Service Level Virtualization (SLV) User Guide

Version 0.13

Authors

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Abstract

For future 5G core networks, Service Based Architecture (SBA) has been proposed in 3GPP Release 15. To realize the idea of SBA, we propose Service Level Virtualization (SLV) in which each network entity is decomposed into different service blocks to provide respective services. In addition, each service block can be virtualized independently into different virtual machine. Thus, SLV can increase the flexibility of the core network.

How to use it?

(1). Download four images from the website: http://www.reconet.org/slv/#download

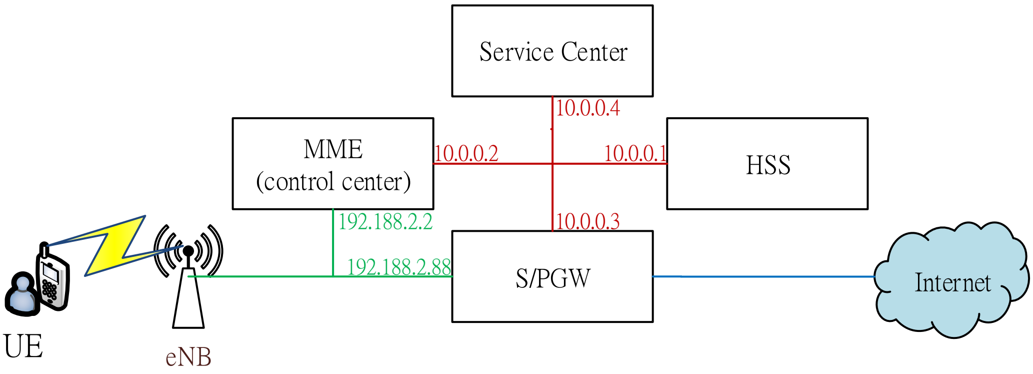
(2). Use virtual machine (hypervisor) to open all images.

(3). Set the network configuration:

The current IP addresses of images are shown in the following figure:

* MME and S/PGW use the red LAN to communicate with each other.

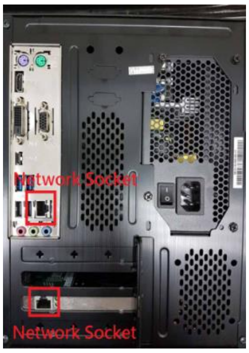
* The green Custom bridges are just used to connect to the eNB.

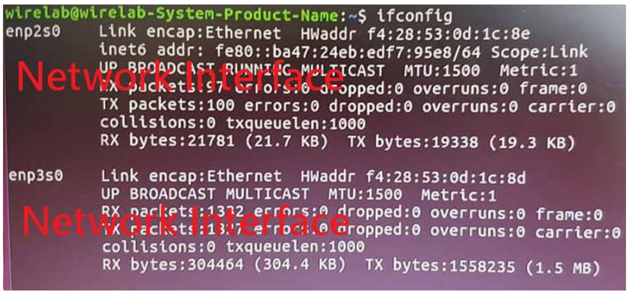


We use ubuntu 16.04 with VMware Workstation 12.5.7 for example below.

3-1. Setup network sockets and NICs (Network Interface Cards)

Set the relationship between **host network sockets** and **host NICs**.

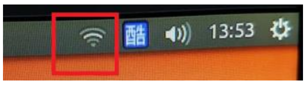




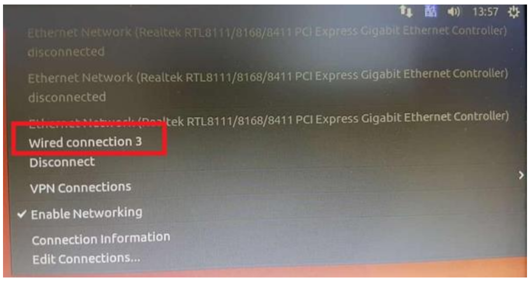
```
wirelab@wirelab-System-Product-Name:~$ ifconfig
enp2s0    Link encap:Ethernet  HWaddr f4:28:53:0d:1c:8e
          inet6 addr: fe80::ba47:24eb:edf7:95e8/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:97 errors:0 dropped:0 overruns:0 frame:0
          TX packets:100 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:21781 (21.7 KB)  TX bytes:19338 (19.3 KB)

enp3s0    Link encap:Ethernet  HWaddr f4:28:53:0d:1c:8d
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:1332 errors:0 dropped:0 overruns:0 frame:0
          TX packets:1327 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:304464 (304.4 KB)  TX bytes:1558235 (1.5 MB)
```

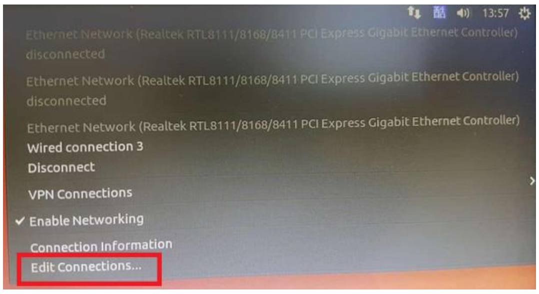
The simplest way to ensure the relationship is that attach one of the network socket to the Internet through an Internet wire. After that, click the Internet settings at the upper right corner.



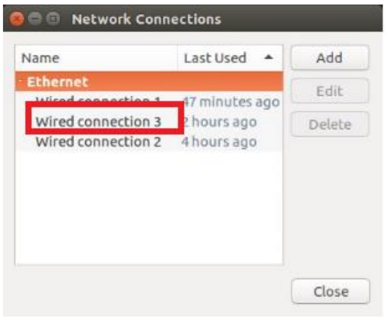
There will be a 'wired connect', remember this wired connection.


13:57
Ethernet Network (Realtek RTL8111/8168/8411 PCI Express Gigabit Ethernet Controller)
disconnected
Ethernet Network (Realtek RTL8111/8168/8411 PCI Express Gigabit Ethernet Controller)
disconnected
Ethernet Network (Realtek RTL8111/8168/8411 PCI Express Gigabit Ethernet Controller)
Wired connection 3
Disconnect
VPN Connections
✓ Enable Networking
Connection Information
Edit Connections...

Then click the 'Edit connections'.

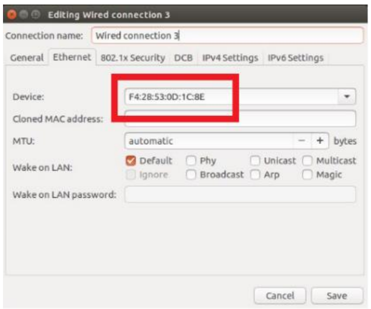

13:57
Ethernet Network (Realtek RTL8111/8168/8411 PCI Express Gigabit Ethernet Controller)
disconnected
Ethernet Network (Realtek RTL8111/8168/8411 PCI Express Gigabit Ethernet Controller)
disconnected
Ethernet Network (Realtek RTL8111/8168/8411 PCI Express Gigabit Ethernet Controller)
Wired connection 3
Disconnect
VPN Connections
✓ Enable Networking
Connection Information
Edit Connections...

Click the corresponding "wired connection" we find in the previous step.



Name	Last Used
Ethernet	
Wired connection 1	47 minutes ago
Wired connection 3	2 hours ago
Wired connection 2	4 hours ago

See the 'Ethernet' page, remember the device address.



Connection name: Wired connection 3

Device: F4:28:53:0D:1C:8E

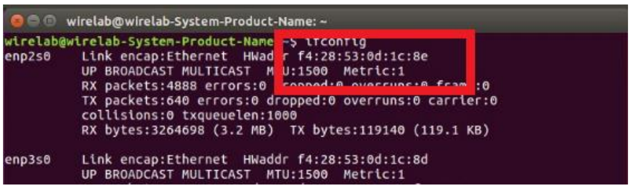
Cloned MAC address:

MTU: automatic − + bytes

Wake on LAN: ☑ Default ☐ Phy ☐ Unicast ☐ Multicast ☐ Ignore ☐ Broadcast ☐ Arp ☐ Magic

Wake on LAN password:

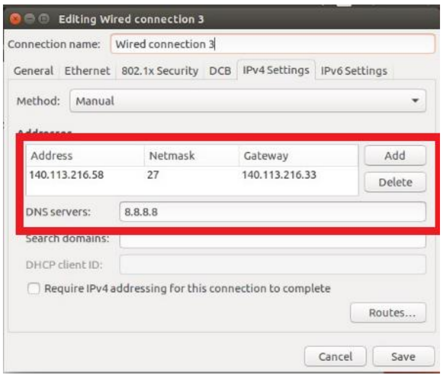
Then command '$ ifconfig', find the NIC which has the same physical address, that is the one the network socket mapped.



```
wirelab@wirelab-System-Product-Name: ~
wirelab@wirelab-System-Product-Name:~$ ifconfig
enp2s0    Link encap:Ethernet  HWaddr f4:28:53:0d:1c:8e
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
          RX packets:4888 errors:0 dropped:0 overruns:0 frame:0
          TX packets:640 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:3264698 (3.2 MB)  TX bytes:119140 (119.1 KB)

enp3s0    Link encap:Ethernet  HWaddr f4:28:53:0d:1c:8d
          UP BROADCAST MULTICAST  MTU:1500  Metric:1
```

Finally, set the internet well.



Editing Wired connection 3

Connection name: Wired connection 3

Method: Manual

Address	Netmask	Gateway
140.113.216.58	27	140.113.216.33

DNS servers: 8.8.8.8

Search domains:

DHCP client ID:

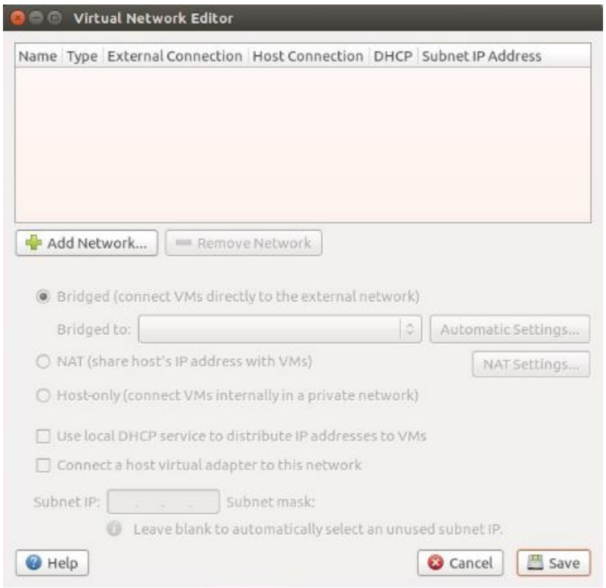
□ Require IPv4 addressing for this connection to complete

Now, we know the relationship between NICs and network sockets.

3-2. Setup NICs and virtual NICs

We have to know the relationship between **host NICs** and **virtual NICs**.

To use the custom mode in the VMware, we have to bridge NICs to virtual NICs. Choose Edit -> Virtual Network Editor -> key in the host password -> remove all settings.



Virtual Network Editor

Name	Type	External Connection	Host Connection	DHCP	Subnet IP Address

● Bridged (connect VMs directly to the external network)

Bridged to:

○ NAT (share host's IP address with VMs)

○ Host-only (connect VMs internally in a private network)

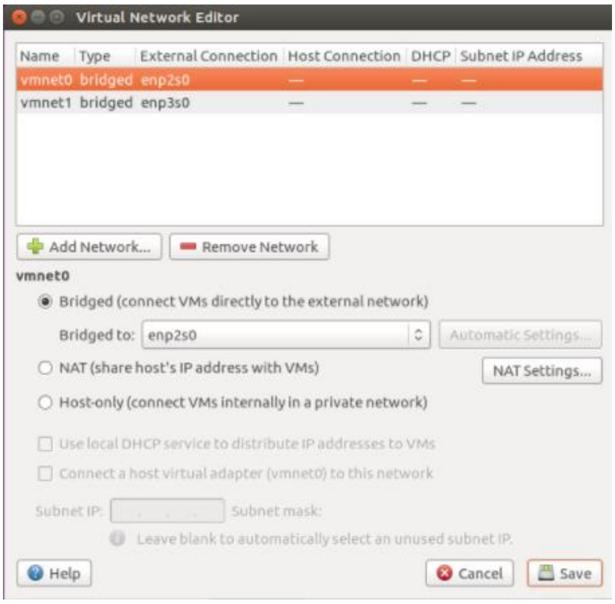
□ Use local DHCP service to distribute IP addresses to VMs

□ Connect a host virtual adapter to this network

Subnet IP: . . .   Subnet mask:

Leave blank to automatically select an unused subnet IP.

Then Add Network -> choose bridge mode -> Add -> select the particular NIC to bridge, and that is the NIC we bridge to the virtual NIC.



Name	Type	External Connection	Host Connection	DHCP	Subnet IP Address
vmnet0	bridged	enp2s0	—	—	—
vmnet1	bridged	enp3s0	—	—	—

vmnet0

● Bridged (connect VMs directly to the external network)

Bridged to: enp2s0

○ NAT (share host's IP address with VMs)

○ Host-only (connect VMs internally in a private network)

□ Use local DHCP service to distribute IP addresses to VMs

□ Connect a host virtual adapter (vmnet0) to this network

Subnet IP: . . . Subnet mask:

Leave blank to automatically select an unused subnet IP.

Now, we know the relationship between NICs and virtual NICs.

3-3. Requirements of each image/VM (Virtual Machines)

We have to know the requirements of **NICs in VMs**, **IPs**, and **NIC modes**.

HSS requires 1 LAN segment.

```
$ sudo ifconfig <VM interface> 10.0.0.1
```

MME requires 1 LAN segment & 1 Custom bridge.

```
$ sudo ifconfig <VM interface A> 10.0.0.2 (LAN)
$ sudo ifconfig <VM interface B> 192.188.2.2
```

Service Center requires 1 LAN segment.

```
$ sudo ifconfig <VM interface> 10.0.0.4
```

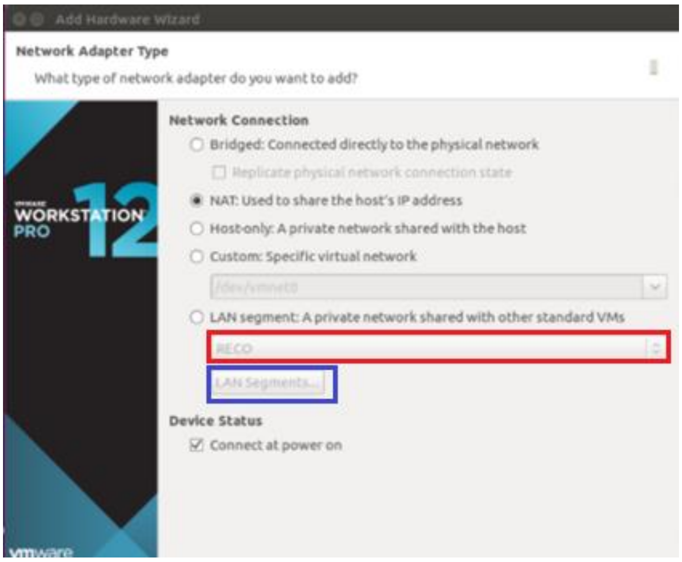
S/PGW requires 1 LAN segment & 2 Custom bridges.

```
$ sudo ifconfig <VM interface A> 10.0.0.3 (LAN)
$ sudo ifconfig <VM interface B> 192.188.2.88
$ sudo ifconfig <VM interface C> <real Internet IP>
```

* For <real Internet IP>, please also set your **default gateway** & **network mask** to connect to the outside Internet successfully.

3-4. Setup the LAN mode and the Custom mode and the others

1. **LAN mode**
   a. Right-click the VM
   b. Left-click “Settings”
   c. Right-click the target NIC
   d. Check the “LAN segment” box
   e. Choose the exits LAN (the red box), or left-click “LAN Segments” to add one (the blue box).



Add Hardware Wizard

Network Adapter Type

What type of network adapter do you want to add?

Network Connection

○ Bridged: Connected directly to the physical network

□ Replicate physical network connection state

● NAT: Used to share the host's IP address

○ Host-only: A private network shared with the host

○ Custom: Specific virtual network

/dev/vmnet0

○ LAN segment: A private network shared with other standard VMs

RECO

LAN Segments...

Device Status

☑ Connect at power on

2. **Custom mode**
   a. Right-click the VM
   b. Left-click “Settings”
   c. Right-click the target NIC
   d. Check the “Custom” box
   e. Choose the exits virtual NIC we set in the step 3-2

   * <VM interface B> pair to the virtual NIC to the eNB.

   * <VM interface C> pair to the virtual NIC to the Internet.

3. **Default gateway**

```
$ sudo route add -net 0.0.0.0 netmask 0.0.0.0 gw <default gateway IP>
```

4. **DNS server**

```
$ sudo chmod 777 /etc/resolvconf/resolv.conf.d/base
$ sudo echo "nameserver 8.8.8.8" > /etc/resolvconf/resolv.conf.d/base
$ sudo resolvconf -u
```

(4). Modify configuration files:

4-1. MME

~RECO/ETC $ sudo vim ./mme.conf

Set 'MME_INTERFACE_NAME_FOR_S1_MME' to <VM interface B>

Set 'MME_IPV4_ADDRESS_FOR_S1_MME' to 192.188.2.2/24

Set 'MME_INTERFACE_NAME_FOR_S11_MME' to <VM interface A>

Set 'MME_IPV4_ADDRESS_FOR_S1_MME' to 10.0.0.2/8

4-2. Service Center

$ sudo vim /usr/local/etc/oai/mme.conf

Set 'MME_INTERFACE_NAME_FOR_S11_MME' to <VM interface A>

Set 'MME_IPV4_ADDRESS_FOR_S1_MME' to 10.0.0.4/8

4-3. S/PGW

$ sudo vim /usr/local/etc/oai/spgw.conf

Set 'SGW_INTERFACE_NAME_FOR_S11' to <VM interface A>

Set 'SGW_IPV4_ADDRESS_FOR_S11' to 10.0.0.3/8

Set 'SGW_INTERFACE_NAME_FOR_S1U_S12_S4_UP' to <VM interface B>

Set 'SGW_IPV4_ADDRESS_FOR_S1U_S12_S4_UP' to 192.188.2.88/24

Set 'PGW_INTERFACE_NAME_FOR_SGI' to <VM interface C>

(5). Run each process:

5-1. HSS

~/RECO/SCRITS/ $ sudo ./run_hss

5-2. S/PGW

~/RECO/SCRITS/ $ sudo ./run_spgw

5-3. MME

~/RECO/SCRITS/ $ sudo python ./pseudo_identifier.py

Then check the five boxes at the first column

Then if any UEs connect, choose the user type for it (**click Human or IoT**)

5-4. Service Center

Open 2 terminals.

(Terminal 1) ~/RECO/location_human/ $ sudo ./location

(Terminal 2) ~/RECO/location_iot/ $ sudo ./location

Important Notice

1. On the desktop of each image, there is a .txt file record the path of running code.
2. The human & IoT services in the service center are just for example. In other words, they are not the real ones that perfect suit the human users or the IoT users.
3. If the NIC in the VM cannot work successfully, and there are more than one NIC in that VM, please try different combination of NICs in the VM to sure which NIC in the VM is <VM interface A> or <VM interface B> or <VM interface C>. This is because the order of NICs in the VM is not fixed. Therefore, the first NIC in the VM may be or may be not the <VM interface A>.