
 - IP address: **SMF-1** (the IP address is automatically retrieved from the SMF configuration)



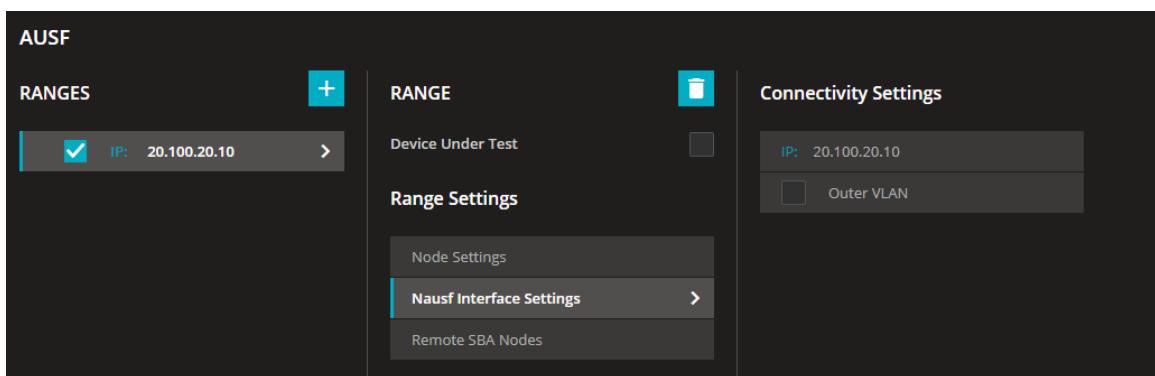
• NRF Configuration

- Nnrf Interface Settings
 - IP address: **20.100.1.10**



• AUSF Configuration

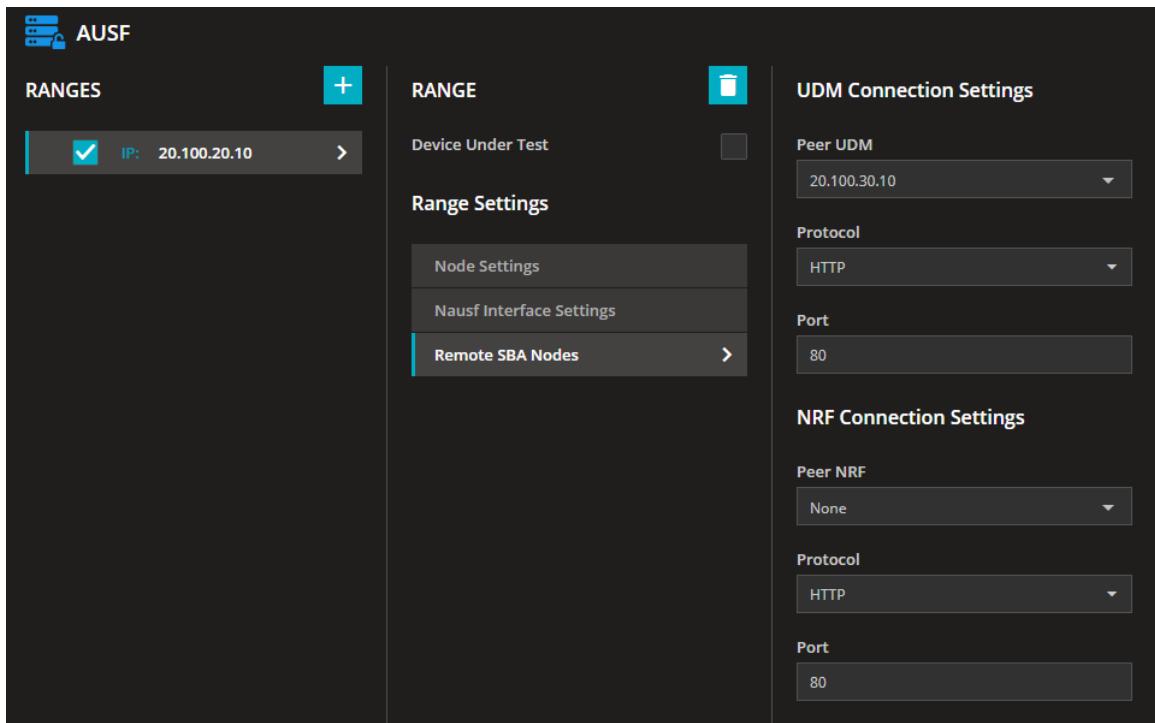
- Nausf Interface Settings
 - IP address: **20.100.20.10**



- Remote SBA Nodes:
 - UDM Connection Settings
 - IP address: **20.100.30.10**
 - Peer NRF: **None**

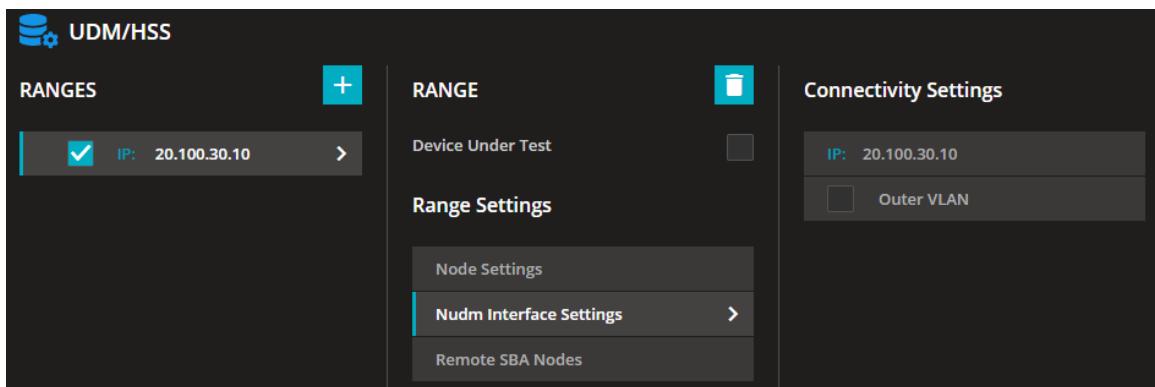
IMPORTANT

In all SBA nodes configuration, a Peer NRF set on **None** means the SBA nodes will not perform the registration process towards NRF. The tests will work because all nodes will know about each other from the IP addresses configured in LoadCore UI/



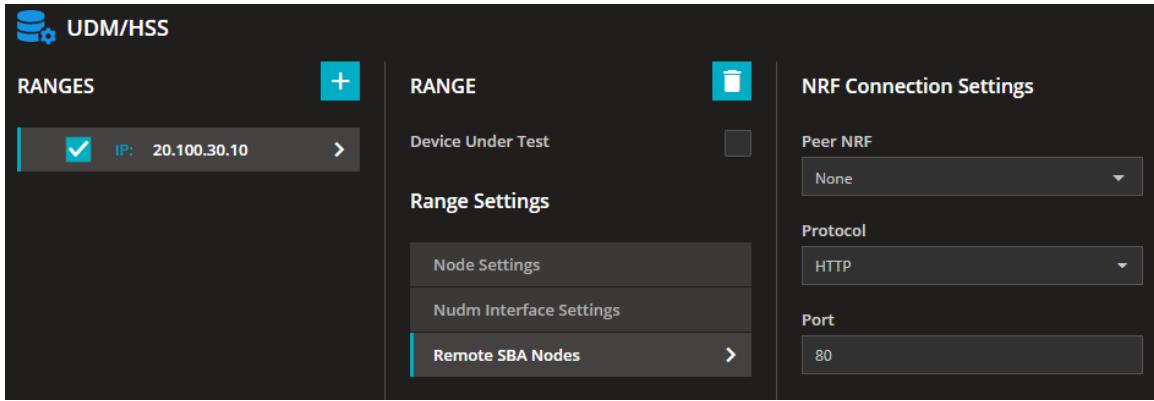
- **UDM/HSS Configuration**

- Nudm Interface Settings
 - IP address: **20.100.30.10**



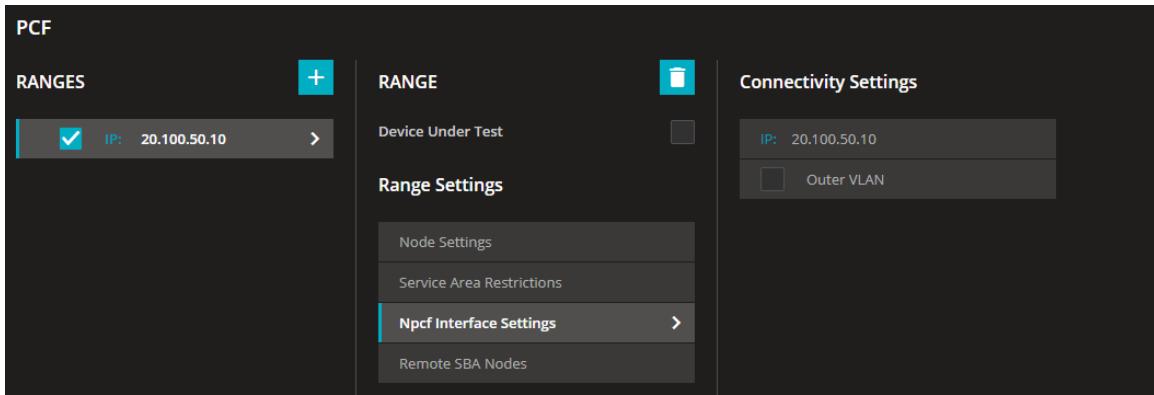
- Remote SBA Nodes:

- Peer NRF: **None**



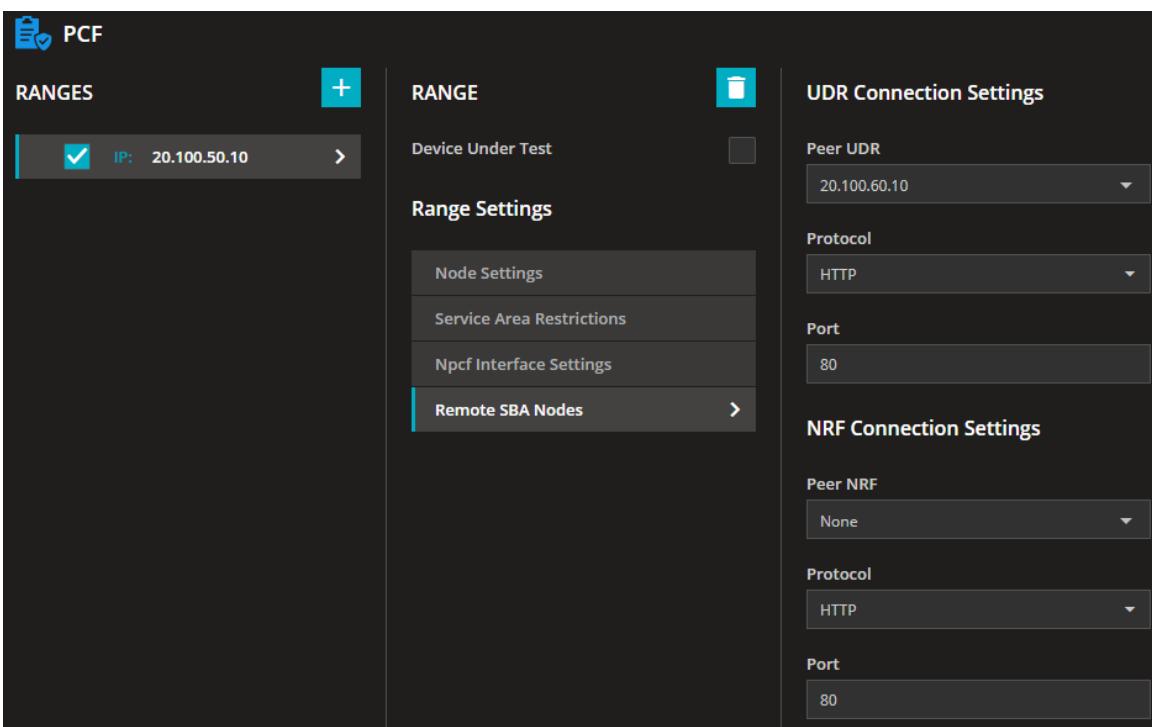
- **PCF configuration**

- Npcf Interface Settings
 - IP address: **20.100.50.10**



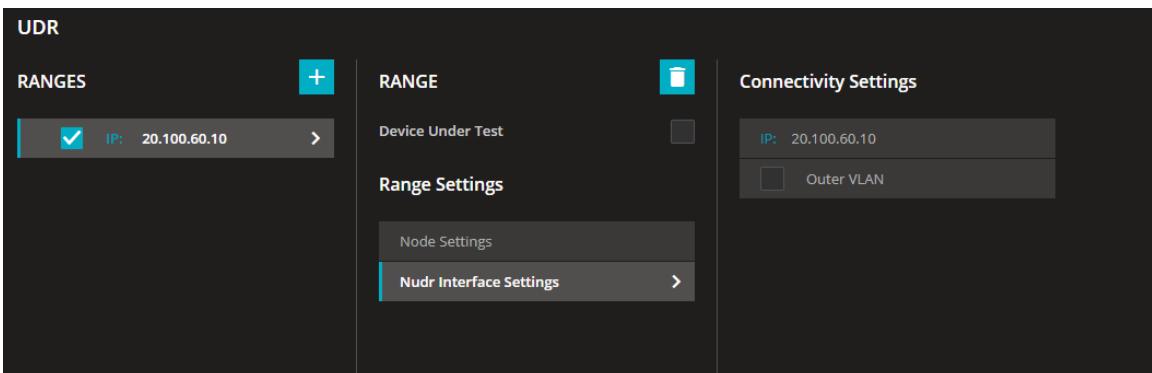
- Remote SBA Nodes
 - UDR Connectivity Settings
 - IP address: **20.100.60.10**

- Peer NRF: **None**



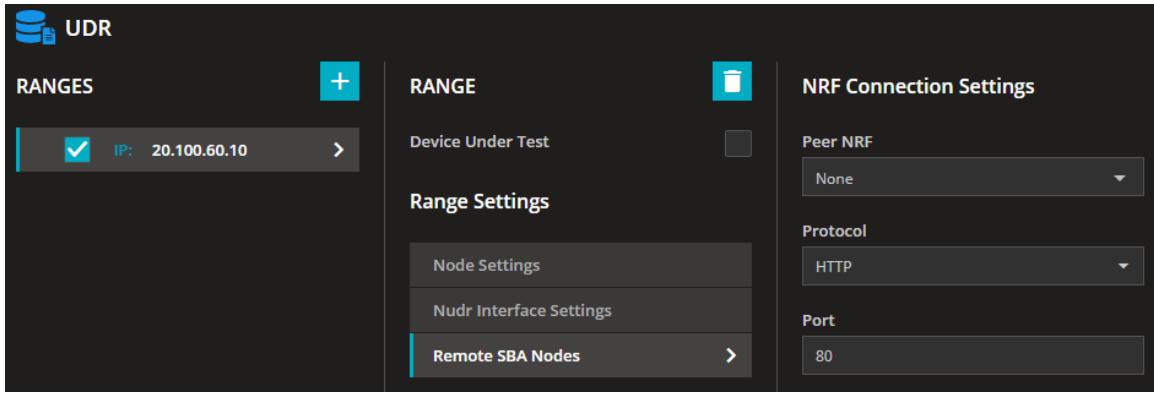
• UDR Configuration

- Nudr Interface Settings
 - IP address: **20.100.60.10**



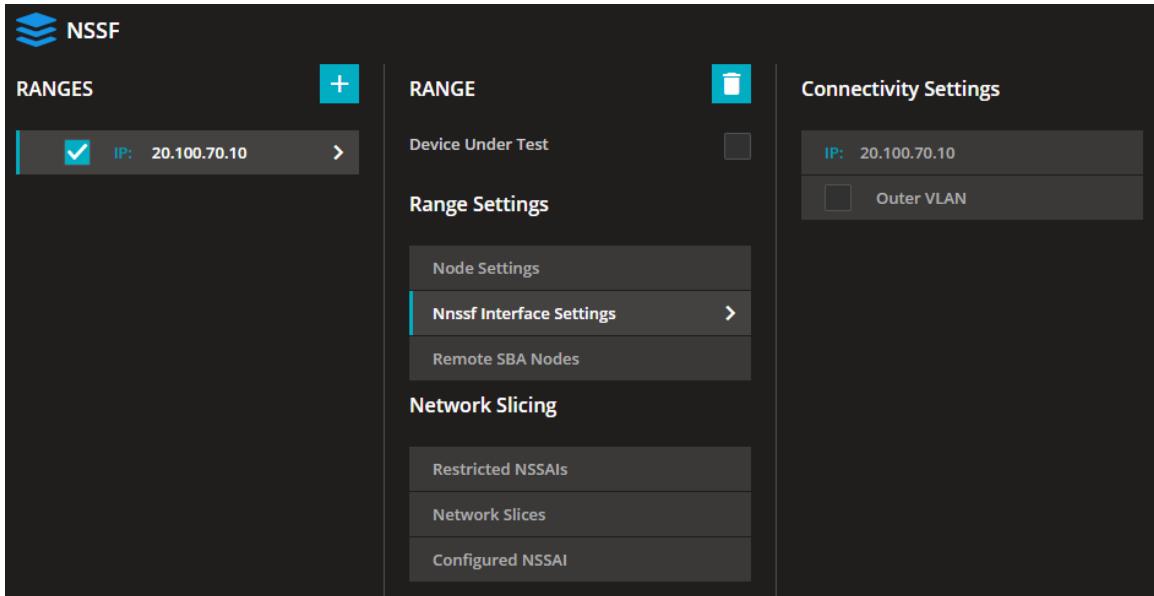
- Remote SBA Nodes

- Peer NRF: **None**



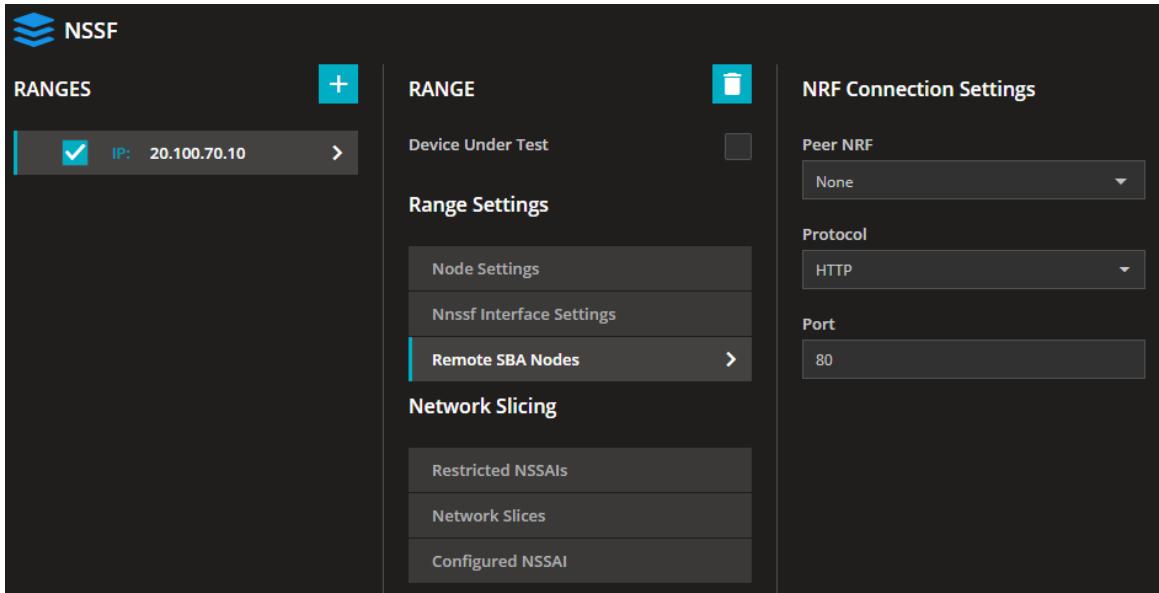
- **NSSF Configuration**

- Nnssf Interface Settings
 - IP address: **20.100.70.10**



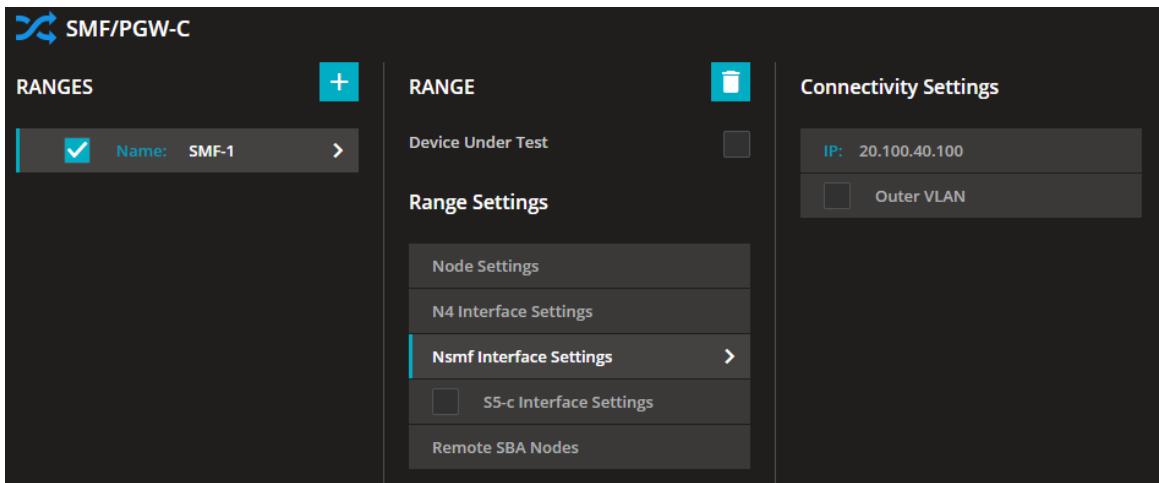
- Remote SBA Nodes

- Peer NRF: **None**



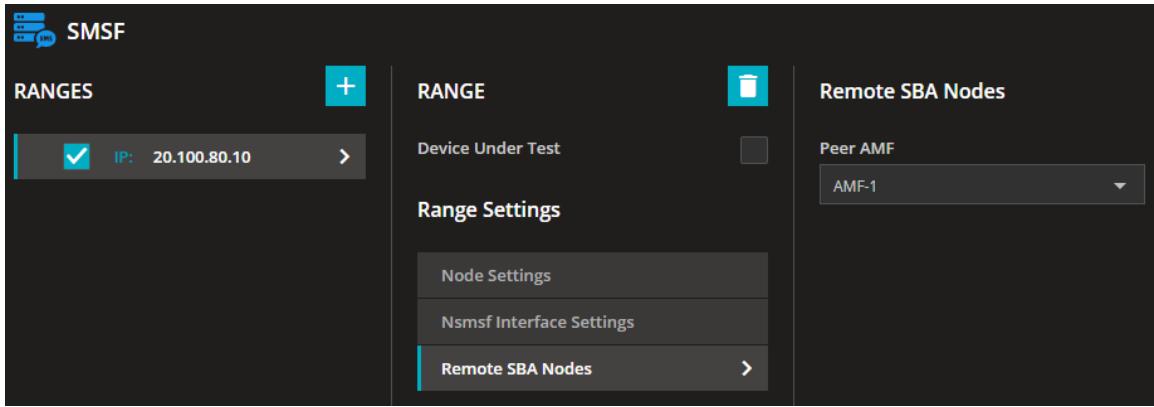
• SMSF Configuration

- Nsmsf Interface Settings
 - IP address: **20.100.80.10**



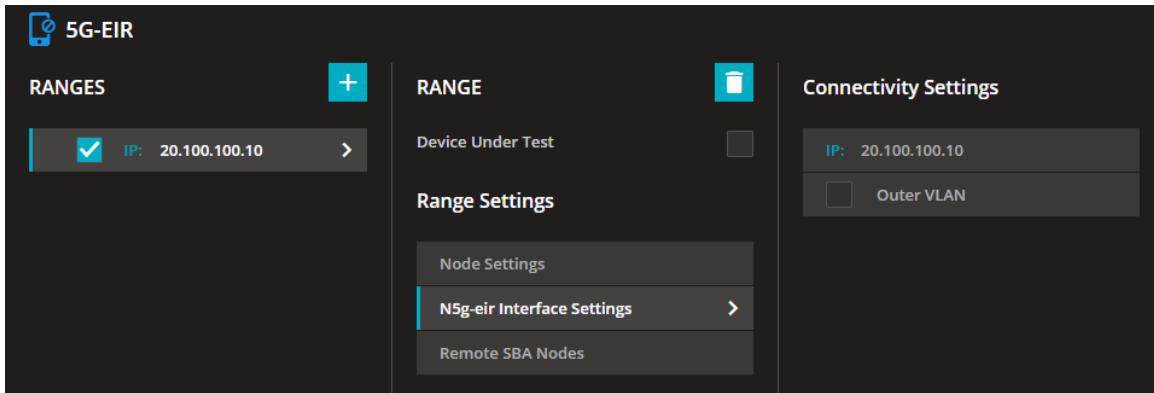
- Remote SBA Nodes

- Peer AMF: **AMF-1**



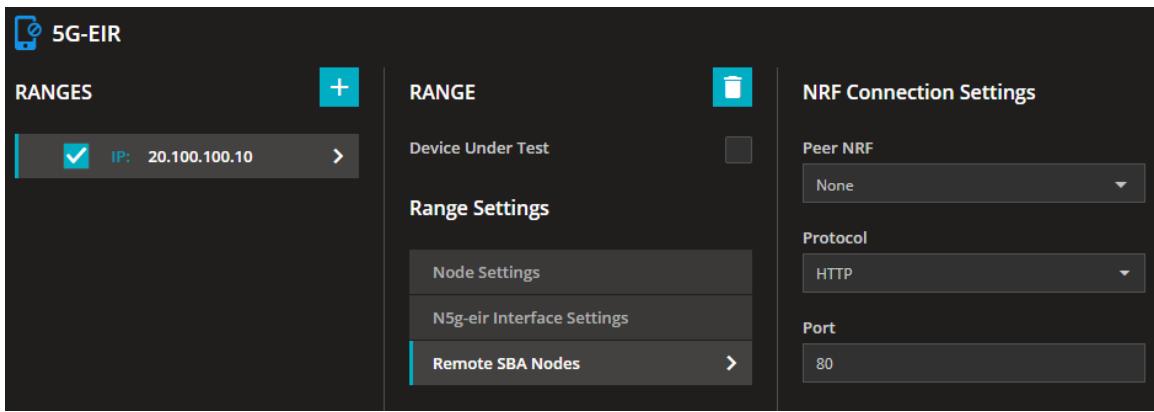
• 5G-EIR Configuration

- N5g-eir Interface Settings
 - IP address: **20.100.100.10**



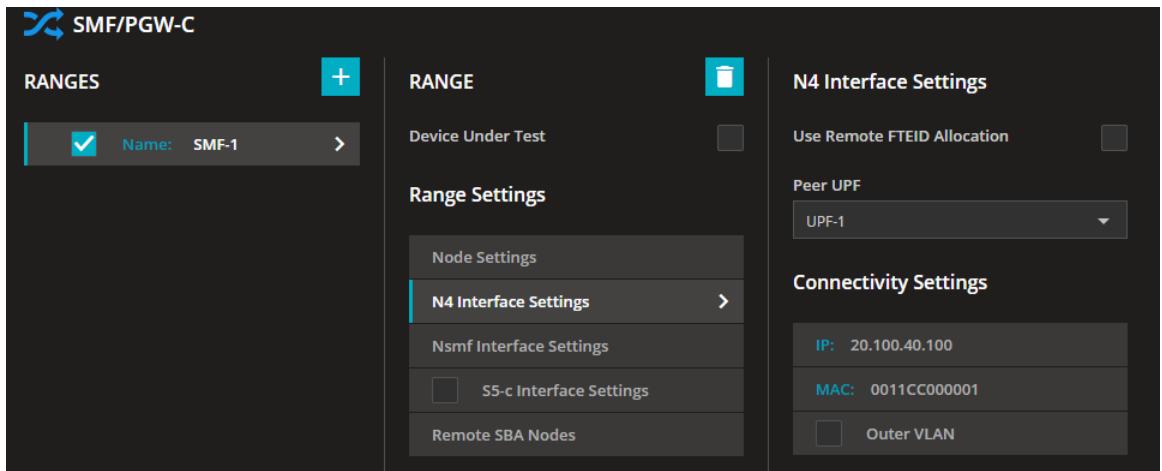
- Remote SBA Nodes

- Peer NRF: **None**

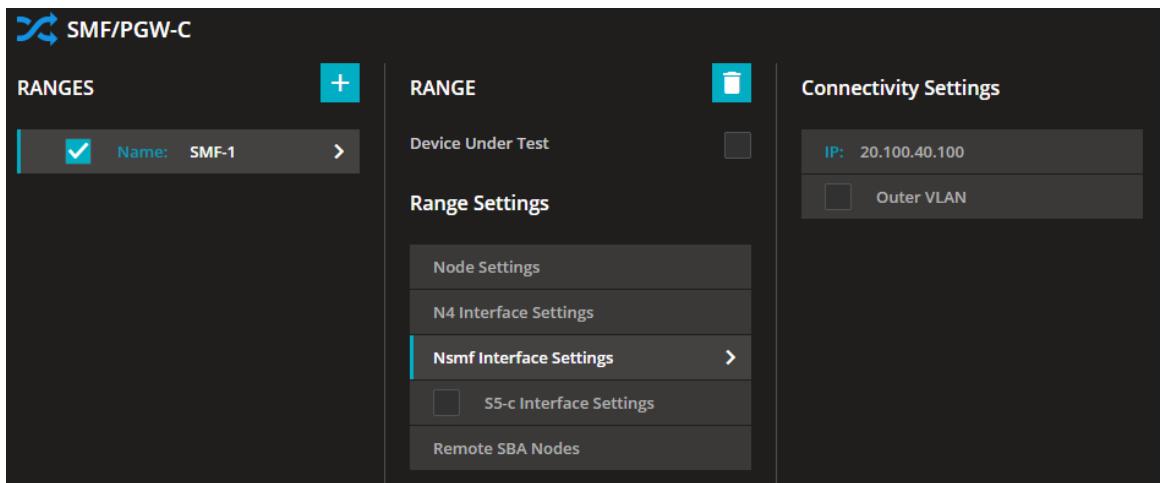


• SMF/PGW-C configuration

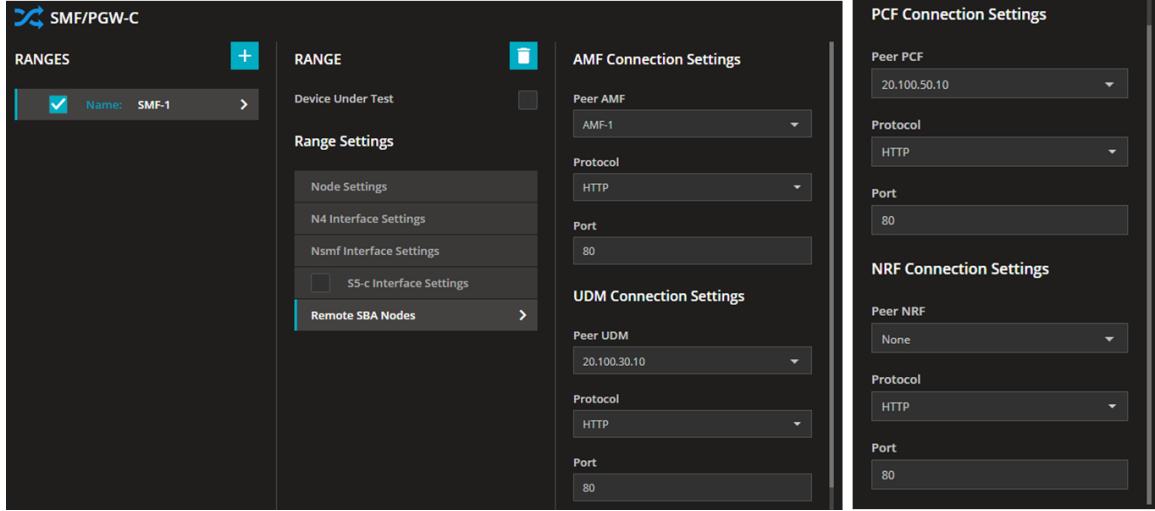
- N4 Interface Settings
 - IP address: **20.100.40.100**
 - Peer-UPF : **UPF-1**



- **Nsmf Interface Settings**
 - IP Address: **20.100.40.10** (same IP address as N4)

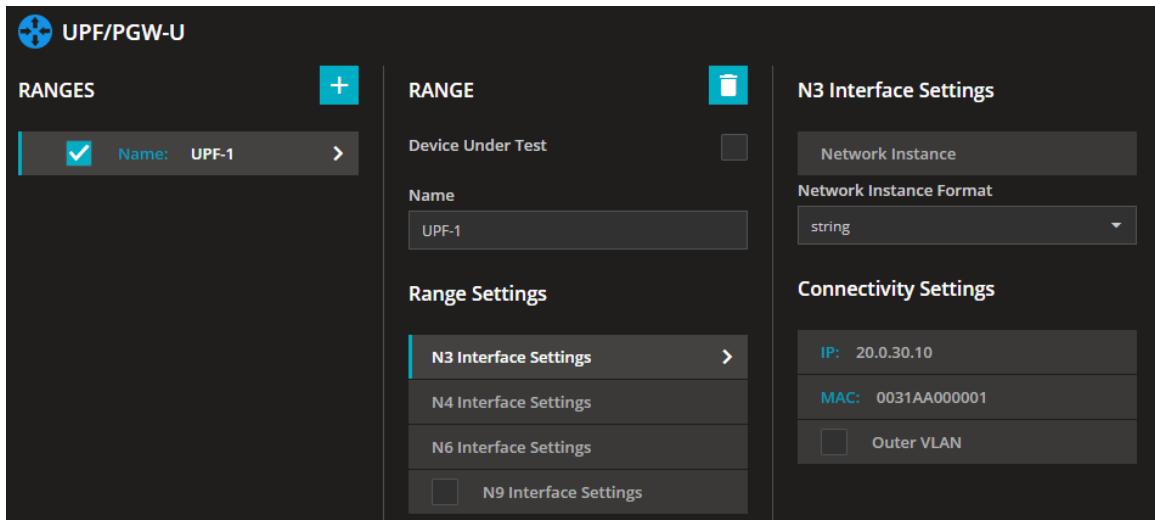


- **Remote SBA Nodes**
 - AMF Connection Settings
 - IP Address: **AMF-1**
 - UDM Connection Settings:
 - IP Address: **20.100.30.10**
 - PCF Connection Settings
 - IP Address: **20.100.50.10**
 - Peer NRF: **None**

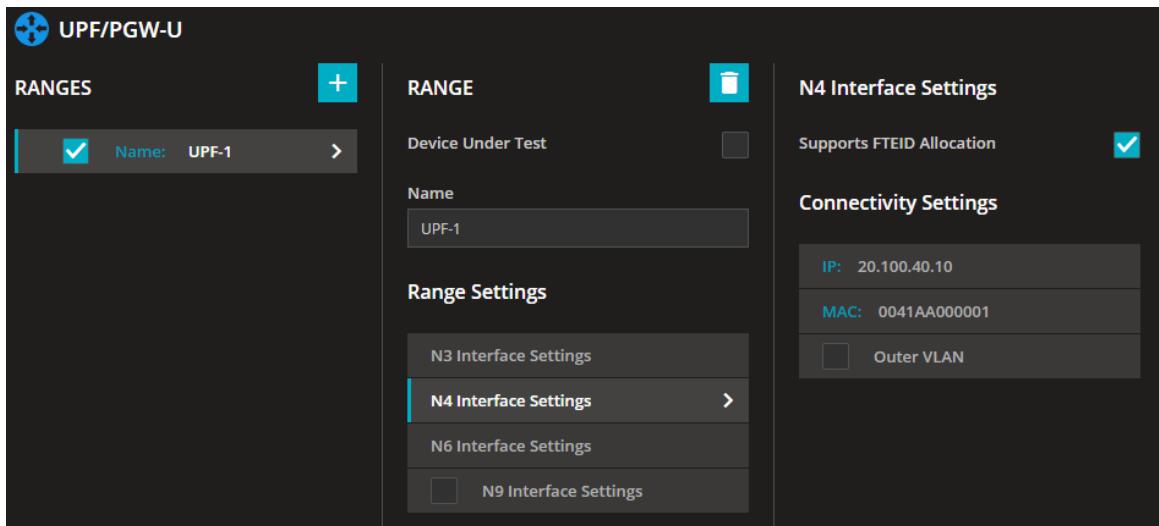


• UPF/PGW-U Configuration

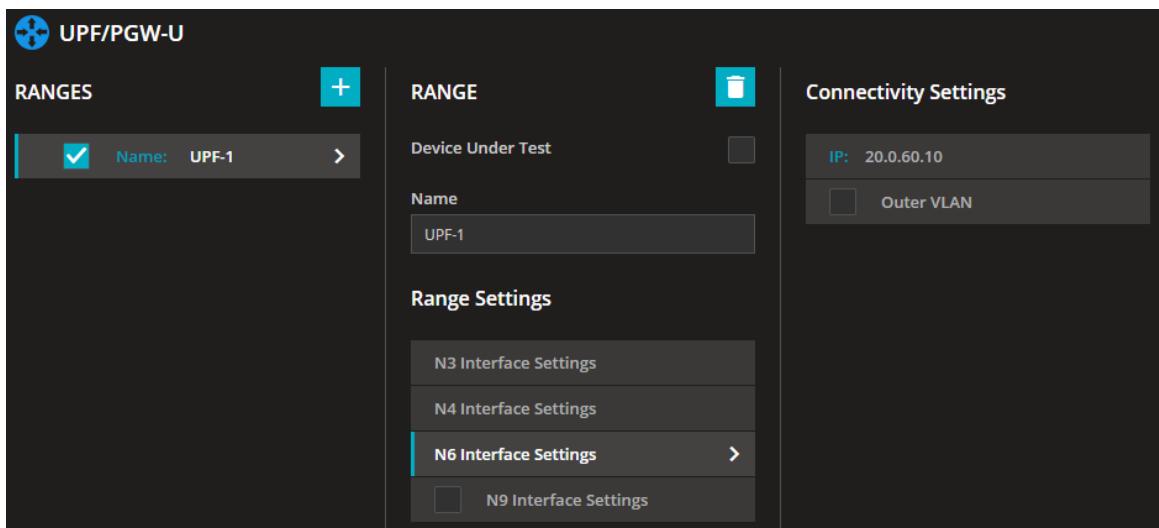
- N3 Interface Settings
 - IP Address: **20.0.30.10**



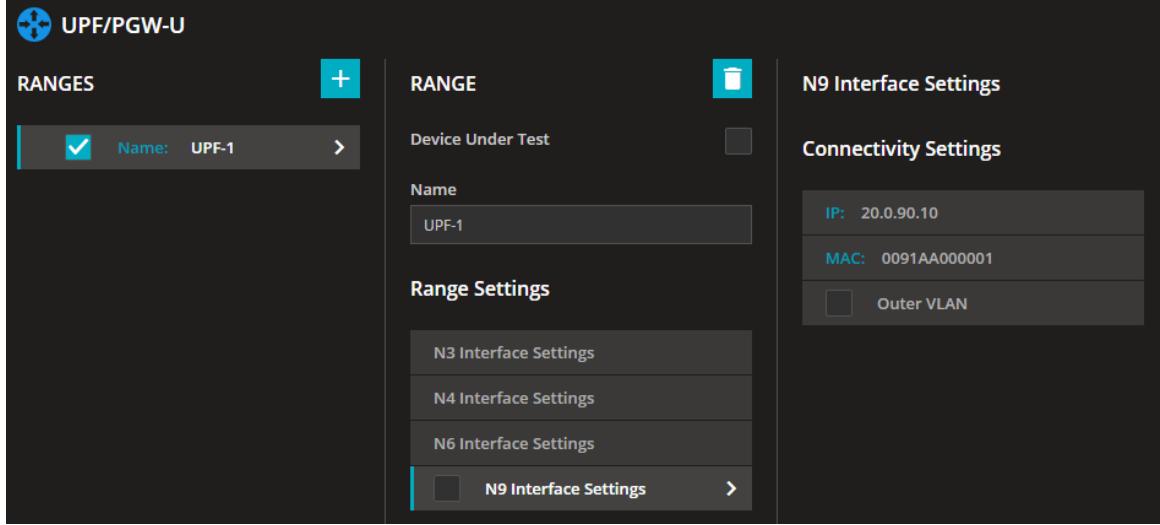
- N4 Interface Settings
 - IP Address: **20.100.40.10**



- N6 Interface Settings
 - IP Address: **20.0.60.10**

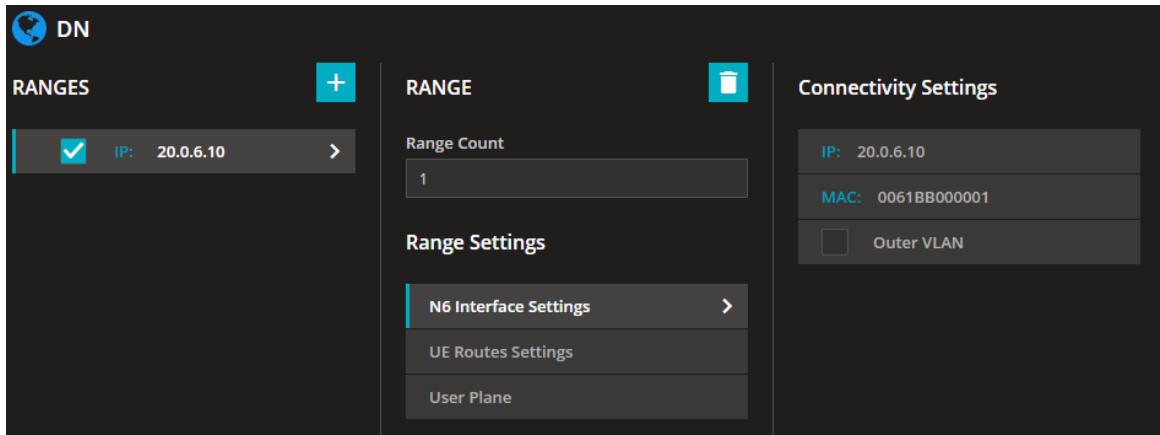


- N9 Interface Settings
 - IP Address: **20.0.90.10**



- **DN Configuration**

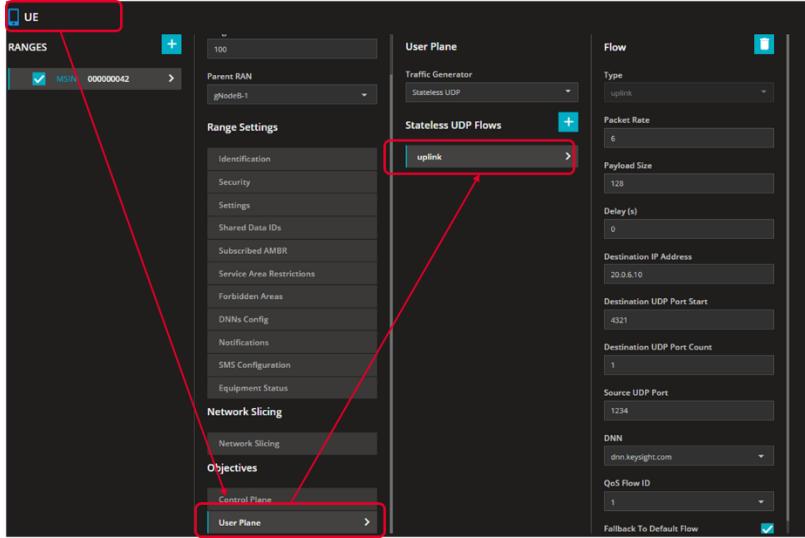
- N6 Interface Settings
 - IP Address: **20.0.6.10**



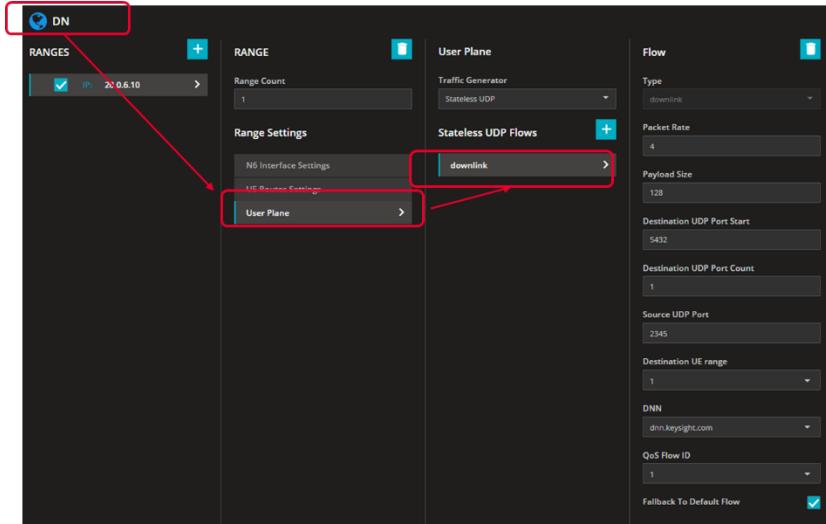
After completing all these steps, you should have the UE range configured and connectivity between 5G Core elements. The next step is to configure traffic flows.

In a wireless network the traffic is generated or received by UE, besides of other activities UE is doing (idle, handover,...). In LoadCore, traffic definition is implemented as UE Objective, therefore the configuration is done by accessing the UE menu:

- Select the **User Plan** objective and set **Stateless UDP** for traffic generator. Other traffic types can be configured too, but for this IxStack should be enabled – over Raw Sockets or over DPDK/Raw.
For this basic test UDP is used.
- There are two places where stateless UDP traffic is configured, according to the traffic direction:
 - For Uplink (UE towards DN traffic), you need to configure it on **UE > User Plane** objectives. The traffic direction cannot be changed, in this menu is only uplink traffic.



- For Downlink (DN towards UE traffic), you need to configure it on the DN node.



For each direction you can play with the packet size, rate, destination IP and port. You can change the values or leave them as they are, the test will run with these defaults.

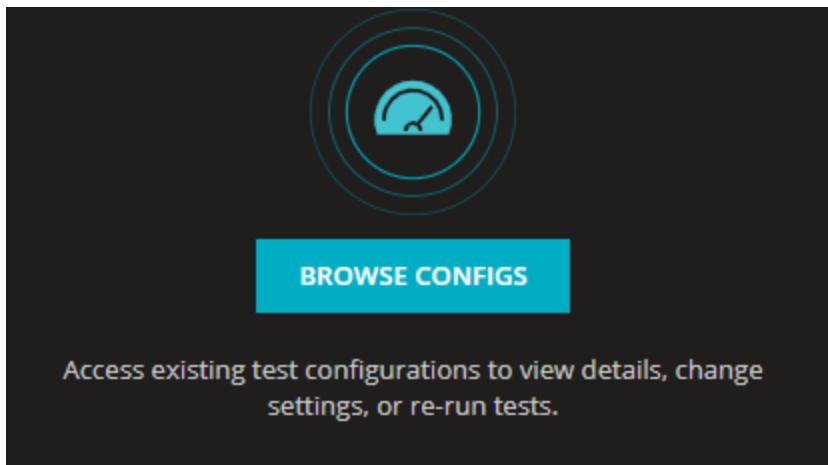
Import a test configuration

If you want to use an already configured test and run it, you can do this by importing the test configuration file (a `.json` file).

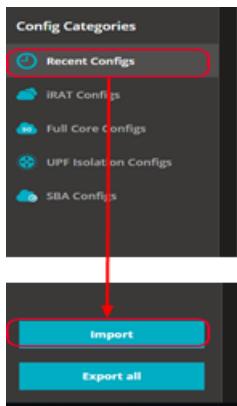
Sample tests can be found on Ixia's download page. You can save the archive and select the tests that best matches your needs.

To import the test configuration file:

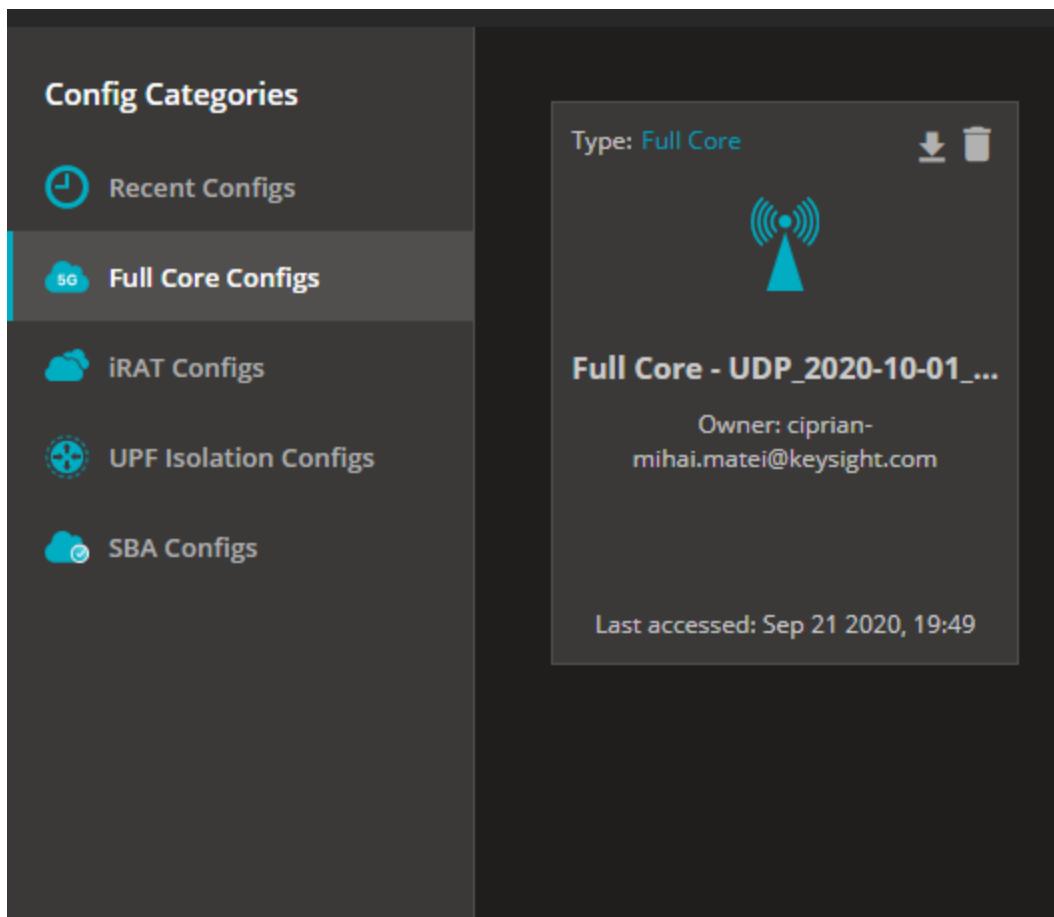
1. Select **LoadCore > Browse Configs**:



2. Select **Recent Configs > Import** and select the test .json file.



3. The test is added in the **Browse Configs > Full Core Configs** section from main LoadCore menu. Select it to create a new session based on this config and run it.



The download page containing the samples can be found at:

- <https://support.ixiacom.com/public/software-downloads/236052>

Run a test

After the complete configuration of the core elements, UEs and test objective definition, to run the test, select **Start Test**. The upper side of the Dashboard will show a summary of the session configuration.

Wait for the complete test initialization and run. If something is not properly configured/working, a message will be added on the Events tab. Select the bell icon and, then, select **Go to Events Page**.

0 OVERVIEW STATISTICS ciprian

Events

All i Info ! Warning ! Error

Date ↑	Type	Message
Mar 28, 2021, 11:40:32 PM	i INFO	Validating test configuration
Mar 28, 2021, 11:40:33 PM	i INFO	Acquire license
Mar 28, 2021, 11:40:35 PM	i INFO	Validate configuration
Mar 28, 2021, 11:40:35 PM	i INFO	Distribute configuration
Mar 28, 2021, 11:40:35 PM	i INFO	Polling Interval is 3
Mar 28, 2021, 11:40:35 PM	i INFO	Registering result
Mar 28, 2021, 11:40:36 PM	i INFO	Reserving 2 test agent(s)
Mar 28, 2021, 11:40:39 PM	i INFO	Initializing 2 newly reserved test agents
Mar 28, 2021, 11:40:39 PM	i INFO	Configuring 2 agent(s)
Mar 28, 2021, 11:40:39 PM	i INFO	Starting 2 agent(s)
Mar 28, 2021, 11:40:51 PM	i INFO	Test running

[GO TO EVENTS PAGE](#) [CLOSE](#)

■ STOP TEST

Filter events by

Message	From	To	Notification type
<input type="text"/> Type keywords	Select a date	Select a date	<input checked="" type="checkbox"/> All <input checked="" type="checkbox"/> i Info <input checked="" type="checkbox"/> ! Warning <input checked="" type="checkbox"/> ! Error

Date ↑	Type	Message
Mar 28, 2021, 11:39:43 PM	i INFO	Reserving 2 test agent(s)
Mar 28, 2021, 11:39:46 PM	i INFO	Initializing 2 newly reserved test agents
Mar 28, 2021, 11:39:46 PM	i INFO	Configuring 2 agent(s)
Mar 28, 2021, 11:39:46 PM	i INFO	Starting 2 agent(s)
Mar 28, 2021, 11:39:52 PM	i INFO	Test execution completed at 2021-03-28 20:39:52. Cleaning up and releasing resources!
Mar 28, 2021, 11:39:52 PM	i INFO	Exporting capture files from agents.
Mar 28, 2021, 11:39:53 PM	i INFO	Releasing 2 agents assigned to the test

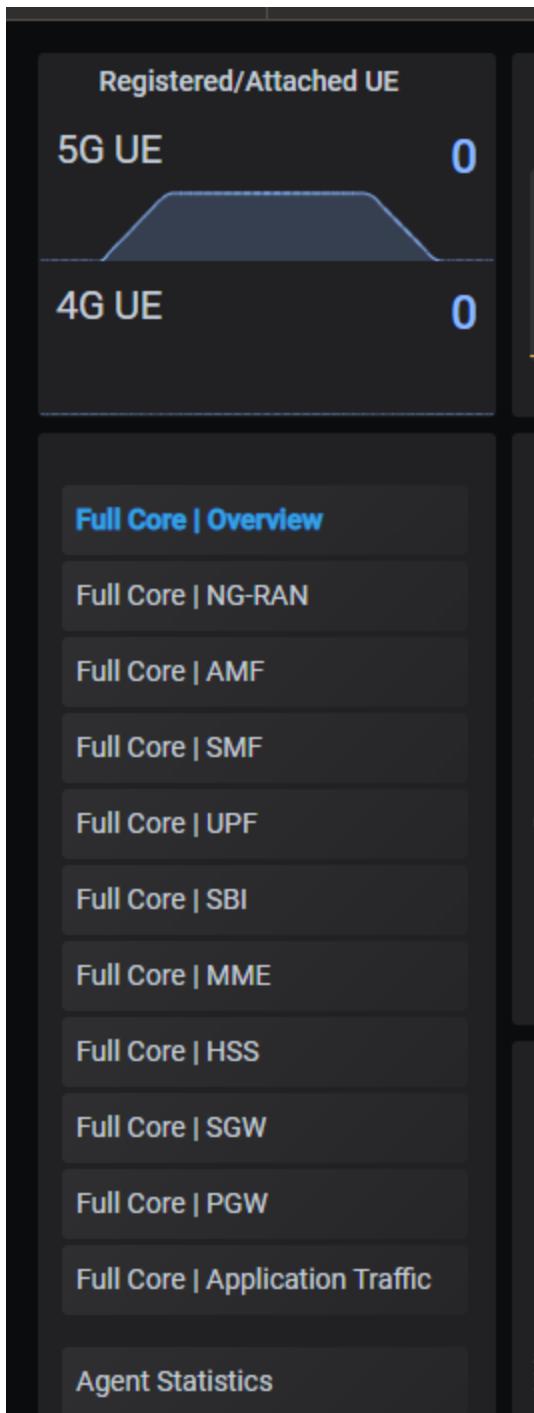
Results Analysis

The following section provides an overview for reading the statistics from LoadCore UI.

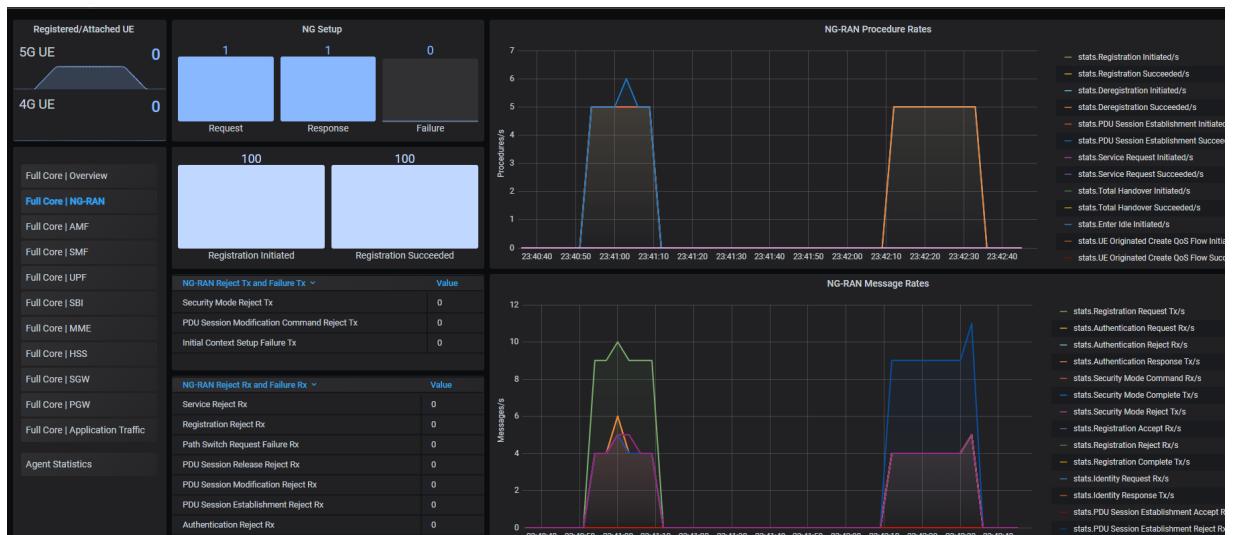
All stats are available under the **Statistic** tab.



The available statistics are displayed here in real-time and grouped under predefined **Dashboards**, per test topology and core node.

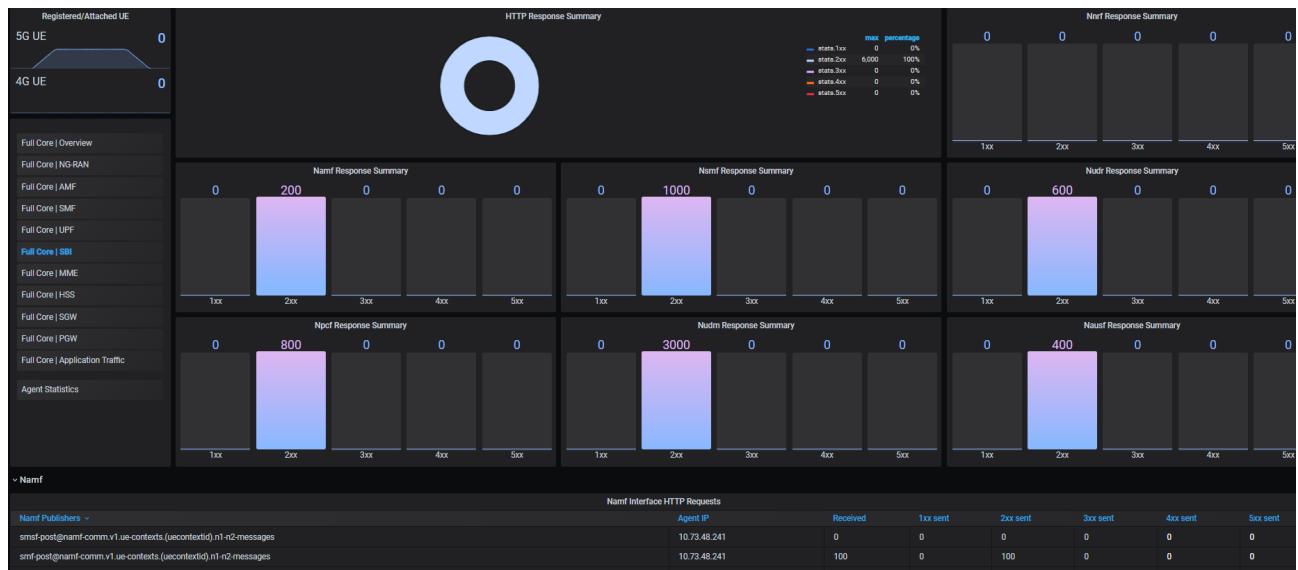


- **Full Core | Overview:** general dashboard displaying a global test overview: how many UEs attached, traffic volume on user plane and control plane.
- **Full Core | Core node:** displays relevant statistics for that node: procedures, rates, errors.



- **Full Core | SBI:** All messages from core SBI region, grouped per message response code.

A successful SBI message has a response code **2xx** (200 or 201) while an error is reported with a different code (for example, starting with **3xx**).



Downloading results, logs and captures

Starting with LoadCore 1.3, the Browse Results section can be accessed in order to retrieve the results, logs and captures of a test that was previously run.

The screenshot shows a 'Test Results' interface. On the left, there's a sidebar with a 'BROWSE RESULTS' button and a message about viewing previous results. Below that is a 'Recent results' section showing a recent run: '33 - Full Core Base Config' from Oct 01, 2020, at 10:55. The main area is titled 'Test Results' and lists 19 test configurations with their names and test names. At the bottom, there are buttons for 'LOAD', 'DOWNLOAD' (with options for CSV or Report), and 'DELETE'.

Config Name	Test Name
142 - SBA Base Config	Wireless-5742186d-fb45-4dfb-bc3d-0e3e0b9c59e2
139 - iRAT Base Config	Wireless-68ef7cf7-d450-4d9b-b537-8ae56d6bd8cf
136 - iRAT Base Config	Wireless-e364dfb-513d-4386-b6ff-49aa0ac9d781
135 - iRAT Base Config	Wireless-c3eab0c9-9e74-4616-1b43-4a35e9f94eb6
133 - Full Core Base Config	Wireless-563a9c70-2055-4522-bc1c9e8617f1c03
132 - Copy of SBA Base Config (copy from Apr 23 07:31:42)	Wireless-cb59cbb-22e9-4d0d-a70c-30834cd0bb5
131 - Fullcore simulation (2021-03-19 11:11:08) (copy from Apr 23 07:28:53)	Wireless-272a4d9d-7a0d-4d9e-a120-72fb9ee24f3
130 - Copy of SBA Base Config	Wireless-bf24345e-910a-48d9-80c3-b13fa013edc
129 - Fullcore simulation (2021-03-19 11:11:08)	Wireless-51bd2d20-b01b-4a14-98c3-3e64dc1aef0
112 - SBA Base Config	Wireless-23e9fc1c3118-4cc9-bcf5-45483821a20
109 - longer mobility path 2020-08-18_11-16-06 (copy from Apr 22 19:43:20)	Wireless-6db58db-5f6a-41a4-ab7e-7026a9630fb
108 - UPF isolation IPv4_PassThru_RouterBackhaulUEs (copy from Apr 22 19:45:49)	Wireless-0e348v9-dc2c-4811-8dec-5d9f14e720006
107 - Sanity test_UPF_Isolation (copy from Apr 22 19:45:18)	Wireless-7945516c-f2c2-4b46-9222-6b5f11cc965
109 - UPF Iso - Tiger + Multiple QoS Flows - Multiple UE Ranges (copy from Apr 22 19:44:5..)	Wireless-f8a92b8-9f9c-4686-b339-63a6a5b5a06
105 - ApplicationTrafficXnIO_noTAC_ImgGET (copy from Apr 22 19:44:15) (copy from Ap..)	Wireless-8d4692c3132-447c-82b8-756371be472
104 - ApplicationTrafficXnIO_TACchange_httpPUT (copy from Apr 22 19:42:03) (copy fr..)	Wireless-b506c996-08a4-40fe-a278-0dd5aecd985
103 - UPF Iso - Tiger + Multiple QoS Flows - Multiple UE Ranges (copy from Apr 22 19:39:03)	Wireless-b22ecbc7666-41e5-be94-a798b03956da
102 - UPF Iso - Tiger + Multiple QoS Flows - 2 HTTPs 2 HTTP (copy from Apr 22 19:37:01)	Wireless-7a71c165-01a2-49b8-8757-4169139e3518

On this section, the following actions are possible:

- Load the test configuration in a new session.
Download the test results.
- Download LoadCore logs and packet capture.

NOTE

To download the captures you need to enable traffic capture on the test agents.

- Delete the test results, by selecting the **Delete** button.

NOTE

At this moment, LoadCore does not have an automatic mechanism to delete old results, therefore this operation must be done manually in order to prevent MW disk to become full (especially running long duration tests).

Generate and retrieve csv statistics using Rest API

The agent's REST API User Guide can be accessed and the commands can be executed from there.

The example below uses Insomnia Rest API client to get the `csv` stats. Same operation can be done also from the agent's REST API User Guide.

NOTE

Replace `{{demo_url}}` with the IP address of the agent from where you want to download the stats.

In this example, the agents are:

- agent_1**: 10.73.51.91 > `<demo_url>` is <https://10.73.51.91:443/api/v1>
- agent_2**: 10.73.52.85 > `<demo_url>` is <https://10.73.52.85:443/api/v1>

agent_1	Normal	5.33 GB	Ubuntu Linux (64-bit)	10.73.51.91	agent_1	30 MHz	540 MB
agent_2	Normal	5.33 GB	Ubuntu Linux (64-bit)	10.73.52.85	agent_2	42 MHz	680 MB
LicenseServer	Normal	6.36 GB	Ubuntu Linux (64-bit)	10.73.53.17	licensing-vm	32 MHz	910 MB
Middleware 1.1	Normal	14.35 GB	Ubuntu Linux (64-bit)	10.73.53.201	middleware11	2.2 GHz	5.66 GB

The command cycle is **Start** > **Stop** > **Get**, as follows:

1. To Start csv logging, issue the following command:

```
POST {{ demo_url }}/statistics/n4-smf-session-messages/csv/start
```

The screenshot shows a user interface for a REST API client. At the top, there is a header bar with the text "POST" and a dropdown menu. Below the header, the URL "demo_url /statistics/n4-smf-session-messages/csv/start" is entered. To the right of the URL is a "Send" button. Below the URL, there is a navigation bar with tabs: "Body" (which is currently selected), "Auth", "Query", "Header", and "Docs".

To capture all stats, issue the command after applying the configuration (PUT command) and before starting the execution (as detailed in Test execution flow).

2. To Stop csv logging, issue the following command:

```
POST {{ demo_url }}/statistics/n4-smf-session-messages/csv/stop
```

This screenshot is similar to the previous one, showing a POST request to stop CSV logging. The URL is "demo_url /statistics/n4-smf-session-messages/csv/stop". The "Body" tab is selected in the navigation bar.

3. Once the test has stopped, you can retrieve entire csv using command:

```
GET {{ demo_url }}/statistics/n4-smf-session-messages/csv
```

This screenshot shows a GET request to retrieve CSV data. The URL is "demo_url /statistics/n4-smf-session-messages/csv". The "Body" tab is selected in the navigation bar.

4. Issuing the above command for (publisher) n4-smf-session-messages will result in stats being listed within **200OK** response window:

200 OK TIME 0 ms SIZE 25 KB

Preview	Header	Cookie	Timeline						
Timestamp	PFCP Session Deletion Request Retries	PFCP Session Deletion Request Tx	PFCP Session Deletion Response Rx	PFCP Session Establishment Request Retries	PFCP Session Establishment Request Tx	PFCP Session Establishment Response Rx	PFCP Session Modification Request Retries	PFCP Session Modification Request Tx	PFCP Session Modification Response Rx
12:23:39:544	0	0	0	0	0	0	0	0	0
12:23:40:560	0	0	0	0	0	0	0	0	0
12:23:41:571	0	0	0	0	0	0	0	0	0
12:23:42:586	0	0	0	0	0	0	0	0	0
12:23:43:771	0	0	0	0	0	0	0	0	0
12:23:44:788	0	0	0	0	0	0	0	0	0
12:23:45:800	0	0	0	0	0	0	0	0	0
12:23:46:803	0	0	0	0	0	0	0	0	0
12:23:47:817	0	0	0	0	0	0	0	0	0
12:23:48:830	0	0	0	0	0	0	0	0	0
12:23:49:842	0	0	0	0	0	0	0	0	0
12:23:50:861	0	0	0	0	0	0	0	0	0
12:23:51:872	0	0	0	0	0	0	0	0	0
12:23:52:880	0	0	0	0	0	0	0	0	0
12:23:53:900	0	0	0	3185	3174	0	0	0	0
12:23:55:942	0	0	0	23675	23674	0	0	0	0
12:23:56:946	0	0	0	33725	33724	0	0	0	0
12:23:57:951	0	0	0	43775	43774	0	0	0	0
12:23:58:951	0	0	0	53775	53774	0	0	0	0
12:23:59:955	0	0	0	63229	63228	0	0	0	0
12:24:00:955	0	0	0	73199	73198	0	0	0	0
12:24:01:959	0	0	0	83199	83199	0	0	0	0
12:24:02:961	0	0	0	93138	93124	0	0	0	0
12:24:03:972	0	0	0	103199	103199	0	0	0	0
12:24:04:972	0	0	0	113199	113197	0	0	0	0

5. You can generate csv stats for any available publisher. For example, to generate csv for SMF session rates:

```
POST {{ demo_url }}/statistics/n4-smf-session-messages-rate/csv/start
POST {{ demo_url }}/statistics/n4-smf-session-messages-rate/csv/stop
GET {{ demo_url }}/statistics/n4-smf-session-messages-rate/csv
```

With the following result:

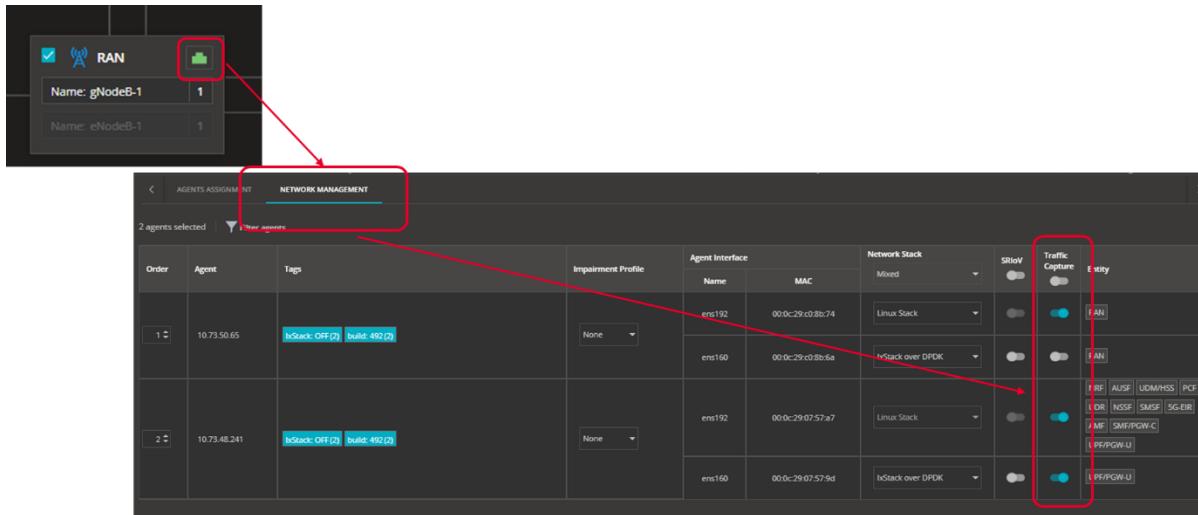
200 OK TIME 234 ms SIZE 1524 B

Preview	Header	Cookie	Timeline						
Timestamp	PFCP Session Deletion Request Retries/s	PFCP Session Deletion Request Tx/s	PFCP Session Deletion Response Rx/s	PFCP Session Establishment Request Retries/s	PFCP Session Establishment Request Tx/s	PFCP Session Establishment Response Rx/s	PFCP Session Modification Request Retries/s	PFCP Session Modification Request Tx/s	PFCP Session Modification Response Rx/s
13:05:56:889	0	0	0	0	0	0	0	0	0
13:05:57:903	0	0	0	0	0	0	0	0	0
13:05:58:918	0	0	0	0	0	0	0	0	0
13:05:59:929	0	0	0	0	0	0	0	0	0
13:06:00:940	0	0	0	0	0	0	0	0	0

Generate and retrieve packet captures

Using LoadCore UI

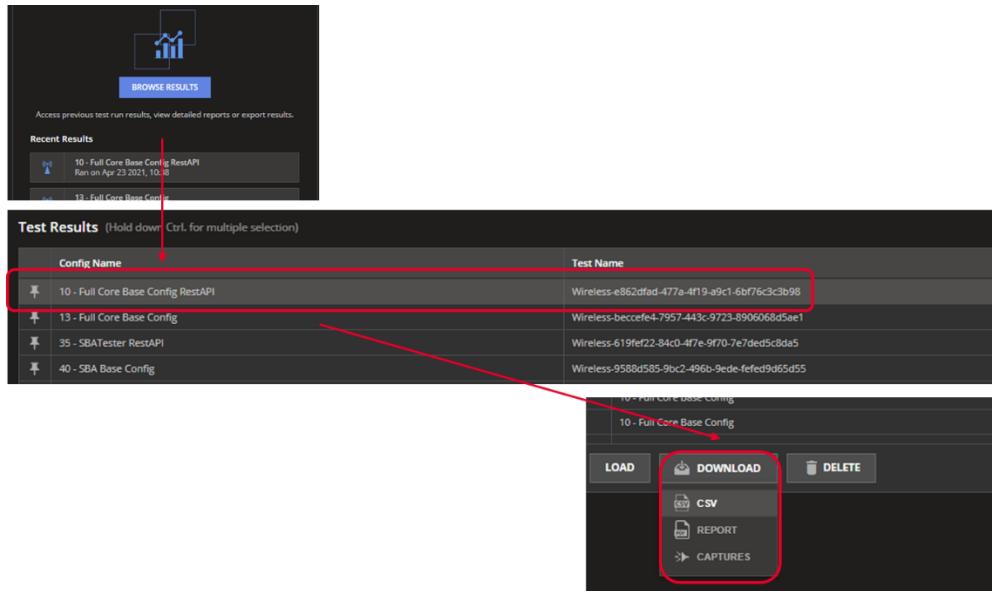
To enable packet capture from the LoadCore UI, select the agent assignment icon on any node, and select the Network Management tab.



IMPORTANT This operation will activate the traffic captures on the selected interfaces and the .pcap files will be automatically saved in the results folder for the test run.

Separate .pcap file will be generated for each test agent.

To download the .pcap files you need to select on Browse Results menu and select the test run you want the captures for, select **Download** and, then, select **Captures**.



If you are using a single agent in the test, then the traffic capture will not contain any packets, since all traffic is performed on loopback interface, not going out. To overcome this, you need to activate/get the capture on that agent using RestAPI calls and apply *any* as interface filter.

Using Rest API commands

The packet capture options are accessible via `/api/v1/capture`. The following operations are currently supported:

- Configuring the packet capture filter (in this case the test interface is **ens160**)
- Starting the packet capture
- Stopping the packet capture
- Downloading the packet capture file

In this example the agents are:

- **agent_1**: 10.73.50.65 > `<demo_url>` is **<https://10.73.50.65:443/api/v1>**
- **agent_2**: 10.73.48.241 > `<demo_url>` is **<https://10.73.48.241:443/api/v1>**

	Virtual machine ▾	Status	Used space	IP address	Host name
□	Middleware 2.1	Normal	17.31 GB	169.254.122.68	kcos-000c290310d7
□	LicenseServer	Normal	6.38 GB	10.73.53.17	licensing-vm
□	agent2	Normal	9.8 GB	10.73.50.65	5GCTE-6a96d7447
□	agent1	Normal	9.81 GB	10.73.48.241	5GCTE-6a96d7447

1. Set up the capture filter using the PATCH command:

```
PATCH {{ demo_url }}/capture/filter -i ens160
```

2. The packet capture can be started using:

```
POST {{ demo_url }}/capture/start
```

3. The packet capture can be stopped using:

```
POST {{ demo_url }}/capture/stop
```

4. The latest packet capture file can be accessed using:

```
GET {{ demo_url }}/capture
```

Using commands from Agent REST API User Guide

The agent's REST API User Guide can be accessed and the commands can be executed from there, as follows:

1. Connect to the Agent User Guide (http://<IP_address_of_the_Agent>).

The screenshot shows a web browser window with the following details:

- Title bar: '5G Core Test Engine REST API'
- Address bar: 'Not secure | 10.73.53.132/doc/index.html'
- Content area:
 - Link: 'SG Core Test Engine REST API'
 - Link: 'License'
 - Navigation sidebar:
 - > Applications
 - > Traffic
 - > Capture

2. From main menu of the web interface access select **Capture** and first define the interface from which the traffic will be captured:

SG Test Engine REST API

SG Test Engine REST API

License

> Applications

> **Capture**

> Debug

> Licensing

> Network

Filter Operations for configuring packet capture options

- GET** /capture/filter Retrieve the filter configured for packet capture
- PATCH** /capture/filter Modify the packet capture filter

Capture Operations for controlling packet capture

- POST** /capture/start Start the packet capture
- POST** /capture/stop Stop the packet capture
- GET** /capture/status Retrieve the packet capture status
- GET** /capture Retrieve the packet capture file, in tcpdump pcap format

In this example the interface name is **ens160** and this value is updated in the message body. This is the test interface used to connect the two agents.

3. Select **Filter** and, then, the **PATCH** operation. Update the interface name and select the **Execute** command.

Filter Operations for configuring packet capture options

- GET** /capture/filter Retrieve the filter configured for packet capture
- PATCH** /capture/filter Modify the packet capture filter

The filter can contain any command line options available for the tcpdump command.

Parameters

No parameters

Request body required

Example Value Model

```
{ "value": "-i ens160" }
```

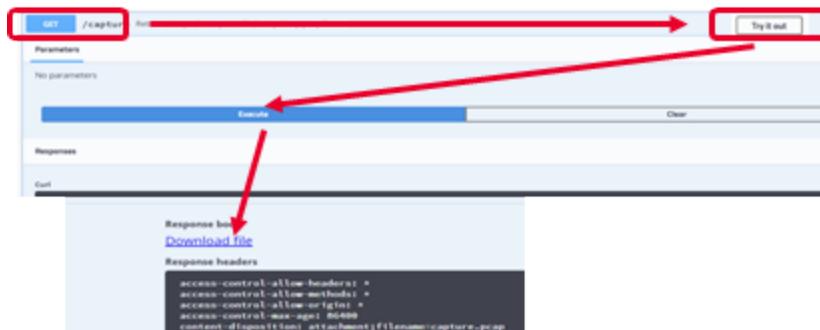
Try it out

4. The capture operation can be started and stopped after running the test.

Capture Operations for controlling packet capture

- POST** /capture/start Start the packet capture
- POST** /capture/stop Stop the packet capture
- GET** /capture/status Retrieve the packet capture status
- GET** /capture Retrieve the packet capture file, in tcpdump pcap format

5. To access the capture file, select the **GET** operation and after executing it, an updated download link is returned in the message body, from where the .pcap file can be downloaded.



To open the .pcap and analyze the captured traffic, use Wireshark.

Running Application traffic (HTTP)

In order to run Application traffic (other than UDP), you need to enable a different traffic engine. This will enable you to configure HTTP GET/PUT, FTP flows or voice traffic.

This traffic engine was designed for performance; therefore, it uses **IxStack over DPDK/Raw** or **Raw Sockets**.

The IxStack over DPDK/Raw mode required additional resources to be allocated to the traffic agents.

IMPORTANT The recommendation for an agent running IxStack over DPDK/Raw, for small number of UEs/TPS, is to assign 16 GB RAM and 8 CPU vCores.

If you need more performance, you need to increase the hardware resources assigned to the IxStack over DPDK/Raw agents, as specified below.

IMPORTANT The amount of RAM memory depends of the NIC you are using. For details, refer to <https://loadcore.htmlsave.net/>.

1. The minimum hardware requirements for Control Plane Only tests (no Application traffic) - default VM:
 - 4 GB RAM out of which 1GB is reserved for HUGE MEM(IxStack over DPDK/Raw)
 - 4 x vCPUs
 - 20 GB HDD
 - 1.2M UEs on gNB
2. The minimum hardware requirements for functional tests with Application traffic (10K UEs):
 - 8 x vCPUs
 - 1 x 10G NIC OR 1 x 40G NIC

	Mellanox	Intel	VMware
RAM (MB)	9971 MB	7686 MB	8011 MB
HugePages	1583 huge pages	440 huge pages	602 huge pages

3. VM with 10GBE NIC:
 - 8 x vCPUs
 - 1 x 10G NIC OR 1 x 40G NIC

	Mellanox	Intel	VMware
RAM (MB)	25196 MB	22911 MB	23235 MB
HugePages	8555 huge pages	7413 huge pages	7575 huge pages

4. VM with 100G NIC:
 - 18 x vCPUs
 - 80 Gbps TPUT with 1000 UEs

	Mellanox	Intel	VMware
RAM (MB)	22644 MB	17503 MB	18234 MB
HugePages	7416 huge pages	4845 huge pages	5211 huge pages

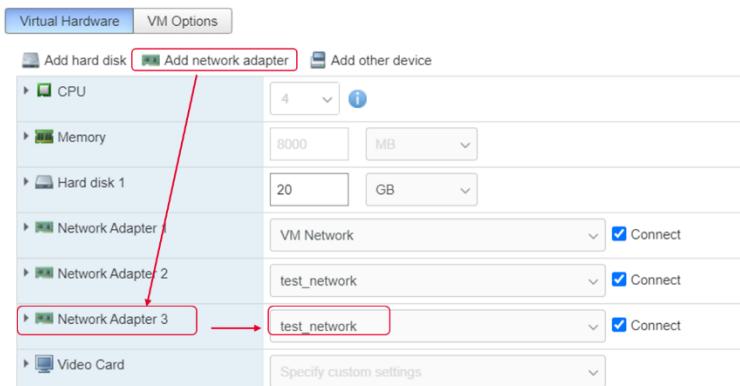
For different scenarios, two additional agents will be deployed having IxStack over DPDK/Raw on. In this way, you can run a simple UDP test for demo purposes with the previously deployed agents (agent_1 and agent_2) and when necessary to show TCP traffic type, you can run the test with the IxStack over DPDK/Raw enabled agents.

Installing additional interfaces on the test agents

In order to have full flexibility we will add an additional test interface to each agent. Also, this extra interface is necessary because the SBI nodes does not have yet support for IxStack over DPDK/Raw.

We will use the existing test interface (**ens160**) and just switch from Linux stack to IxStack over DPDK/Raw, and the new test interface will be used with Linux stack (and assigned for SBI nodes).

To do this, we will log to the ESXi interface, stop the agents and add one more interface (**ens192** in this case), and connect it to the same test network.



For both agents increase the HW resources as displayed below:

Hardware Configuration	
CPU	8 vCPUs
Memory	16 GB
Hard disk 1	20 GB
Network adapter 1	VM Network (Connected)
Network adapter 2	test_network (Connected)

In these tests the following are used:

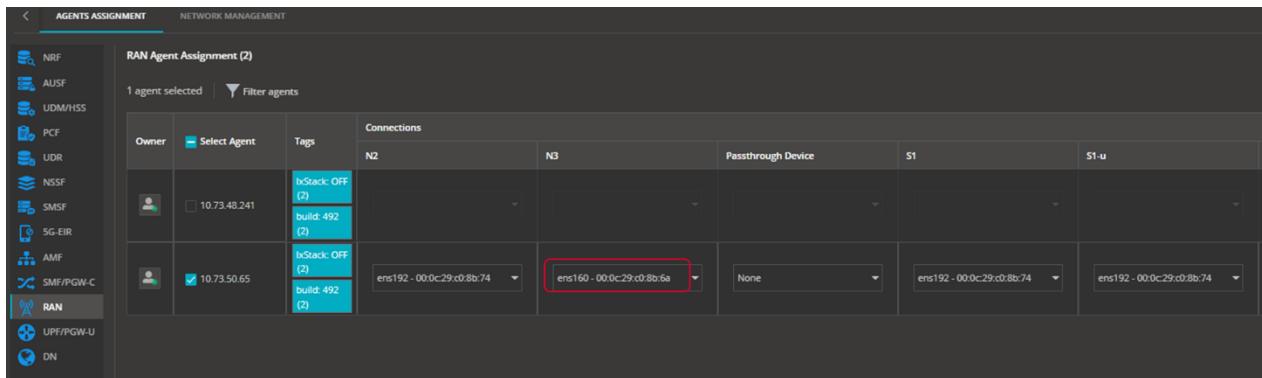
- Ens160 – for all tests with app traffic (HTTP, HTTPS, FTP, Voice)
- Ens192 – for all tests with Stateless UDP flows and for simulating the SBI nodes
- Agent_1 (three interfaces):

- One for management (**ens32**)
 - One for test, running IxStack over DPDK/Raw, for User Plane (**ens160**)
 - One for test, for Control Plane, no IxStack over DPDK/Raw (**ens192**)
 - Agent_2 (three interfaces)
 - One for management (**ens32**)
 - One for test, running IxStack over DPDK/Raw, for User Plane (**ens160**)
 - One for test, for Control Plane , simulating the rest of the modes (AMF_SMF_SBI part), no IxStack over DPDK/Raw(**ens192**)

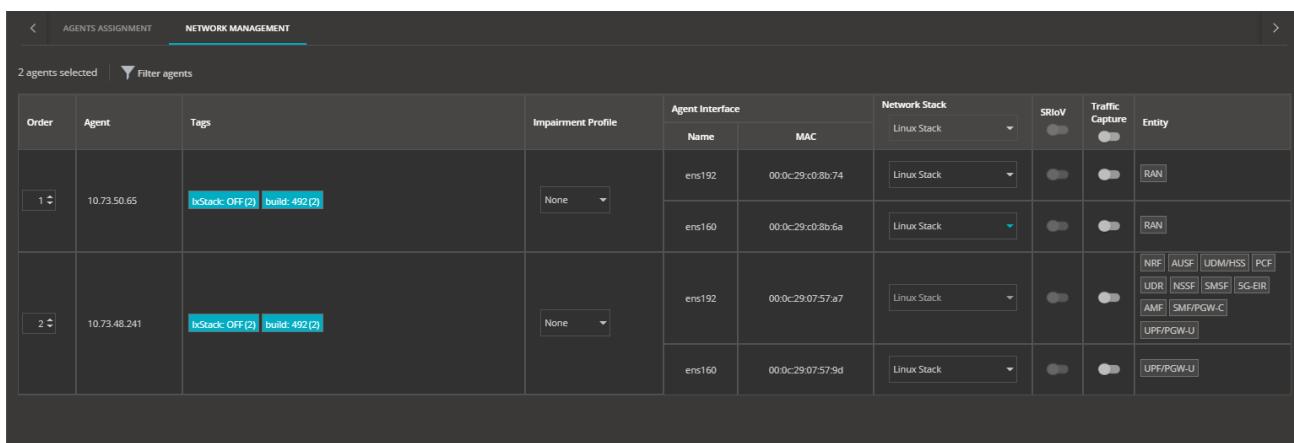
Enabling IxStack over DPDK/Raw

To run application traffic, you need to use IxStack on test interfaces that are assigned for user plane (N3, N6).

From the main topology, select the green icon (for agent assignment) and for NG-RAN and UPF/PGW-U assign the interface **ens160** for N3 and all the other interfaces on the nodes will remain on **ens192**.



After completing this step, select the **Network Management** tab. Notice that **ens160** is assigned to two nodes, and **ens192** is assigned to all nodes, as follows:



For the rows in the table with **ens160**, set **Network Stack** to **IxStack over DPDK/Raw** by selecting it from the drop-down list.

	Network Stack	SRIoV
c	Mixed	OFF
0:8b:74	Linux Stack	OFF
0:8b:6a	IxStack over DPDK	OFF
0:75:7a7	Linux Stack IxStack	OFF
0:75:7d	Linux Stack IxStack over Raw Sockets IxStack over DPDK	OFF

AGENTS ASSIGNMENT										NETWORK MANAGEMENT				
2 agents selected			Filter agents											
Order	Agent	Tags	Impairment Profile	Agent Interface		Network Stack		SRIOV	Traffic Capture	Entity	NRF	AUSF	UDM/HSS	PCF
				Name	MAC	Mixed	Linux Stack				UDR	NSSF	SMSF	5G-EIR
1	10.73.50.65	IxStack: OFF (2) build: 492 (2)	None	ens192	00:0c:29:c0:8b:74	Linux Stack	OFF	OFF	OFF	RAN	AMF	SMF/PGW-C	UPF/PGW-U	UPF/PGW-U
				ens160	00:0c:29:c0:8b:6a	IxStack over DPDK	OFF	OFF	OFF	RAN				
2	10.73.48.241	IxStack: OFF (2) build: 492 (2)	None	ens192	00:0c:29:07:57:a7	Linux Stack	OFF	OFF	OFF	UPF/PGW-U				
				ens160	00:0c:29:07:57:9d	IxStack over DPDK	OFF	OFF	OFF	UPF/PGW-U				

Configure HugePages on both Agents

IxStack over DPDK/Raw and high performance requires hugepages support configured on both agents running with IxStack over DPDK/Raw.

IMPORTANT This step is not needed if you are building a testbed for demo purposes, with small number of UEs and less throughput.

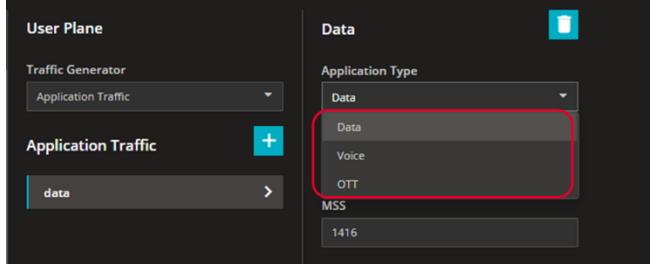
To do this, edit the `/boot/grub/grub.cfg` file and add `hugepages=8192`.

```
ixia@5GCTE-6a96d7447: /boot/grub
set timeout=1
menuentry '5G Core Test Engine - Linux 4.15.0-74-generic' {
    linux /boot/vmlinuz-4.15.0-74-generic root=UUID=b0cc522e-5f39-498b-b81b-7058
42d07744 net.ifnames=1 hugepagesz=2M hugepages=8192 ro quiet
    initrd /boot/initrd.img-4.15.0-74-generic
}
~
```

To complete the process, reboot the agent.

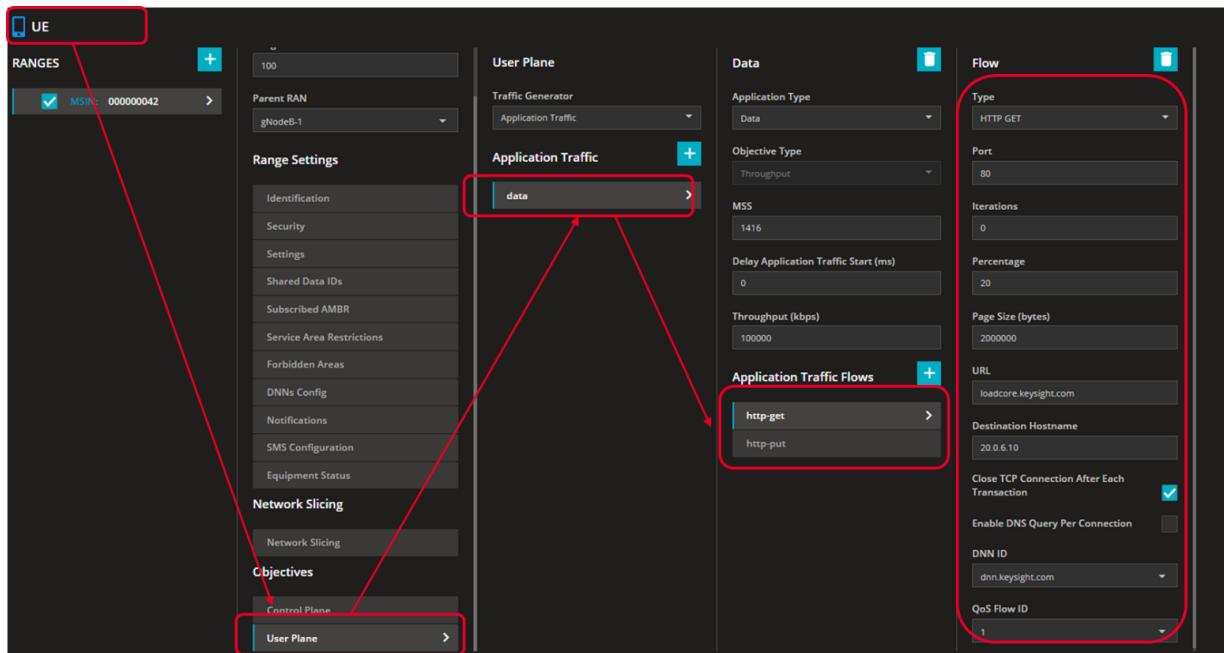
Application traffic configuration

Starting with LoadCore 2.1, there are three types of application traffic that can be used: **data**, **voice** and **video**.



The configuration of this type of traffic be done in two places:

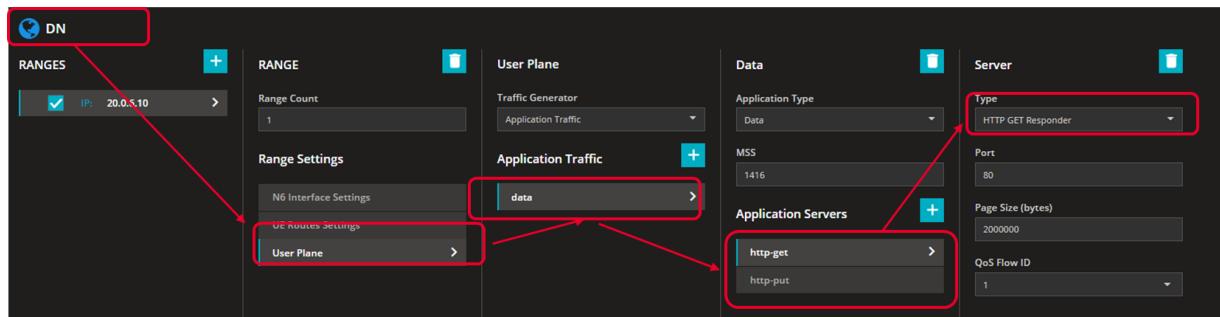
- On **UE > User Plane** objective: this controls the traffic that is sent or received by the UE, for both directions.



- On **DN > User Plane**: here you are configuring the server settings in order to answer the traffic the UE is sending. The configuration should match the settings you defined in the **UE > Control Plane > App traffic** (from the step above).

Here you are configuring the parameters for the endpoint considered *the responder* of the

traffic.



Create Custom Dashboard

There are two way to create a custom dashboard in order to display statistics:

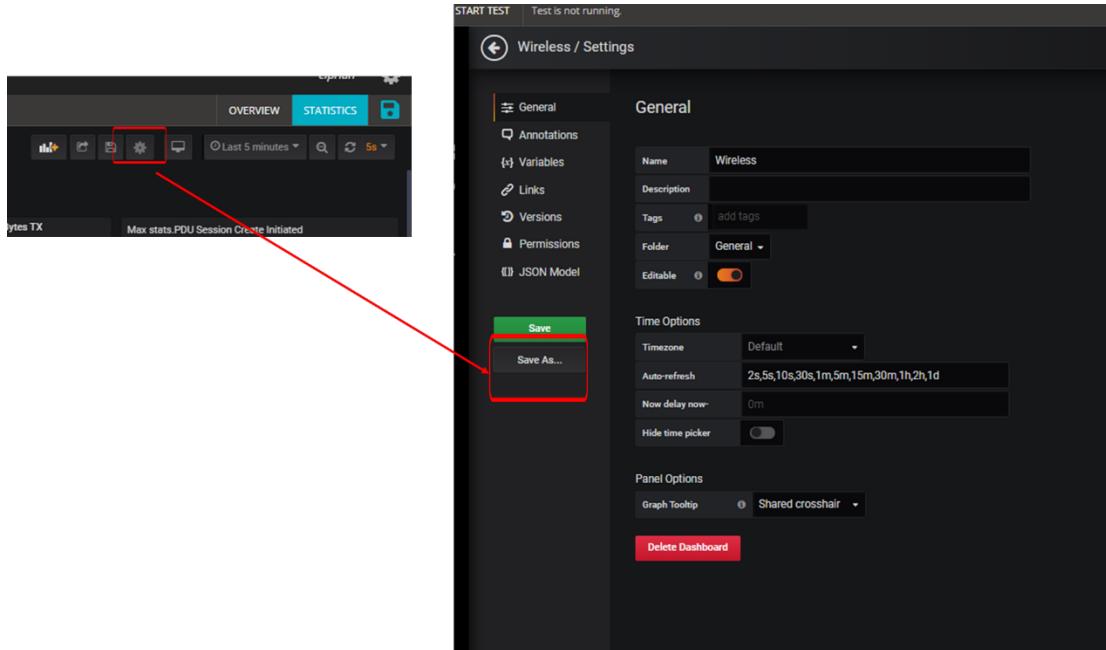
- create a dashboard based on an existing one (a pre-defined dashboard), or
- create a new dashboard and customize it based on your requirements

Create a dashboard based on an existing one

For consistency purposes (in order to keep same look and feel of the upper part of the dashboard), it is recommended to start from an already defined dashboard, save a copy of it and then modify it.

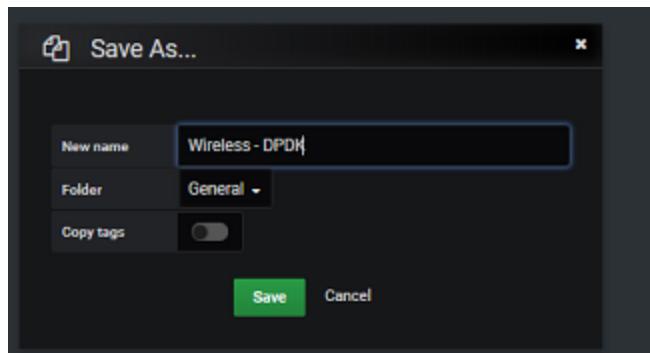
In this example, a new dashboard **Wireless-DPDK**, is created starting from the general one (**Wireless**), as follows:

1. From the Statistics tab, select the Wireless dashboard.
2. Select **View** and press the **ESC** key twice. This will open the top menu and a new side menu to customize dashboards.
3. From the top menu, select the **Settings** icon and, then, select **Save as**.



4. On the Save as window, you can save a copy of the current dashboard (**Wireless**) with a different name, and modify it according to your needs:

- Set the name of the new dashboard to **Wireless-DPDK**.

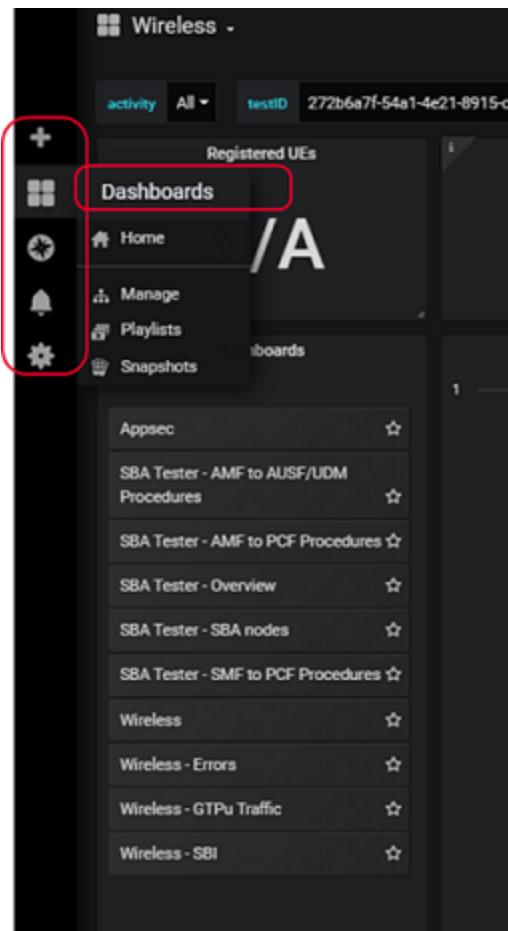


- Select the location of the new dashboard (it is recommended to keep it under the **General** folder, to be on the same list with the default dashboards).
- Select **Save**.

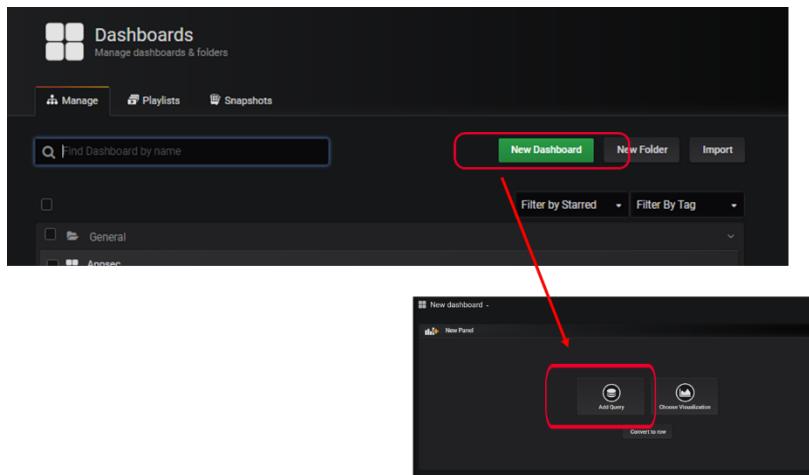
Create a new dashboard

To create a completely new dashboard, do the following:

- From the upper-left menu, select + icon and, then, select **Create a new dashboard**.

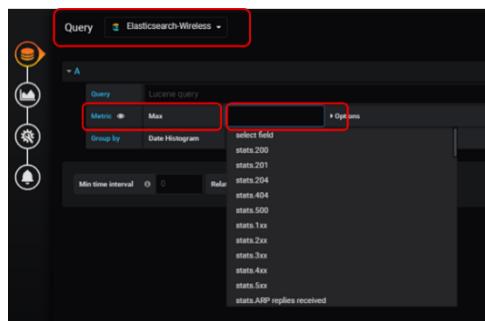


- Select **New Dashboard** and, then, from the New Dashboard window, select **Add Query**.



3. Configure the new dashboard:

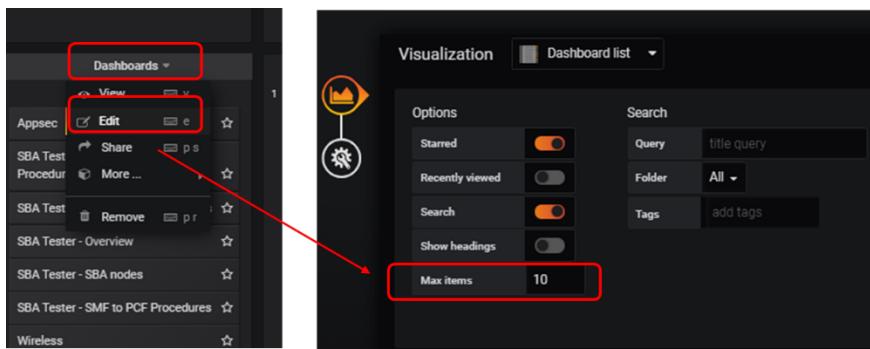
- Make sure you are selecting elastic search for the query type.



- Select **Metric Type : Max**.
- Select the metric you want to display.
- Save the dashboard with a relevant name.

IMPORTANT if the newly defined dashboard is not present in the list of available dashboards, then the number of displayed dashboards must be increased.

To modify the number of displayed dashboards, select **Dashboards > Edit > Visualization**, and change the value of **Max items** to increase/decrease the number of dashboard to be displayed. By default, the **Max items** value is set to 10.



Log Collection

Starting with LoadCore 1.3, logs collections can be easily retrieved from LoadCore UI, as follows:

1. From the LoadCore UI dashboard page, select **Browse Results**.
2. From the Test Results table, select the test for which you want to download the log collection.

The screenshot shows the LoadCore UI interface. At the top, there is a header bar with the title "Test Results" and a note "(Hold down Ctrl. for multiple selection)". Below this is a table with two columns: "Config Name" and "Test Name". The table contains five rows of data. At the bottom of the table, there is a toolbar with three buttons: "LOAD", "DOWNLOAD", and "DELETE". A red box highlights the "DOWNLOAD" button. A dropdown menu is open under the "DOWNLOAD" button, showing three options: "CSV", "Report", and "Captures & Logs".

Config Name	Test Name
132 - Copy of SBA Base Config (copy from Apr 23 07:31:42)	Wireless-cb53f2f6-22e9-4d0d-a70c-3083d4cddb5
131 - fullcore simulation (2021-03-10 11:11:08) (copy from Apr 23 07:28:53)	Wireless-272a4d9d-7a06-4d9e-a12d-a72bf9ae2f43
130 - Copy of SBA Base Config	Wireless-bf24345e-910a-48d9-80c3-b15fac013edc
129 - fullcore simulation (2021-03-10 11:11:08)	Wireless-51b2d520-b01b-4a14-98c3-3ab4d1ca4cb0

3. Select **Download Captures/Logs** and select the download location. This will download an archive containing both MW and Agent logs.

The logs can be also accessed using SSH on MW and Agents (as in the previous versions):

- **Agent logs:**

1. Connect to the agent using ssh (credentials **ixia /ixia**).

2.

```
sudo tail -f /var/log/syslog
```

- this contains communication between the port - manager on the agent and port manager on the MW machine

3. Check `/opt/5gc-test-engine/lizard-log.txt`.

4. Check `/opt/5gc-test-engine/logs/service.log`.

- this is the LoadCore log (if you reached this point, this means that the communication between the agents and the MW is already working)

- **Middleware (Cluster) logs:**

Kubectl commands can be done when logged in as root (there is separate procedure to log in as root, not to be confused with console login):

```
kubectl get pods --all-namespaces  
kubectl get pods -n keysight-wap  
kubectl logs podname -n keysight-wap
```

(for example: `kubectl logs agent-controller-5566944d54-w8w2k -n keysight-wap`)

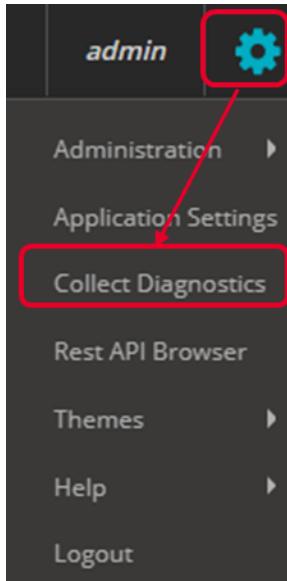
To collect diagnostics run the following command after logging in as console:

```
kcos logs diagnostics collect -a
```

Debug commands

How to collect diagnostics

Starting with LoadCore 2.1, the diagnostics files can be collected automatically from LoadCore UI by selecting the Settings icon and, then, select **Collect Diagnostics**.



An archive will be downloaded will all the diagnostic files from Middleware and agent.

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