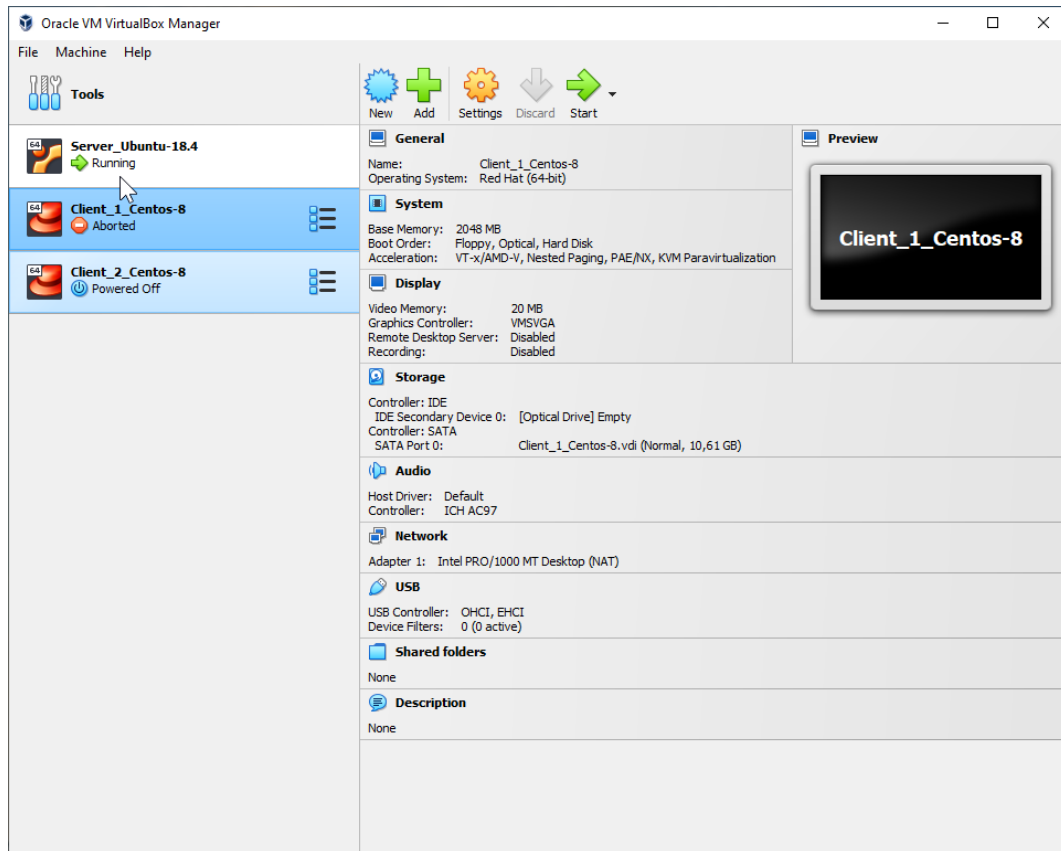
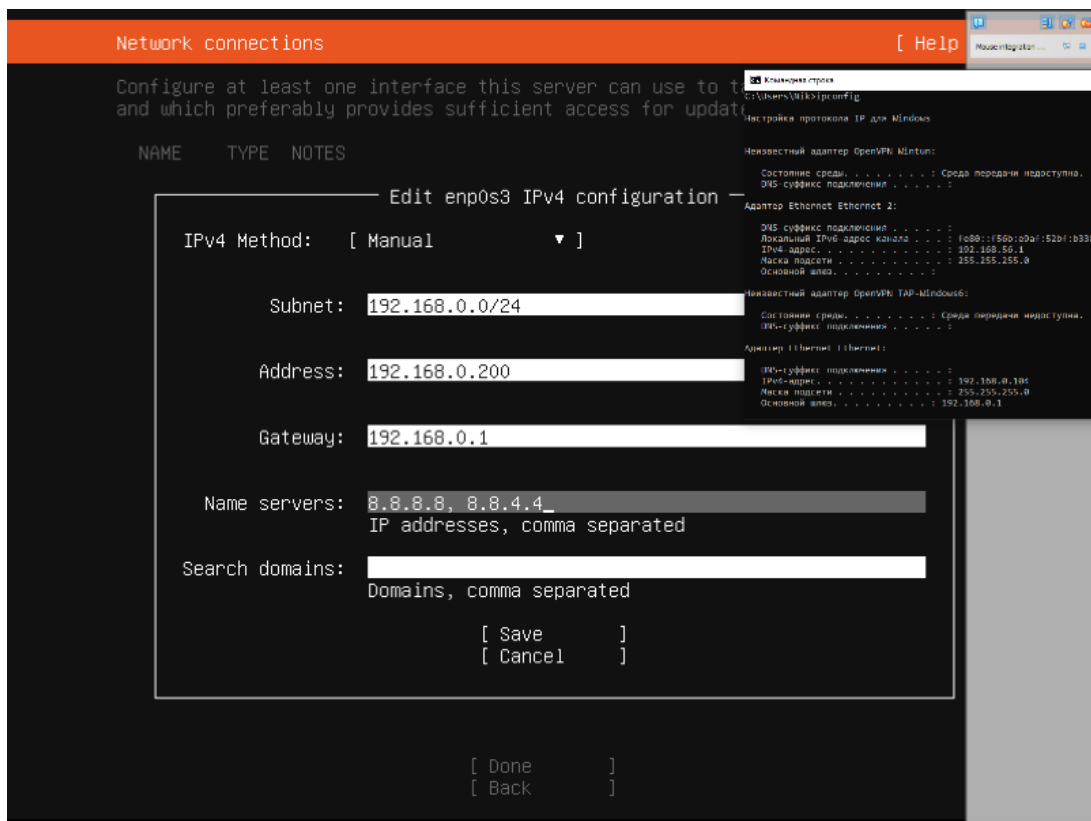


EPAM University Programs DevOps external course

Module – Linux Networking



Configuring DHCP server



Client_1 та Client_2 – Віртуальні машини, на яких розгорнуто ОС Linux (бажано різні дистрибутиви, наприклад Ubuntu та CentOS). Інтерфейси підключені в режимі «Внутрішня мережа» до мереж Net2, Net3 та Net4 як показано на рисунку 1. Адреса мережі Net2 – 10.Y.D.0/24, де Y – дві останні цифри з вашого року народження, D – дата народження. Адреса мережі Net3 – 10.M.Y.0/24, де M – номер місяця народження. Адреса мережі Net4 – 172.16.D.0/24. Увага! Якщо, адресний простір Net2, Net3 або Net4 перетинається з адресним простором Net1 – відповідну адресу можна змінити на власний розсуд.

1. На Server_1 налаштувати статичні адреси на всіх інтерфейсах.

nano /etc/netplan/00-installer-config.yaml

```
root@Server-1: /home/nik
GNU nano 6.2 /etc/netplan/00-installer-config.yaml *
# This is the network config written by 'subiquity'
network:
  ethernet:
    enp0s3:
      addresses:
        - 192.168.0.200/24
      dhcp4: false
      gateway4: 192.168.0.1
      nameservers:
        addresses:
          - 192.168.0.1
          - 8.8.8.8
          - 8.8.4.4
        search: []
    enp0s8:
      addresses:
        - 10.87.7.2/24
    enp0s9:
      addresses:
        - 10.7.87.2/24
  version: 2
```

Ip interface can't finish on "0" – addr subnet and "1" - gateway

Netplan apply

```
root@Server-1:/home/nik# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:05:74:86 brd ff:ff:ff:ff:ff:ff
    inet 192.168.0.200/24 brd 192.168.0.255 scope global enp0s3
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:bf:50:07 brd ff:ff:ff:ff:ff:ff
    inet 10.87.7.2/24 brd 10.87.7.255 scope global enp0s8
        valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:4e:2f:af brd ff:ff:ff:ff:ff:ff
    inet 10.7.87.2/24 brd 10.7.87.255 scope global enp0s9
        valid_lft forever preferred_lft forever
root@Server-1:/home/nik#
```

2. На Server_1 налаштувати DHCP сервіс, який буде конфігурувати адреси Int1 Client_1 та Client_2

nano /etc/dhcp/dhcpd.conf

```
root@Server-1: /home/nik
GNU nano 6.2 /etc/dhcp/dhcpd.conf
dhcpd.conf
#
# Sample configuration file for ISC dhcpd
#
# Attention: If /etc/ltsp/dhcpd.conf exists, that will be used as
# configuration file instead of this file.
#
# option definitions common to all supported networks...
#option domain-name "example.org";
#option domain-name-servers ns1.example.org, ns2.example.org;

default-lease-time 600;
max-lease-time 72000;

# The ddns-updates-style parameter controls whether or not the server will
# attempt to do a DNS update when a lease is confirmed. We default to the
# behavior of the version 2 packages ('none', since DHCP v2 didn't
# have support for DDNS.)
ddns-update-style none;

# If this DHCP server is the official DHCP server for the local
# network, the authoritative directive should be uncommented.
authoritative;

#----- client 1 -----
#----- net 2 -----

# A slightly different configuration for an internal subnet.
subnet 10.87.7.0 netmask 255.255.255.0 {
    range 10.87.7.2 10.87.7.254;
    # option domain-name-servers ns1.internal.example.org;
    # option domain-name "internal.example.org";
    # option subnet-mask 255.255.255.224;
    # option routers 10.5.5.1;
    # option broadcast-address 10.5.5.31;
    # default-lease-time 600;
    # max-lease-time 7200;
}

host Client-1
{
    hardware ethernet 08:00:27:da:65:7b;
    fixed-address 10.87.7.101;
    option routers 10.87.7.1;
}

#----- client 2 -----
#----- net 3 -----

# A slightly different configuration for an internal subnet.
subnet 10.7.87.0 netmask 255.255.255.0 {
    range 10.7.87.2 10.7.87.254;
    # option domain-name-servers ns1.internal.example.org;
    # option domain-name "internal.example.org";
    # option subnet-mask 255.255.255.224;
    # option routers 10.5.5.1;
    # option broadcast-address 10.5.5.31;
    # default-lease-time 600;
    # max-lease-time 7200;
}

host Client-2
{
    hardware ethernet 08:00:27:f5:9b:5c;
    fixed-address 10.7.87.102;
    option routers 10.7.87.1;
}

^G Help      ^O Write Out  ^W Where Is   ^R Cut        ^T Execute    ^C Locat
^X Exit      ^R Read File  ^_ Replace    ^U Paste      ^J Justify    ^/ Go To
```

systemctl restart isc-dhcp-server

hardware ethernet – MAC address of interface client VM

fixed-address - IP address of interface client VM

option routers - gateway address of interface client VM

Client-1 - Settings

Network

Adapter 1 Adapter 2 Adapter 3 Adapter 4

☒ Enable Network Adapter

Attached to: Internal Network

Name: Net2

Advanced

Adapter Type: Intel PRO/1000 MT Desktop (82540EM)

Promiscuous Mode: Deny

MAC Address: 080027DA657B

☒ Cable Connected

Port Forwarding

OK Cancel Help

Client-2 - Settings

Network

Adapter 1 Adapter 2 Adapter 3 Adapter 4

☒ Enable Network Adapter

Attached to: Internal Network

Name: Net3

Advanced

Adapter Type: Intel PRO/1000 MT Desktop (82540EM)

Promiscuous Mode: Deny

MAC Address: 080027F59B5C

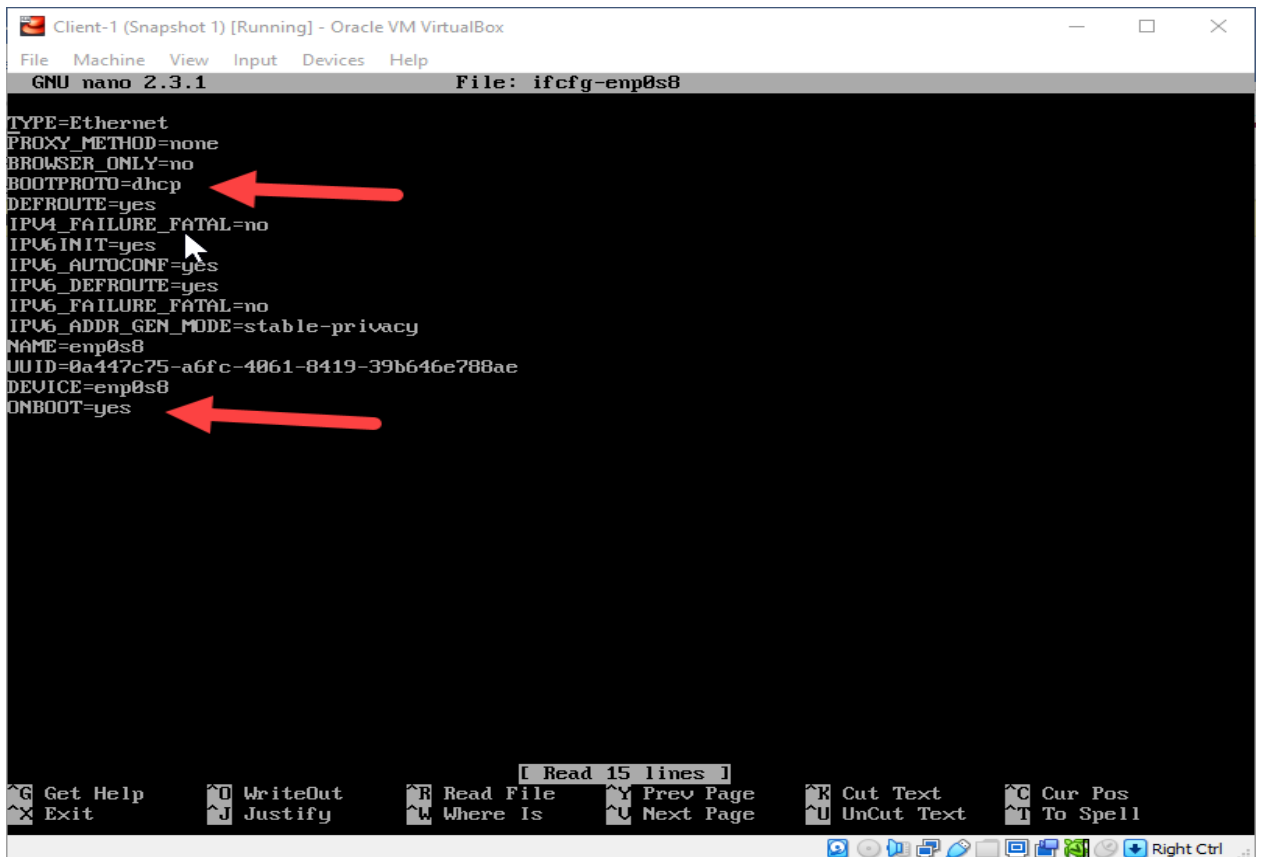
☒ Cable Connected

Port Forwarding

OK Cancel Help

Client-1

`cd /etc/sysconfig/network-scripts`

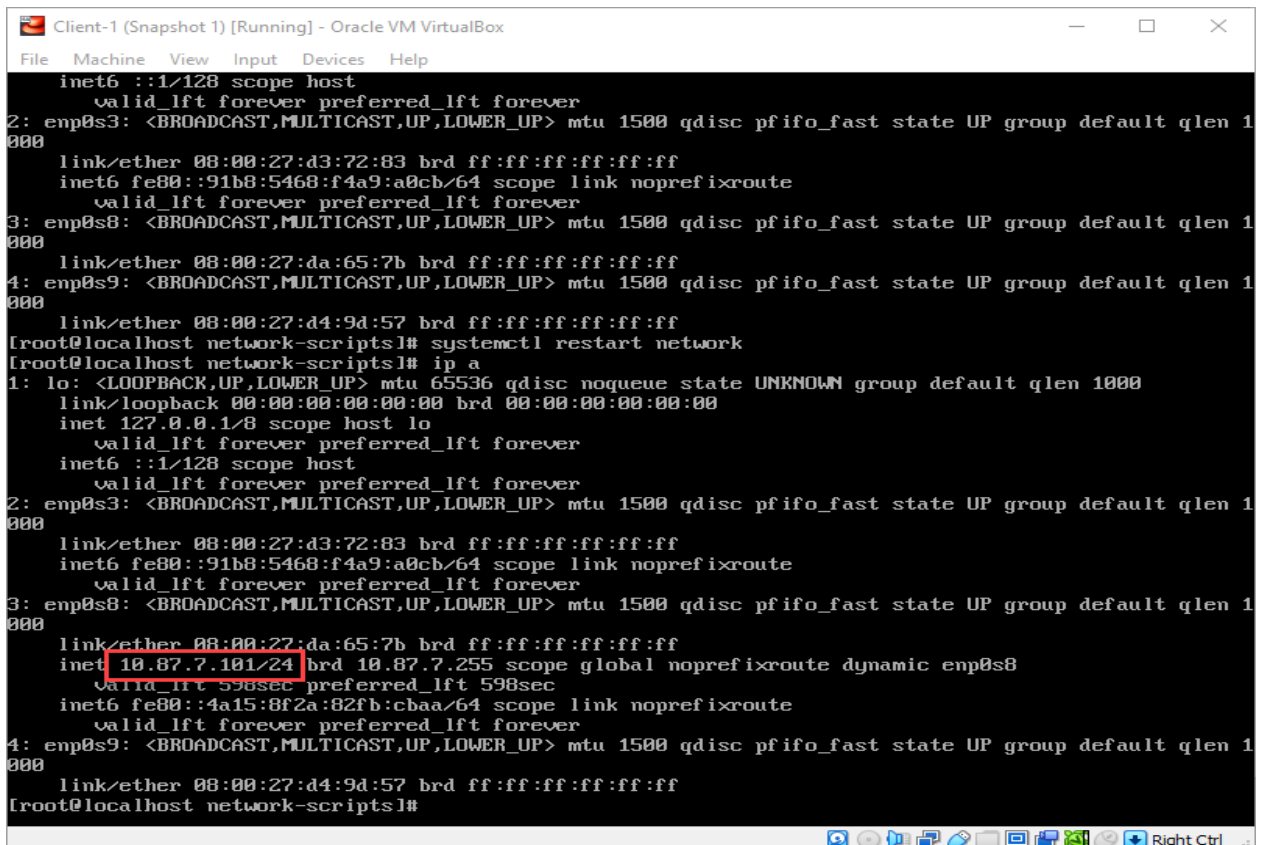


The screenshot shows a terminal window titled "Client-1 (Snapshot 1) [Running] - Oracle VM VirtualBox". The terminal is running the nano text editor, editing the file `ifcfg-emps8`. The configuration is for an Ethernet interface. Two red arrows point to the `BOOTPROTO=dhcp` and `ONBOOT=yes` lines. The terminal output is as follows:

```
GNU nano 2.3.1 File: ifcfg-emps8

TYPE=Ethernet
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=dhcp
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6_INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=emp0s8
UUID=0a447c75-a6fc-4061-8419-39b646e788ae
DEVICE=emp0s8
ONBOOT=yes
```

The bottom of the terminal shows the nano editor's command palette with options like Get Help, Exit, WriteOut, Justify, Read File, Where Is, Prev Page, Next Page, Cut Text, UnCut Text, Cur Pos, and To Spell.



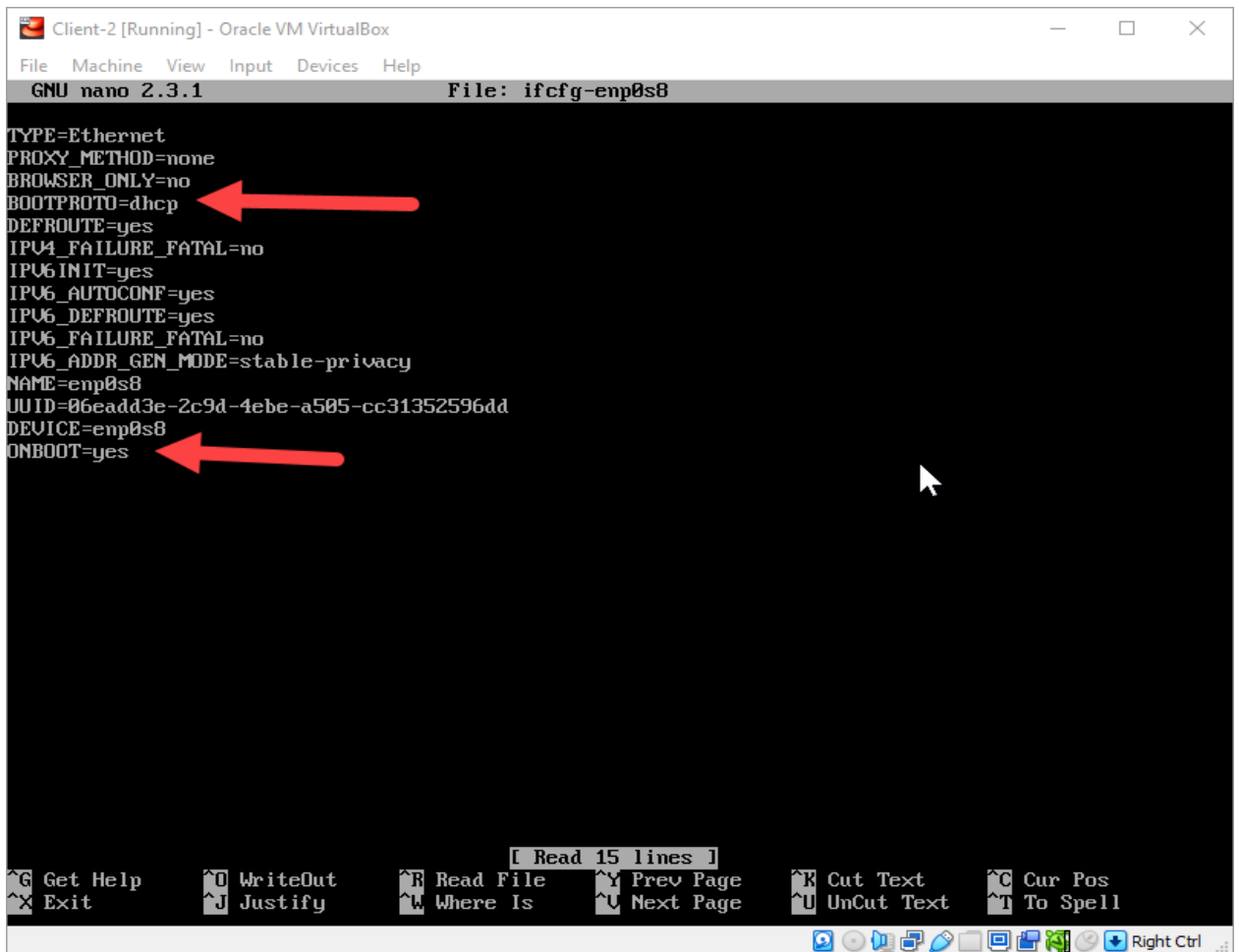
The screenshot shows a terminal window titled "Client-1 (Snapshot 1) [Running] - Oracle VM VirtualBox". The terminal is running the `ip netns exec` command to show the network configuration of the `emp0s8` interface. The output is as follows:

```
Client-1 (Snapshot 1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help

inet6 ::1/128 scope host
    valid_lft forever preferred_lft forever
2: emp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:d3:72:83 brd ff:ff:ff:ff:ff:ff
    inet6 fe80::91b8:5468:f4a9:a0cb/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: emp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:da:65:7b brd ff:ff:ff:ff:ff:ff
4: emp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:d4:9d:57 brd ff:ff:ff:ff:ff:ff
[root@localhost network-scripts]# systemctl restart network
[root@localhost network-scripts]# ip netns exec
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: emp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:d3:72:83 brd ff:ff:ff:ff:ff:ff
    inet6 fe80::91b8:5468:f4a9:a0cb/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: emp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:da:65:7b brd ff:ff:ff:ff:ff:ff
    inet 10.87.7.101/24 brd 10.87.7.255 scope global noprefixroute dynamic emp0s8
        valid_lft 598sec preferred_lft 598sec
    inet6 fe80::4a15:8f2a:82fb:cbaa/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
4: emp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:d4:9d:57 brd ff:ff:ff:ff:ff:ff
[root@localhost network-scripts]#
```

systemctl restart network

Client-2



The screenshot shows a terminal window titled "Client-2 [Running] - Oracle VM VirtualBox". Inside, the nano 2.3.1 text editor is open, editing the file "ifcfg-emp0s8". The configuration is for an Ethernet interface. Two red arrows highlight the settings "BOOTPROTO=dhcp" and "ONBOOT=yes".

```
GNU nano 2.3.1 File: ifcfg-emp0s8

TYPE=Ethernet
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=dhcp
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6_INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=emp0s8
UUID=06eadd3e-2c9d-4ebe-a505-cc31352596dd
DEVICE=emp0s8
ONBOOT=yes
```

At the bottom of the nano editor, there is a menu bar with the following options: [Read 15 lines], ^G Get Help, ^O WriteOut, ^R Read File, ^Y Prev Page, ^K Cut Text, ^C Cur Pos, ^X Exit, ^J Justify, ^W Where Is, ^U Next Page, ^U UnCut Text, ^T To Spell. The bottom status bar shows "Right Ctrl" and a cursor icon.

```
Client-2 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help

[ Read 15 lines ]

[root@localhost network-scripts]# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:03:f6:8a brd ff:ff:ff:ff:ff:ff
    inet6 fe80::a56e:fdea:e5b7:7205/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:f5:9b:5c brd ff:ff:ff:ff:ff:ff
    inet 10.7.87.102/24 brd 10.7.87.255 scope global noprefixroute dynamic enp0s8
        valid_lft 565sec preferred_lft 565sec
    inet6 fe80::1657:36a:7cc2:ea18/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:c5:9d:e7 brd ff:ff:ff:ff:ff:ff
[root@localhost network-scripts]# _
```

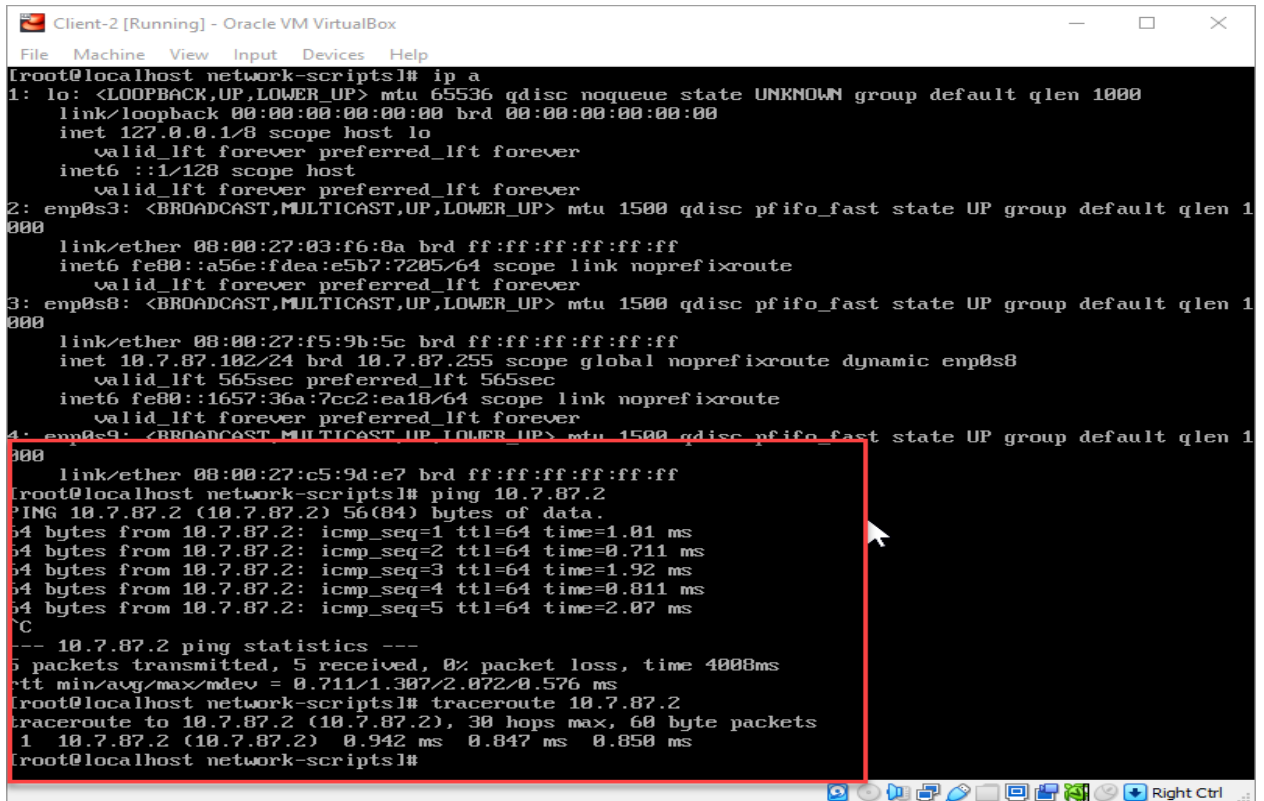
3. За допомогою команд ping та traceroute перевірити зв'язок між віртуальними машинами. Результат пояснити.

Client-1 Ping to Server-1

```
Client-1 (Snapshot 1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help

    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:d3:72:83 brd ff:ff:ff:ff:ff:ff
    inet6 fe80::91b8:5468:f4a9:a0cb/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:da:65:7b brd ff:ff:ff:ff:ff:ff
    inet 10.87.7.101/24 brd 10.87.7.255 scope global noprefixroute dynamic enp0s8
        valid_lft 598sec preferred_lft 598sec
    inet6 fe80::4a15:8f2a:82fb:cbaa/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:d4:9d:57 brd ff:ff:ff:ff:ff:ff
[root@localhost network-scripts]# ping 10.87.7.2
PING 10.87.7.2 (10.87.7.2) 56(84) bytes of data:
64 bytes from 10.87.7.2: icmp_seq=1 ttl=64 time=1.48 ms
64 bytes from 10.87.7.2: icmp_seq=2 ttl=64 time=1.65 ms
64 bytes from 10.87.7.2: icmp_seq=3 ttl=64 time=2.82 ms
64 bytes from 10.87.7.2: icmp_seq=4 ttl=64 time=1.30 ms
64 bytes from 10.87.7.2: icmp_seq=5 ttl=64 time=0.820 ms
64 bytes from 10.87.7.2: icmp_seq=6 ttl=64 time=0.641 ms
64 bytes from 10.87.7.2: icmp_seq=7 ttl=64 time=3.69 ms
64 bytes from 10.87.7.2: icmp_seq=8 ttl=64 time=0.689 ms
^C
--- 10.87.7.2 ping statistics ---
8 packets transmitted, 8 received, 0% packet loss, time 7031ms
rtt min/avg/max/mdev = 0.641/1.639/3.692/1.021 ms
[root@localhost network-scripts]# traceroute 10.87.7.2
traceroute to 10.87.7.2 (10.87.7.2), 30 hops max, 60 byte packets
 1 10.87.7.2 (10.87.7.2) 0.665 ms 0.597 ms 0.772 ms
[root@localhost network-scripts]#
```

Client-2 Ping to Server-1



```
Client-2 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
root@localhost network-scripts1# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:03:f6:8a brd ff:ff:ff:ff:ff:ff
    inet6 fe80::a56e:fdea:e5b7:7205/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:f5:9b:5c brd ff:ff:ff:ff:ff:ff
    inet 10.7.87.102/24 brd 10.7.87.255 scope global noprefixroute dynamic enp0s8
        valid_lft 565sec preferred_lft 565sec
    inet6 fe80::1657:36a:7cc2:ea18/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:c5:9d:e7 brd ff:ff:ff:ff:ff:ff
root@localhost network-scripts1# ping 10.7.87.2
PING 10.7.87.2 (10.7.87.2) 56(84) bytes of data.
64 bytes from 10.7.87.2: icmp_seq=1 ttl=64 time=1.01 ms
64 bytes from 10.7.87.2: icmp_seq=2 ttl=64 time=0.711 ms
64 bytes from 10.7.87.2: icmp_seq=3 ttl=64 time=1.92 ms
64 bytes from 10.7.87.2: icmp_seq=4 ttl=64 time=0.811 ms
64 bytes from 10.7.87.2: icmp_seq=5 ttl=64 time=2.07 ms
^C
--- 10.7.87.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4000ms
rtt min/avg/max/mdev = 0.711/1.307/2.072/0.576 ms
root@localhost network-scripts1# traceroute 10.7.87.2
traceroute to 10.7.87.2 (10.7.87.2), 30 hops max, 60 byte packets
 1 10.7.87.2 (10.7.87.2) 0.942 ms 0.847 ms 0.850 ms
root@localhost network-scripts1#
```

Ping and traceroute to Client-1 and Client-2 from Server-1


```

root@Server-1: ~
314 ssh-copy-id -i ~/rsa_client-1 root@10.87.7.101 -p asd
315 ssh-copy-id -iO ~/rsa_client-1 root@10.87.7.101 -p asd
316 ssh-copy-id -i ~/rsa_client-1 root@10.87.7.101
317 ssh 10.87.7.101
318 ssh-copy-id -i ~/rsa_client-1 tmn@10.87.7.101
319 ssh-copy-id -i ~/rsa_client-1 nik@10.87.7.101
320 ssh-copy-id -i ~/rsa_client-1.pub root@10.87.7.101
321 ssh-copy-id -i ~/rsa_client-1 root@10.87.7.101
322 dd
323 ll
324 nano /etc/dhcp/dhcpd.conf
325 systemctl restart isc-dhcp-server
326 ip a
327 netplan apply
328 systemctl restart isc-dhcp-server
329 systemctl status isc-dhcp-server
330 systemctl restart isc-dhcp-server
331 ip a
332 nano /etc/dhcp/dhcpd.conf
333 systemctl restart isc-dhcp-server
334 nano /etc/dhcp/dhcpd.conf
335 systemctl restart isc-dhcp-server
336 netplan apply
337 systemctl restart isc-dhcp-server
338 nano /etc/dhcp/dhcpd.conf
339 history
root@Server-1:~# 305
305: command not found
root@Server-1:~# !305
ping 10.87.7.101
PING 10.87.7.101 (10.87.7.101) 56(84) bytes of data.
64 bytes from 10.87.7.101: icmp_seq=1 ttl=64 time=0.737 ms
64 bytes from 10.87.7.101: icmp_seq=2 ttl=64 time=1.81 ms
64 bytes from 10.87.7.101: icmp_seq=3 ttl=64 time=1.06 ms
64 bytes from 10.87.7.101: icmp_seq=4 ttl=64 time=1.79 ms
64 bytes from 10.87.7.101: icmp_seq=5 ttl=64 time=1.25 ms
64 bytes from 10.87.7.101: icmp_seq=6 ttl=64 time=0.587 ms
64 bytes from 10.87.7.101: icmp_seq=7 ttl=64 time=4.12 ms
64 bytes from 10.87.7.101: icmp_seq=8 ttl=64 time=1.06 ms
64 bytes from 10.87.7.101: icmp_seq=9 ttl=64 time=0.748 ms
64 bytes from 10.87.7.101: icmp_seq=10 ttl=64 time=0.701 ms
^C
--- 10.87.7.101 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9019ms
rtt min/avg/max/mdev = 0.587/1.384/4.117/0.998 ms
root@Server-1:~# !306
ping 10.7.87.102
PING 10.7.87.102 (10.7.87.102) 56(84) bytes of data.
64 bytes from 10.7.87.102: icmp_seq=1 ttl=64 time=0.793 ms
64 bytes from 10.7.87.102: icmp_seq=2 ttl=64 time=4.34 ms
64 bytes from 10.7.87.102: icmp_seq=3 ttl=64 time=0.700 ms
64 bytes from 10.7.87.102: icmp_seq=4 ttl=64 time=2.22 ms
64 bytes from 10.7.87.102: icmp_seq=5 ttl=64 time=2.97 ms
64 bytes from 10.7.87.102: icmp_seq=6 ttl=64 time=2.33 ms
64 bytes from 10.7.87.102: icmp_seq=7 ttl=64 time=2.35 ms
64 bytes from 10.7.87.102: icmp_seq=8 ttl=64 time=1.54 ms
64 bytes from 10.7.87.102: icmp_seq=9 ttl=64 time=2.13 ms
^C
--- 10.7.87.102 ping statistics ---
9 packets transmitted, 9 received, 0% packet loss, time 8016ms
rtt min/avg/max/mdev = 0.700/2.153/4.340/1.047 ms
root@Server-1:~# !307
traceroute 10.7.87.102
traceroute to 10.7.87.102 (10.7.87.102), 30 hops max, 60 byte packets
1 10.7.87.102 (10.7.87.102) 0.738 ms !X 0.408 ms !X 0.546 ms !X
root@Server-1:~# !308
traceroute 10.87.7.101
traceroute to 10.87.7.101 (10.87.7.101), 30 hops max, 60 byte packets
1 10.87.7.101 (10.87.7.101) 0.566 ms !X 0.329 ms !X 0.581 ms !X
root@Server-1:~#

```

Client-1 (Snapshot 1) [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

GNU nano 2.3.1 File: ifcfg-ens9

```
TYPE=Ethernet
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=dhcp
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=ens9
UUID=92b6b35f-86c8-4bcb-b91c-90203b5fec8f
DEVICE=ens9
ONBOOT=yes
IPADDR=172.16.7.2
NETMASK=255.255.255.0
NETWORK=172.16.7.0
```

[Read 18 lines]

Get Help WriteOut Read File Prev Page Cut Text Cur Pos
Exit Justify Where Is Next Page UnCut Text To Spell

Right Ctrl

Client-2 [Running] - Oracle VM VirtualBox

File Machine View Input Devices Help

GNU nano 2.3.1 File: ifcfg-ens9 Modified

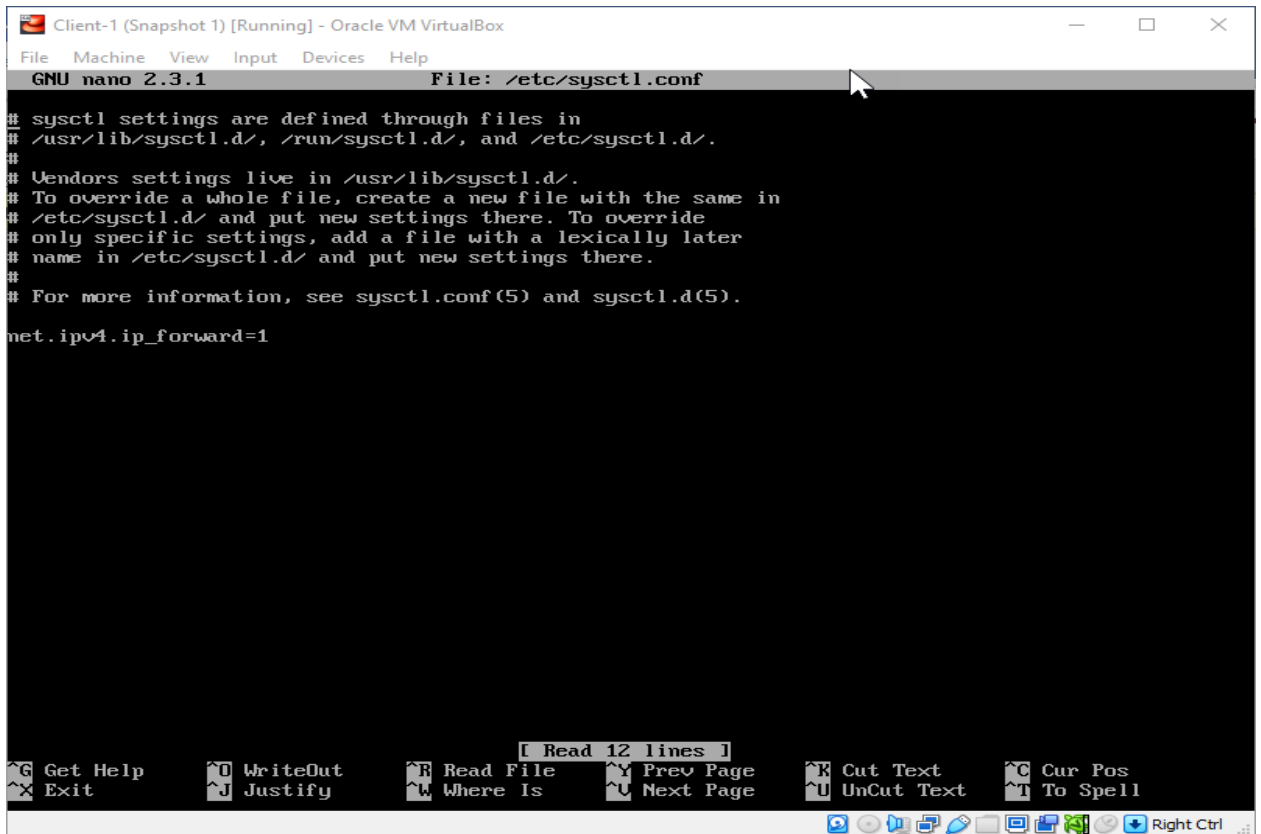
```
TYPE=Ethernet
PROXY_METHOD=none
BROWSER_ONLY=no
BOOTPROTO=dhcp
DEFROUTE=yes
IPV4_FAILURE_FATAL=no
IPV6INIT=yes
IPV6_AUTOCONF=yes
IPV6_DEFROUTE=yes
IPV6_FAILURE_FATAL=no
IPV6_ADDR_GEN_MODE=stable-privacy
NAME=ens9
UUID=6fede224-b3e0-4beb-be42-7cdbcc5bd7cd
DEVICE=ens9
ONBOOT=yes
IPADDR=172.16.7.3
NETMASK=255.255.255.0
NETWORK=172.16.7.0
```

Save modified buffer (ANSWERING "No" WILL DESTROY CHANGES) ?

Y Yes
N No C Cancel

Right Ctrl

nano /etc/sysctl.conf



```
Client-1 (Snapshot 1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
GNU nano 2.3.1 File: /etc/sysctl.conf

# sysctl settings are defined through files in
# /usr/lib/sysctl.d/, /run/sysctl.d/, and /etc/sysctl.d/.
#
# Vendors settings live in /usr/lib/sysctl.d/.
# To override a whole file, create a new file with the same in
# /etc/sysctl.d/ and put new settings there. To override
# only specific settings, add a file with a lexically later
# name in /etc/sysctl.d/ and put new settings there.
#
# For more information, see sysctl.conf(5) and sysctl.d(5).

net.ipv4.ip_forward=1

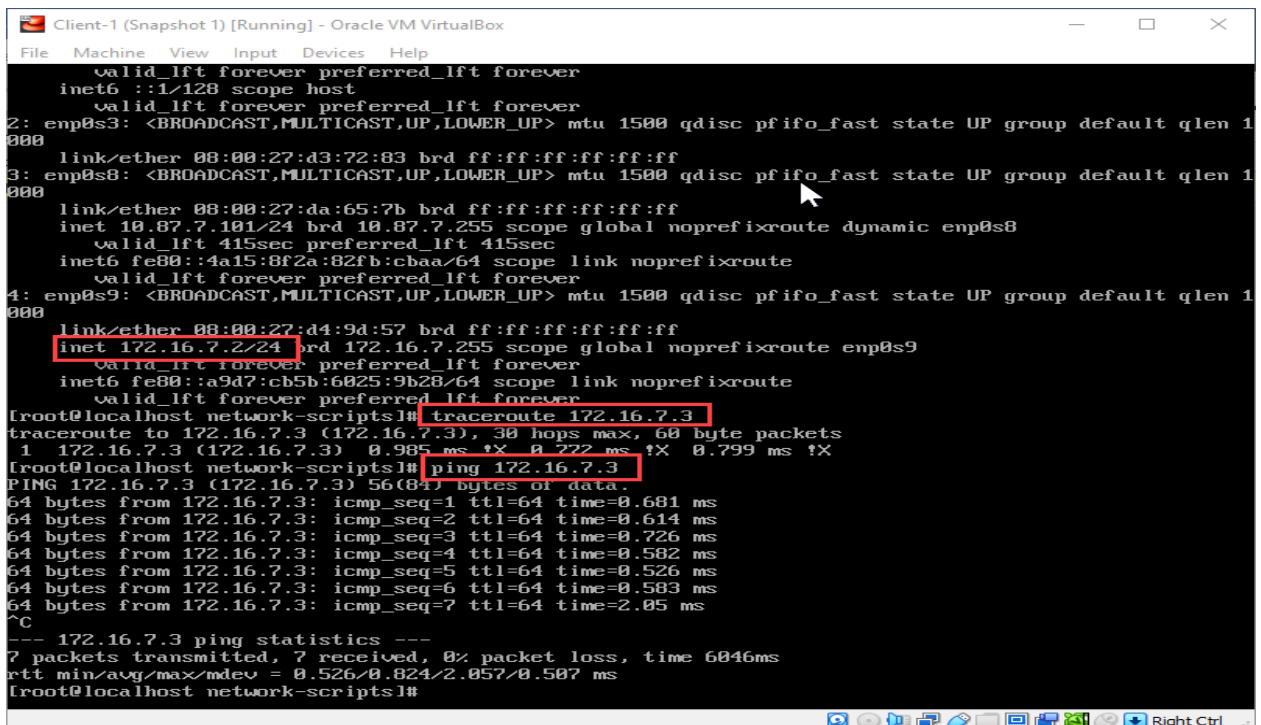
^G Get Help  ^O WriteOut  ^R Read File  ^Y Prev Page  ^K Cut Text  ^C Cur Pos
^X Exit      ^J Justify   ^W Where Is   ^U Next Page  ^U UnCut Text ^T To Spell

Read 12 lines
Right Ctrl
```

net.ipv4.ip_forward=1

net.ipv6.conf.all.forwarding=1

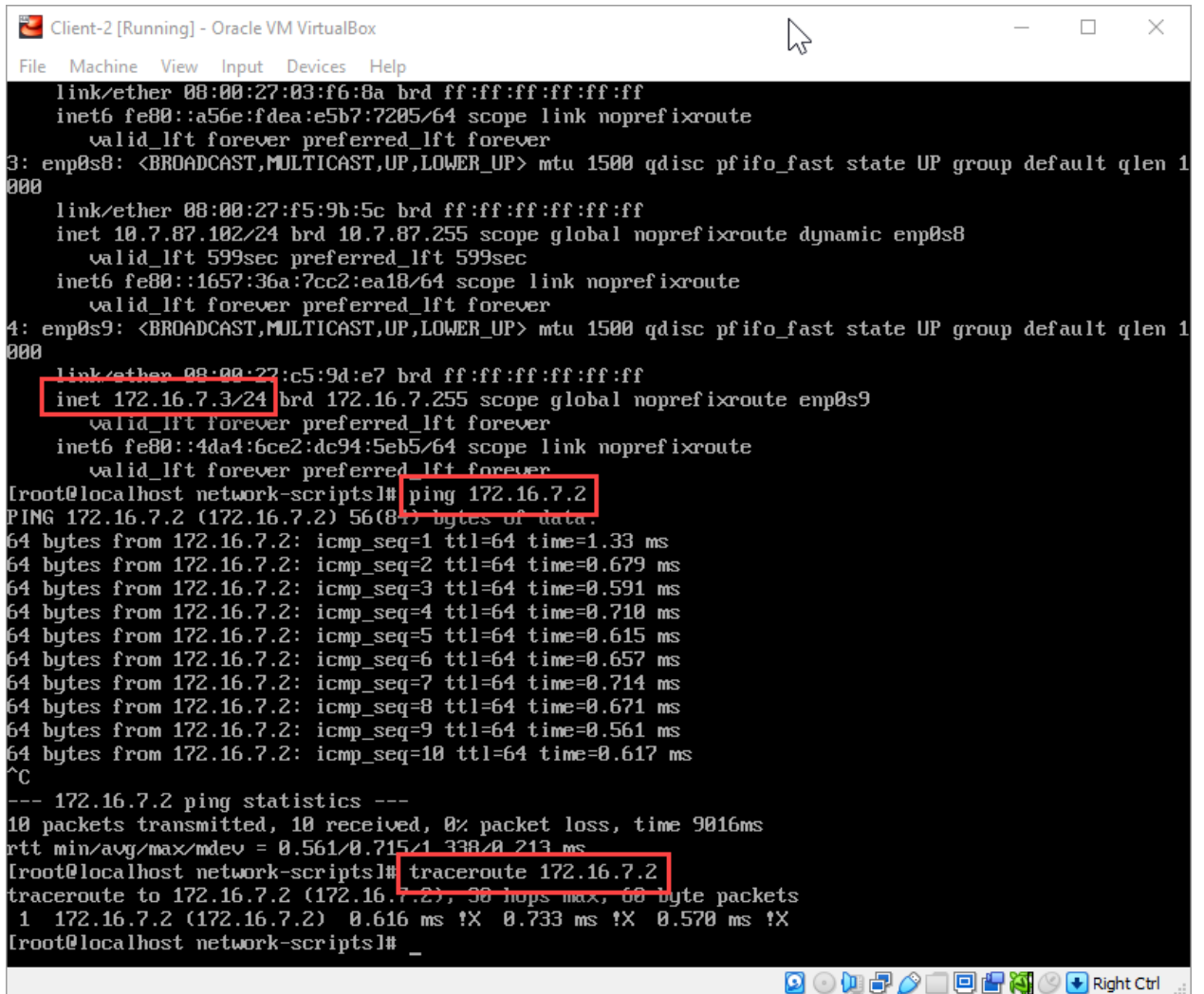
systemctl restart network



```
Client-1 (Snapshot 1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help

    valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
    valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1
000
    link/ether 08:00:27:d3:72:83 brd ff:ff:ff:ff:ff:ff
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1
000
    link/ether 08:00:27:da:65:7b brd ff:ff:ff:ff:ff:ff
    inet 10.87.7.101/24 brd 10.87.7.255 scope global noprefixroute dynamic enp0s8
    valid_lft 415sec preferred_lft 415sec
    inet6 fe80::4a15:8f2a:82fb:cbaa/64 scope link noprefixroute
    valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1
000
    link/ether 08:00:27:d4:9d:57 brd ff:ff:ff:ff:ff:ff
    inet 172.16.7.2/24 brd 172.16.7.255 scope global noprefixroute enp0s9
    valid_lft forever preferred_lft forever
    inet6 fe80::a9d7:cb5b:6025:9b28/64 scope link noprefixroute
    valid_lft forever preferred_lft forever
[root@localhost network-scripts]# tracert 172.16.7.3
tracert to 172.16.7.3 (172.16.7.3), 30 hops max, 60 byte packets
 1 172.16.7.3 (172.16.7.3)  0.985 ms !X  0.222 ms !X  0.799 ms !X
[root@localhost network-scripts]# ping 172.16.7.3
PING 172.16.7.3 (172.16.7.3) 56(84) bytes of data.
 64 bytes from 172.16.7.3: icmp_seq=1 ttl=64 time=0.681 ms
 64 bytes from 172.16.7.3: icmp_seq=2 ttl=64 time=0.614 ms
 64 bytes from 172.16.7.3: icmp_seq=3 ttl=64 time=0.726 ms
 64 bytes from 172.16.7.3: icmp_seq=4 ttl=64 time=0.582 ms
 64 bytes from 172.16.7.3: icmp_seq=5 ttl=64 time=0.526 ms
 64 bytes from 172.16.7.3: icmp_seq=6 ttl=64 time=0.583 ms
 64 bytes from 172.16.7.3: icmp_seq=7 ttl=64 time=2.05 ms
^C
--- 172.16.7.3 ping statistics ---
 7 packets transmitted, 7 received, 0% packet loss, time 6046ms
rtt min/avg/max/mdev = 0.526/0.824/2.057/0.507 ms
[root@localhost network-scripts]#
```

For work connection between two VM you need set forward=1 all VM !!!



```
Client-2 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help

link/ether 08:00:27:03:f6:8a brd ff:ff:ff:ff:ff:ff
inet6 fe80::a56e:fdea:e5b7:7205/64 scope link noprefixroute
valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
link/ether 08:00:27:f5:9b:5c brd ff:ff:ff:ff:ff:ff
inet 10.7.87.102/24 brd 10.7.87.255 scope global noprefixroute dynamic enp0s8
valid_lft 599sec preferred_lft 599sec
inet6 fe80::1657:36a:7cc2:ea18/64 scope link noprefixroute
valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
link/ether 08:00:27:c5:9d:e7 brd ff:ff:ff:ff:ff:ff
inet 172.16.7.3/24 brd 172.16.7.255 scope global noprefixroute enp0s9
valid_lft forever preferred_lft forever
inet6 fe80::4da4:6ce2:dc94:5eb5/64 scope link noprefixroute
valid_lft forever preferred_lft forever
[root@localhost network-scripts]# ping 172.16.7.2
PING 172.16.7.2 (172.16.7.2) 56(84) bytes of data:
64 bytes from 172.16.7.2: icmp_seq=1 ttl=64 time=1.33 ms
64 bytes from 172.16.7.2: icmp_seq=2 ttl=64 time=0.679 ms
64 bytes from 172.16.7.2: icmp_seq=3 ttl=64 time=0.591 ms
64 bytes from 172.16.7.2: icmp_seq=4 ttl=64 time=0.710 ms
64 bytes from 172.16.7.2: icmp_seq=5 ttl=64 time=0.615 ms
64 bytes from 172.16.7.2: icmp_seq=6 ttl=64 time=0.657 ms
64 bytes from 172.16.7.2: icmp_seq=7 ttl=64 time=0.714 ms
64 bytes from 172.16.7.2: icmp_seq=8 ttl=64 time=0.671 ms
64 bytes from 172.16.7.2: icmp_seq=9 ttl=64 time=0.561 ms
64 bytes from 172.16.7.2: icmp_seq=10 ttl=64 time=0.617 ms
^C
--- 172.16.7.2 ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9016ms
rtt min/avg/max/mdev = 0.561/0.715/1.338/0.213 ms
[root@localhost network-scripts]# traceroute 172.16.7.2
traceroute to 172.16.7.2 (172.16.7.2), 30 hops max, 60 byte packets
 1 172.16.7.2 (172.16.7.2) 0.616 ms !X 0.733 ms !X 0.570 ms !X
[root@localhost network-scripts]#
```

Ping Client-1 Server-1 Client-2

Ip route add 10.7.87.0/24 via 10.87.7.2 dev enp0s8

10.7.87.0/24 – subnet which we want to go

10.87.7.2 – IP addr of interface on Server for Client-1 subnet

```
Client-1 (Snapshot 2) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
--- 10.7.87.102 ping statistics ---
507 packets transmitted, 392 received, 22% packet loss, time 506873ms
rtt min/avg/max/mdev = 0.783/1.216/6.167/0.601 ms
root@Client-1 ~]# ip route add 10.7.87.0/24 via 10.87.7.2 dev enp0s8
RTNETLINK answers: File exists
root@Client-1 ~]#
root@Client-1 ~]#
root@Client-1 ~]#
root@Client-1 ~]#
root@Client-1 ~]#
root@Client-1 ~]# ip route add 10.7.87.0/24 via 10.87.7.2 dev enp0s8
RTNETLINK answers: File exists
root@Client-1 ~]#
root@Client-1 ~]#
root@Client-1 ~]# ip route add 10.7.87.0/24 via 10.87.7.2 dev enp0s8
root@Client-1 ~]# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default gateway 0.0.0.0 UG 101 0 0 enp0s8
10.7.87.0 10.87.7.2 255.255.255.0 UG 0 0 0 enp0s8
10.87.7.0 0.0.0.0 255.255.255.0 U 101 0 0 enp0s8
172.16.7.0 0.0.0.0 255.255.255.0 U 102 0 0 enp0s9
root@Client-1 ~]# ping 10.7.87.102
PING 10.7.87.102 (10.7.87.102) 56(84) bytes of data:
64 bytes from 10.7.87.102: icmp_seq=1 ttl=63 time=1.58 ms
64 bytes from 10.7.87.102: icmp_seq=2 ttl=63 time=1.06 ms
64 bytes from 10.7.87.102: icmp_seq=3 ttl=63 time=1.08 ms
64 bytes from 10.7.87.102: icmp_seq=4 ttl=63 time=1.11 ms
64 bytes from 10.7.87.102: icmp_seq=5 ttl=63 time=1.17 ms
64 bytes from 10.7.87.102: icmp_seq=6 ttl=63 time=1.28 ms
64 bytes from 10.7.87.102: icmp_seq=7 ttl=63 time=1.40 ms
64 bytes from 10.7.87.102: icmp_seq=8 ttl=63 time=0.860 ms
^C
--- 10.7.87.102 ping statistics ---
8 packets transmitted, 8 received, 0% packet loss, time 7015ms
rtt min/avg/max/mdev = 0.860/1.196/1.581/0.213 ms
root@Client-1 ~]#
```

Check receiving tcp packages: tcpdump -i enp0s8

```

root@Server-1: /home/nik
19:06:16.119679 IP 10.7.87.102 > 10.87.7.101: ICMP echo reply, id 2233, seq 318, length 64
19:06:17.121044 IP 10.87.7.101 > 10.7.87.102: ICMP echo request, id 2233, seq 319, length 64
19:06:17.121664 IP 10.7.87.102 > 10.87.7.101: ICMP echo reply, id 2233, seq 319, length 64
^C
555 packets captured
555 packets received by filter
0 packets dropped by kernel
root@Server-1: /home/nik# ^C
root@Server-1: /home/nik# nano /etc/dhcp/dhcpd.conf
root@Server-1: /home/nik# nano /etc/dhcp/dhcpd.conf
root@Server-1: /home/nik#
root@Server-1: /home/nik# tcpdump -i enp0s8
tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on enp0s8, link-type EN10MB (Ethernet), snapshot length 262144 bytes
[[[A^[[A^[[A19:15:25.740821 IP 10.87.7.101 > 10.7.87.102: ICMP echo request, id 2350, seq 1, length 64
19:15:25.741408 IP 10.7.87.102 > 10.87.7.101: ICMP echo reply, id 2350, seq 1, length 64
19:15:26.743595 IP 10.87.7.101 > 10.7.87.102: ICMP echo request, id 2350, seq 2, length 64
19:15:26.744166 IP 10.7.87.102 > 10.87.7.101: ICMP echo reply, id 2350, seq 2, length 64
19:15:27.745218 IP 10.87.7.101 > 10.7.87.102: ICMP echo request, id 2350, seq 3, length 64
19:15:27.745781 IP 10.7.87.102 > 10.87.7.101: ICMP echo reply, id 2350, seq 3, length 64
19:15:28.747682 IP 10.87.7.101 > 10.7.87.102: ICMP echo request, id 2350, seq 4, length 64
19:15:28.748255 IP 10.7.87.102 > 10.87.7.101: ICMP echo reply, id 2350, seq 4, length 64
19:15:29.748488 IP 10.87.7.101 > 10.7.87.102: ICMP echo request, id 2350, seq 5, length 64
19:15:29.749058 IP 10.7.87.102 > 10.87.7.101: ICMP echo reply, id 2350, seq 5, length 64
19:15:30.750865 IP 10.87.7.101 > 10.7.87.102: ICMP echo request, id 2350, seq 6, length 64
19:15:30.751231 IP 10.7.87.102 > 10.87.7.101: ICMP echo reply, id 2350, seq 6, length 64
19:15:30.755052 ARP, Request who-has Server-1 tell 10.87.7.101, length 46
19:15:30.755060 ARP, Reply Server-1 is-at 08:00:27:bf:50:07 (oui Unknown), length 28
19:15:30.901507 ARP, Request who-has 10.87.7.101 tell Server-1, length 28
19:15:30.902124 ARP, Reply 10.87.7.101 is-at 08:00:27:da:65:7b (oui Unknown), length 46
19:15:31.752954 IP 10.87.7.101 > 10.7.87.102: ICMP echo request, id 2350, seq 7, length 64
19:15:31.753478 IP 10.7.87.102 > 10.87.7.101: ICMP echo reply, id 2350, seq 7, length 64
19:15:32.755959 IP 10.87.7.101 > 10.7.87.102: ICMP echo request, id 2350, seq 8, length 64
19:15:32.756310 IP 10.7.87.102 > 10.87.7.101: ICMP echo reply, id 2350, seq 8, length 64
19:15:54.297927 IP 10.87.7.101.bootpc > Server-1.bootps: BOOTP/DHCP, Request from 08:00:27:da:65:7b (oui Unknown), length 300
19:15:54.298145 IP Server-1.bootps > 10.87.7.101.bootpc: BOOTP/DHCP, Reply, length 300

```

Client-2 Where we want to go

```

Client-1 (Snapshot 2) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
RTNETLINK answers: File exists
[root@Client-1 ~]#
[root@Client-1 ~]#
[root@Client-1 ~]#
[root@Client-1 ~]#
[root@Client-1 ~]#
[root@Client-1 ~]# ip route add 10.7.87.0/24 via 10.87.7.2 dev enp0s8
RTNETLINK answers: File exists
[root@Client-1 ~]#
[root@Client-1 ~]#
[root@Client-1 ~]# ip route add 10.7.87.0/24 via 10.87.7.2 dev enp0s8
[root@Client-1 ~]# route
Kernel IP routing table
Destination    Gateway         Genmask         Flags Metric Ref    Use Iface
default        gateway         0.0.0.0         UG    0      0      0 enp0s8
10.7.87.0      10.87.7.2      255.255.255.0   UG    0      0      0 enp0s8
10.87.7.0      0.0.0.0        255.255.255.0   U     101    0      0 enp0s8
172.16.7.0     0.0.0.0        255.255.255.0   U     102    0      0 enp0s9
[root@Client-1 ~]# ping 10.7.87.102
PING 10.7.87.102 (10.7.87.102) 56(84) bytes of data:
64 bytes from 10.7.87.102: icmp_seq=1 ttl=63 time=1.58 ms
64 bytes from 10.7.87.102: icmp_seq=2 ttl=63 time=1.06 ms
64 bytes from 10.7.87.102: icmp_seq=3 ttl=63 time=1.08 ms
64 bytes from 10.7.87.102: icmp_seq=4 ttl=63 time=1.11 ms
64 bytes from 10.7.87.102: icmp_seq=5 ttl=63 time=1.17 ms
64 bytes from 10.7.87.102: icmp_seq=6 ttl=63 time=1.28 ms
64 bytes from 10.7.87.102: icmp_seq=7 ttl=63 time=1.40 ms
64 bytes from 10.7.87.102: icmp_seq=8 ttl=63 time=0.860 ms
^C
--- 10.7.87.102 ping statistics ---
8 packets transmitted, 8 received, 0% packet loss, time 7015ms
rtt min/avg/max/mdev = 0.860/1.196/1.581/0.213 ms
[root@Client-1 ~]# traceroute 10.7.87.102
traceroute to 10.7.87.102 (10.7.87.102), 30 hops max, 60 byte packets
 1 10.87.7.2 (10.87.7.2) 0.575 ms 0.364 ms 0.475 ms
 2 10.7.87.102 (10.7.87.102) 1.480 ms !X 1.273 ms !X 0.846 ms !X
[root@Client-1 ~]#

```

4 На віртуальному інтерфейсу lo Client_1 призначити дві IP адреси за таким правилом: 172.17.D+10.1/24 та 172.17.D+20.1/24.

```
Client-1 (Snapshot 1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
[ Wrote 18 lines ]

[root@localhost network-scripts]# systemctl restart network
^C
[root@localhost network-scripts]# ^C
[root@localhost network-scripts]# ^C
[root@localhost network-scripts]# systemctl restart network
[root@localhost network-scripts]# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet 172.17.17.1/24 brd 172.17.17.255 scope host lo
        valid_lft forever preferred_lft forever
    inet 172.17.27.1/24 brd 172.17.27.255 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:d3:72:83 brd ff:ff:ff:ff:ff:ff
    inet6 fe80::91b8:5468:f4a9:a8cb/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:da:65:7b brd ff:ff:ff:ff:ff:ff
    inet 10.87.7.101/24 brd 10.87.7.255 scope global noprefixroute dynamic enp0s8
        valid_lft 598sec preferred_lft 598sec
    inet6 fe80::4a15:8f2a:82fb:cbaa/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:d4:9d:57 brd ff:ff:ff:ff:ff:ff
[root@localhost network-scripts]#
[root@localhost network-scripts]#
[root@localhost network-scripts]# _
```

4.1 Налаштувати маршрутизацію таким чином, щоб трафік з Client_2 до 172.17.D+10.1 проходив через Server_1

On client-2:

Ip route add 172.17.17.0/24 via 10.7.87.2

172.17.17.0/24 – subnet on client-1 in interface lo

10.7.87.2 – ip interface for client-2 subnet on server

```
Client-2 (Snapshot 1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
    valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:f5:9b:5c brd ff:ff:ff:ff:ff:ff
    inet 10.7.87.102/24 brd 10.7.87.255 scope global noprefixroute dynamic enp0s8
        valid_lft 407sec preferred_lft 407sec
    inet6 fe80::1657:36a:7cc2:ea18/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:c5:9d:e7 brd ff:ff:ff:ff:ff:ff
    inet 172.16.7.3/24 brd 172.16.7.255 scope global noprefixroute enp0s9
        valid_lft forever preferred_lft forever
    inet6 fe80::4da4:6ce2:dc94:5eb5/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
[root@Client-2 ~]# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default gateway 0.0.0.0 UG 101 0 0 enp0s8
10.7.87.0 0.0.0.0 255.255.255.0 U 101 0 0 enp0s8
172.16.7.0 0.0.0.0 255.255.255.0 U 102 0 0 enp0s9
172.17.17.0 10.7.87.2 255.255.255.0 UG 0 0 0 enp0s8
[root@Client-2 ~]# ip route add 172.17.17.0/24 via 10.7.87.2^C
[root@Client-2 ~]# ping 172.17.17.1
PING 172.17.17.1 (172.17.17.1) 56(84) bytes of data:
64 bytes from 172.17.17.1: icmp_seq=1 ttl=63 time=1.35 ms
64 bytes from 172.17.17.1: icmp_seq=2 ttl=63 time=1.30 ms
64 bytes from 172.17.17.1: icmp_seq=3 ttl=63 time=1.36 ms
^C
--- 172.17.17.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2005ms
rtt min/avg/max/mdev = 1.301/1.341/1.369/0.029 ms
[root@Client-2 ~]# traceroute 172.17.17.1
traceroute to 172.17.17.1 (172.17.17.1), 30 hops max, 60 byte packets
 1 10.7.87.2 (10.7.87.2) 0.457 ms 0.555 ms 0.506 ms
 2 172.17.17.1 (172.17.17.1) 1.138 ms !X 2.009 ms !X 1.800 ms !X
[root@Client-2 ~]#
```

On Server:

ip route add 172.17.17.0/24 via 10.87.7.101

172.17.17.0/24 – subnet on client-1 in interface lo

10.87.7.101– ip interface – enp0s8 in Client-1

```
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:05:74:86 brd ff:ff:ff:ff:ff:ff
    inet 192.168.0.200/24 brd 192.168.0.255 scope global enp0s3
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:bf:50:07 brd ff:ff:ff:ff:ff:ff
    inet 10.87.7.2/24 brd 10.87.7.255 scope global enp0s8
        valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:4e:2f:af brd ff:ff:ff:ff:ff:ff
    inet 10.7.87.2/24 brd 10.7.87.255 scope global enp0s9
        valid_lft forever preferred_lft forever
root@Server-1:/home/nik# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default gateway 0.0.0.0 UG 0 0 0 enp0s3
10.7.87.0 0.0.0.0 255.255.255.0 U 0 0 0 enp0s9
10.87.7.0 0.0.0.0 255.255.255.0 U 0 0 0 enp0s8
172.17.17.0 10.87.7.101 255.255.255.0 UG 0 0 0 enp0s8
192.168.0.0 0.0.0.0 255.255.255.0 U 0 0 0 enp0s3
root@Server-1:/home/nik#
```

On Client-1

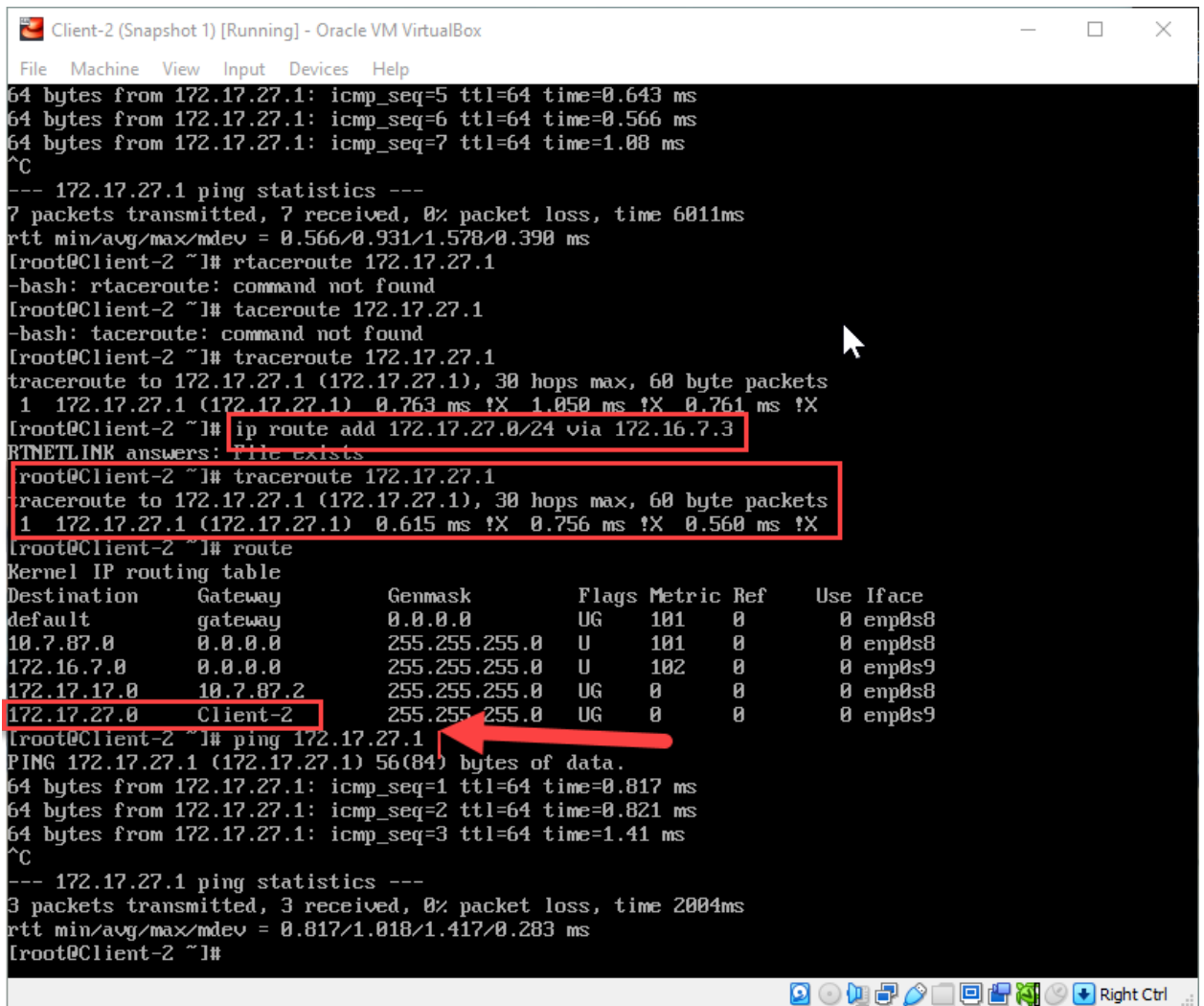
Ip route add 10.7.87.0/24 via 10.87.7.2 dev enp0s8

10.7.87.0/24 – subnet which we want to go

10.87.7.2 – IP addr of interface on Server for Client-1 subnet

```
Client-1 (Snapshot 2) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
inet 172.17.17.1/24 brd 172.17.17.255 scope host lo
    valid_lft forever preferred_lft forever
inet 172.17.27.1/24 brd 172.17.27.255 scope host lo
    valid_lft forever preferred_lft forever
inet6 ::1/128 scope host
    valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:d3:72:83 brd ff:ff:ff:ff:ff:ff
    inet 192.168.0.103/24 brd 192.168.0.255 scope global noprefixroute dynamic enp0s3
        valid_lft 6120sec preferred_lft 6120sec
    inet6 fe80::91b8:5468:f4a9:a0cb/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:da:65:7b brd ff:ff:ff:ff:ff:ff
    inet 10.87.7.101/24 brd 10.87.7.255 scope global noprefixroute dynamic enp0s8
        valid_lft 521sec preferred_lft 521sec
    inet6 fe80::4a15:8f2a:82fb:cbaa/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group default qlen 1000
    link/ether 08:00:27:d4:9d:57 brd ff:ff:ff:ff:ff:ff
    inet 172.16.7.2/24 brd 172.16.7.255 scope global noprefixroute enp0s9
        valid_lft forever preferred_lft forever
    inet6 fe80::a9d7:cb5b:6025:9b28/64 scope link noprefixroute
        valid_lft forever preferred_lft forever
root@Client-1 ~l# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default gateway 0.0.0.0 UG 100 0 0 enp0s3
default gateway 0.0.0.0 UG 101 0 0 enp0s8
10.7.87.0 10.87.7.2 255.255.255.0 UG 0 0 0 enp0s8
10.87.7.0 0.0.0.0 255.255.255.0 U 101 0 0 enp0s8
172.16.7.0 0.0.0.0 255.255.255.0 U 102 0 0 enp0s9
192.168.0.0 0.0.0.0 255.255.255.0 U 100 0 0 enp0s3
root@Client-1 ~l#
```

4.2 Налаштувати маршрутизацію таким чином, щоб трафік з Client_2 до 172.17.D+10.1 проходив через Net4. Для перевірки використати traceroute.



```
Client-2 (Snapshot 1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
64 bytes from 172.17.27.1: icmp_seq=5 ttl=64 time=0.643 ms
64 bytes from 172.17.27.1: icmp_seq=6 ttl=64 time=0.566 ms
64 bytes from 172.17.27.1: icmp_seq=7 ttl=64 time=1.08 ms
^C
--- 172.17.27.1 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6011ms
rtt min/avg/max/mdev = 0.566/0.931/1.578/0.390 ms
[root@Client-2 ~]# rtaceroute 172.17.27.1
-bash: rtaceroute: command not found
[root@Client-2 ~]# taceroute 172.17.27.1
-bash: taceroute: command not found
[root@Client-2 ~]# traceroute 172.17.27.1
traceroute to 172.17.27.1 (172.17.27.1), 30 hops max, 60 byte packets
 1 172.17.27.1 (172.17.27.1) 0.763 ms !X 1.050 ms !X 0.761 ms !X
[root@Client-2 ~]# ip route add 172.17.27.0/24 via 172.16.7.3
RTNETLINK answers: File exists
[root@Client-2 ~]# traceroute 172.17.27.1
traceroute to 172.17.27.1 (172.17.27.1), 30 hops max, 60 byte packets
 1 172.17.27.1 (172.17.27.1) 0.615 ms !X 0.756 ms !X 0.560 ms !X
[root@Client-2 ~]# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default gateway 0.0.0.0 UG 101 0 0 enp0s8
10.7.87.0 0.0.0.0 255.255.255.0 U 101 0 0 enp0s8
172.16.7.0 0.0.0.0 255.255.255.0 U 102 0 0 enp0s9
172.17.17.0 10.7.87.2 255.255.255.0 UG 0 0 0 enp0s8
172.17.27.0 Client-2 255.255.255.0 UG 0 0 0 enp0s9
[root@Client-2 ~]# ping 172.17.27.1
PING 172.17.27.1 (172.17.27.1) 56(84) bytes of data.
64 bytes from 172.17.27.1: icmp_seq=1 ttl=64 time=0.817 ms
64 bytes from 172.17.27.1: icmp_seq=2 ttl=64 time=0.821 ms
64 bytes from 172.17.27.1: icmp_seq=3 ttl=64 time=1.41 ms
^C
--- 172.17.27.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2004ms
rtt min/avg/max/mdev = 0.817/1.018/1.417/0.283 ms
[root@Client-2 ~]#
```

On client-2:

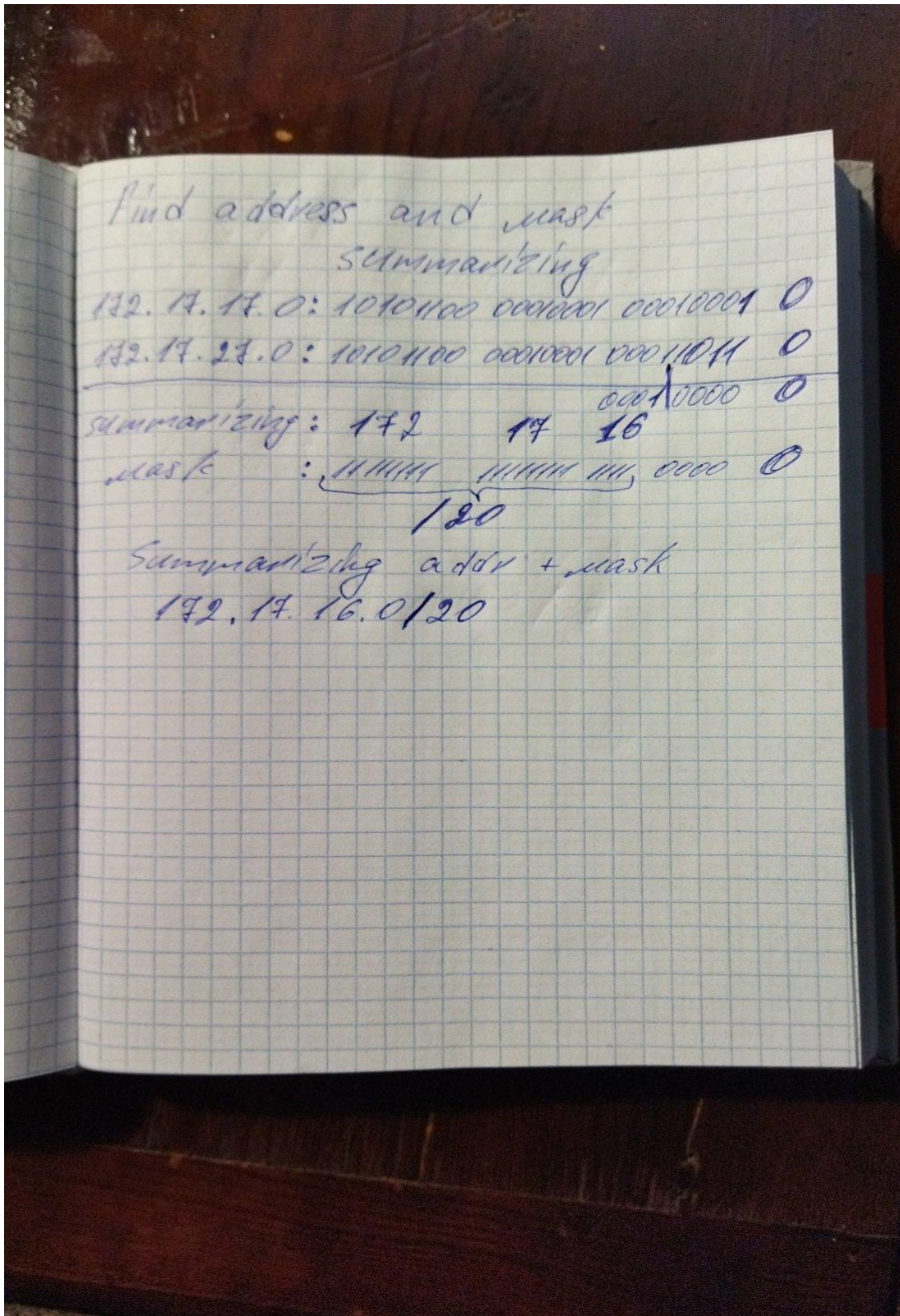
ip route add 172.17.27.0/24 via 172.16.7.3

172.17.27.0/24 – subnet on client-1 in interface lo

172.16.7.3 – subnet between client-1 and client-2 and interface enp0s9

5. Розрахувати спільну адресу та маску (summarizing) адрес 172.17.D+10.1 та 172.17.D+20.1, при чому префікс має бути максимально можливим. Видалити маршрути, встановлені на попередньому кроці та замінити їх об'єднаним маршрутом, якій має проходити через Server_1.

5.1 Розрахувати спільну адресу та маску (summarizing) адрес 172.17.D+10.1 та 172.17.D+20.1, при чому префікс має бути максимально можливим.



5.2 Видалити маршрути, встановлені на попередньому кроці та замінити їх об'єднаним маршрутом, якій має проходити через Server_1.

On client-2:

Ip route add 172.17.16.0/20 via 10.7.87.2

172.17.16.0/20 – summarizing subnet for 172.17.17.0 and 172.17.27.0 on client-1 in interface lo

10.7.87.2 – IP addr of interface on Server for Client-2 subnet

```
Client-2 (Snapshot 1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
[root@Client-2 ~]# ip route del 172.17.16.0/22 via 10.7.87.2
[root@Client-2 ~]# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default gateway 0.0.0.0 UG 101 0 0 enp0s8
10.7.87.0 0.0.0.0 255.255.255.0 U 101 0 0 enp0s8
172.16.2.0 0.0.0.0 255.255.255.0 U 102 0 0 enp0s9
172.17.16.0 10.7.87.2 255.255.240.0 UG 0 0 0 enp0s8
[root@Client-2 ~]# ping 172.17.27.1
PING 172.17.27.1 (172.17.27.1) 56(84) bytes of data:
64 bytes from 172.17.27.1: icmp_seq=1 ttl=63 time=1.24 ms
64 bytes from 172.17.27.1: icmp_seq=2 ttl=63 time=1.18 ms
64 bytes from 172.17.27.1: icmp_seq=3 ttl=63 time=1.18 ms
^C
--- 172.17.27.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2004ms
rtt min/avg/max/mdev = 1.181/1.204/1.249/0.031 ms
[root@Client-2 ~]# ping 172.17.17.1
PING 172.17.17.1 (172.17.17.1) 56(84) bytes of data:
64 bytes from 172.17.17.1: icmp_seq=1 ttl=63 time=1.22 ms
64 bytes from 172.17.17.1: icmp_seq=2 ttl=63 time=1.26 ms
64 bytes from 172.17.17.1: icmp_seq=3 ttl=63 time=4.35 ms
^C64 bytes from 172.17.17.1: icmp_seq=4 ttl=63 time=1.18 ms
64 bytes from 172.17.17.1: icmp_seq=5 ttl=63 time=1.50 ms
^C
--- 172.17.17.1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4010ms
rtt min/avg/max/mdev = 1.182/1.904/4.351/1.229 ms
[root@Client-2 ~]# traceroute 172.17.27.1
traceroute to 172.17.27.1 (172.17.27.1), 30 hops max, 60 byte packets
 1 10.7.87.2 (10.7.87.2) 0.614 ms 0.368 ms 0.461 ms
 2 172.17.27.1 (172.17.27.1) 1.261 ms !X 1.048 ms !X 0.617 ms !X
[root@Client-2 ~]# traceroute 172.17.17.1
traceroute to 172.17.17.1 (172.17.17.1), 30 hops max, 60 byte packets
 1 10.7.87.2 (10.7.87.2) 0.666 ms 0.931 ms 0.651 ms
 2 172.17.17.1 (172.17.17.1) 0.833 ms !X 1.311 ms !X 1.054 ms !X
[root@Client-2 ~]# _
```

On Server

```

root@Server-1:/home/nik# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default gateway 0.0.0.0 UG 0 0 0 enp0s3
10.7.87.0 0.0.0.0 255.255.255.0 U 0 0 0 enp0s9
10.87.7.0 0.0.0.0 255.255.255.0 U 0 0 0 enp0s8
172.17.16.0 10.87.7.101 255.255.240.0 UG 0 0 0 enp0s8
192.168.0.0 0.0.0.0 255.255.255.0 U 0 0 0 enp0s3
root@Server-1:/home/nik# ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
        valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:05:74:86 brd ff:ff:ff:ff:ff:ff
    inet 192.168.0.200/24 brd 192.168.0.255 scope global enp0s3
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:bf:50:07 brd ff:ff:ff:ff:ff:ff
    inet 10.87.7.2/24 brd 10.87.7.255 scope global enp0s8
        valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:4e:2f:af brd ff:ff:ff:ff:ff:ff
    inet 10.7.87.2/24 brd 10.7.87.255 scope global enp0s9
        valid_lft forever preferred_lft forever
root@Server-1:/home/nik#

```

ip route add 172.17.16.0/20 via 10.87.7.101

172.17.16.0/20 – summarizing subnet for 172.17.17.0 and 172.17.27.0 on client-1 in interface lo

10.87.7.101– ip interface – enp0s8 in Client-1

On Client-1

```

[root@Client-1 ~]# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default gateway 0.0.0.0 UG 100 0 0 enp0s3
default gateway 0.0.0.0 UG 101 0 0 enp0s8
10.7.87.0 10.87.7.2 255.255.255.0 UG 0 0 0 enp0s8
10.87.7.0 0.0.0.0 255.255.255.0 U 101 0 0 enp0s8
172.16.7.0 0.0.0.0 255.255.255.0 U 102 0 0 enp0s9
192.168.0.0 0.0.0.0 255.255.255.0 U 100 0 0 enp0s3
[root@Client-1 ~]#

```

Ip route add 10.7.87.0/24 via 10.87.7.2 dev enp0s8

10.7.87.0/24 – subnet which we want to go

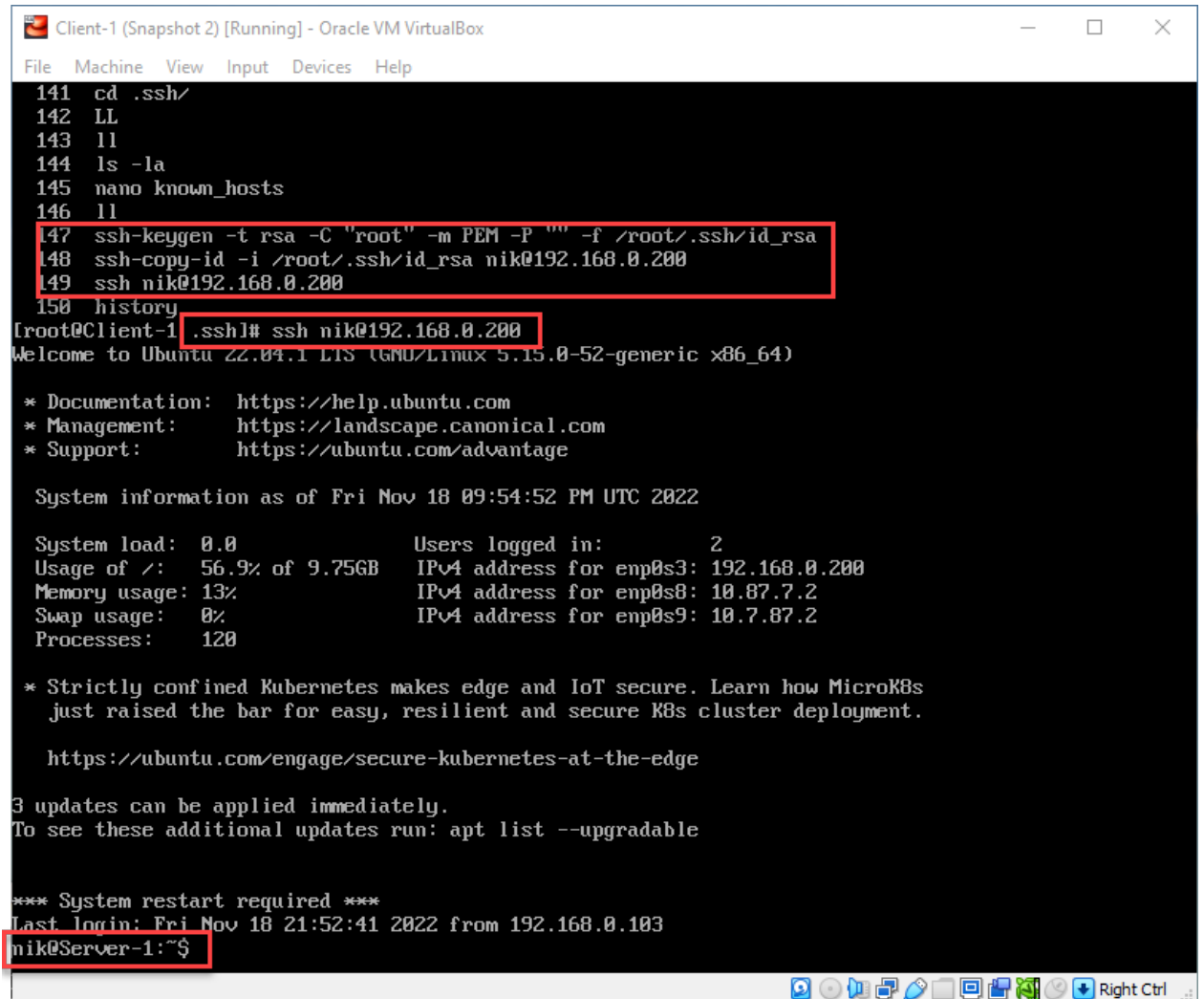
10.87.7.2 – IP addr of interface on Server for Client-1 subnet

6 Налаштувати SSH сервіс таким чином, щоб Client_1 та Client_2 могли підключатись до Server_1 та один до одного.

Ssh connection Client-1 to Server

```
ssh-keygen -t rsa -C "nik" -m PEM -P "" -f /root/.ssh/id_rsa
```

```
ssh-copy-id -i /root/.ssh/id_rsa root@192.168.0.200
```



```
Client-1 (Snapshot 2) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
141 cd .ssh/
142 LL
143 ll
144 ls -la
145 nano known_hosts
146 ll
147 ssh-keygen -t rsa -C "root" -m PEM -P "" -f /root/.ssh/id_rsa
148 ssh-copy-id -i /root/.ssh/id_rsa nik@192.168.0.200
149 ssh nik@192.168.0.200
150 history
[root@Client-1 ~]# ssh nik@192.168.0.200
Welcome to Ubuntu 22.04.1 LTS (GNU/Linux 5.15.0-52-generic x86_64)

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

System information as of Fri Nov 18 09:54:52 PM UTC 2022

System load:  0.0               Users logged in:      2
Usage of /:   56.9% of 9.75GB    IPv4 address for enp0s3: 192.168.0.200
Memory usage: 13%              IPv4 address for enp0s8: 10.87.7.2
Swap usage:   0%                IPv4 address for enp0s9: 10.7.87.2
Processes:   120

 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.

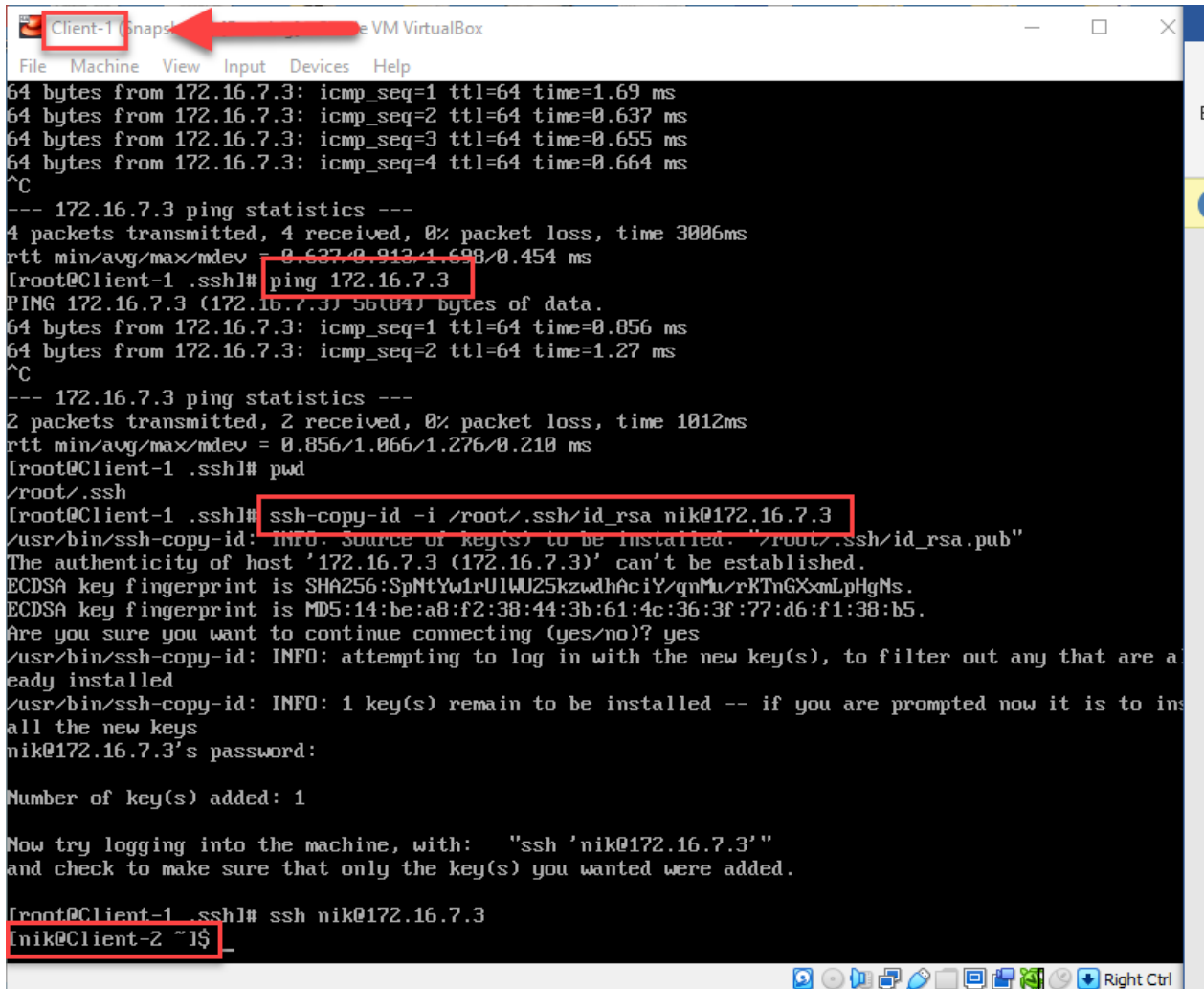
https://ubuntu.com/engage/secure-kubernetes-at-the-edge

3 updates can be applied immediately.
To see these additional updates run: apt list --upgradable

*** System restart required ***
Last login: Fri Nov 18 21:52:41 2022 from 192.168.0.103
mik@Server-1:~$
```


Ssh connection Client-1 to Client-2

ssh-copy-id -i /root/.ssh/id_rsa root@172.16.7.3



The screenshot shows a terminal window titled "Client-1 (Snapshot) - VM VirtualBox". A red arrow points to the title bar. The terminal output shows a series of ping tests to 172.16.7.3, followed by the execution of the command `ssh-copy-id -i /root/.ssh/id_rsa nik@172.16.7.3`. The command prompts for the source of the key, the authenticity of the host, and confirmation to continue. It then displays the ECDSA key fingerprints and confirms the installation of the new key. Finally, it prompts for the password of the user 'nik' on host 172.16.7.3. The terminal shows the successful completion of the key installation and the prompt for the password.

```
Client-1 (Snapshot) - VM VirtualBox
File Machine View Input Devices Help
64 bytes from 172.16.7.3: icmp_seq=1 ttl=64 time=1.69 ms
64 bytes from 172.16.7.3: icmp_seq=2 ttl=64 time=0.637 ms
64 bytes from 172.16.7.3: icmp_seq=3 ttl=64 time=0.655 ms
64 bytes from 172.16.7.3: icmp_seq=4 ttl=64 time=0.664 ms
^C
--- 172.16.7.3 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3006ms
rtt min/avg/max/mdev = 0.637/0.913/1.698/0.454 ms
[root@Client-1 .ssh]# ping 172.16.7.3
PING 172.16.7.3 (172.16.7.3) 56(84) bytes of data.
64 bytes from 172.16.7.3: icmp_seq=1 ttl=64 time=0.856 ms
64 bytes from 172.16.7.3: icmp_seq=2 ttl=64 time=1.27 ms
^C
--- 172.16.7.3 ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1012ms
rtt min/avg/max/mdev = 0.856/1.066/1.276/0.210 ms
[root@Client-1 .ssh]# pwd
/root/.ssh
[root@Client-1 .ssh]# ssh-copy-id -i /root/.ssh/id_rsa nik@172.16.7.3
/usr/bin/ssh-copy-id: INFO: source of key(s) to be installed: "/root/.ssh/id_rsa.pub"
The authenticity of host '172.16.7.3 (172.16.7.3)' can't be established.
ECDSA key fingerprint is SHA256:SpNtYw1rU1WU25kzwdhAciY/qnMu/rKTnGXxmLpHgNs.
ECDSA key fingerprint is MD5:14:be:a8:f2:38:44:3b:61:4c:36:3f:77:d6:f1:38:b5.
Are you sure you want to continue connecting (yes/no)? yes
/usr/bin/ssh-copy-id: INFO: attempting to log in with the new key(s), to filter out any that are al
eady installed
/usr/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompted now it is to ins
all the new keys
nik@172.16.7.3's password:
Number of key(s) added: 1
Now try logging into the machine, with: "ssh 'nik@172.16.7.3'"
and check to make sure that only the key(s) you wanted were added.
[root@Client-1 .ssh]# ssh nik@172.16.7.3
[nik@Client-2 ~]$
```

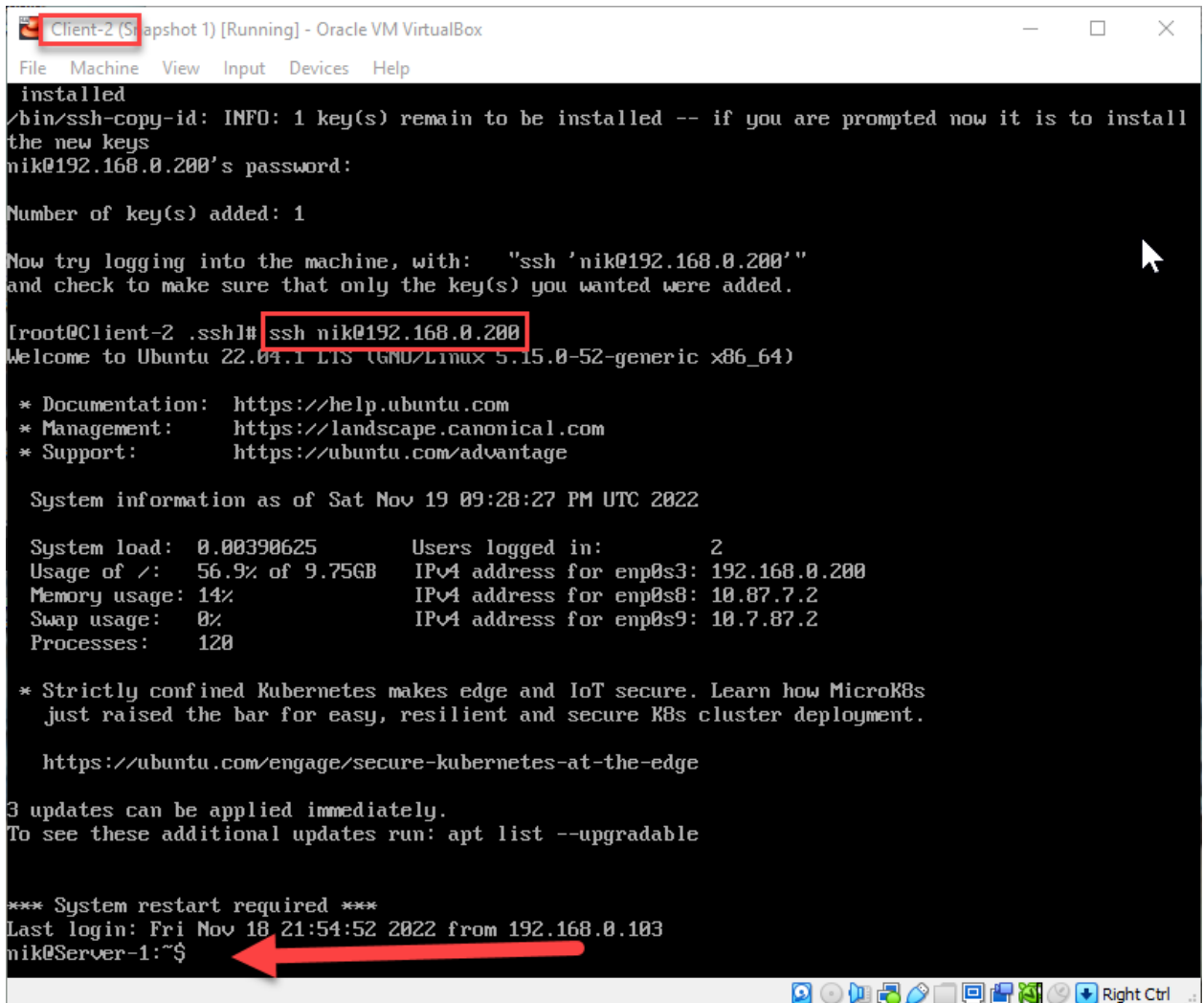
Ssh connection Client-2 to Server

Ip route add 192.168.0.0/24 via 10.7.87.102

Route from subnet of Server to interface IP of Client-2

ssh-keygen -t rsa -C "nik" -m PEM -P "" -f /root/.ssh/id_rsa

ssh-copy-id -i /root/.ssh/id_rsa root@192.168.0.200



```
Client-2 (Snapshot 1) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
installed
/bin/ssh-copy-id: INFO: 1 key(s) remain to be installed -- if you are prompted now it is to install
the new keys
nik@192.168.0.200's password:
Number of key(s) added: 1
Now try logging into the machine, with: "ssh 'nik@192.168.0.200'"
and check to make sure that only the key(s) you wanted were added.
[root@Client-2 .ssh]# ssh nik@192.168.0.200
Welcome to Ubuntu 22.04.1 LTS (GNU/Linux 5.15.0-52-generic x86_64)

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

System information as of Sat Nov 19 09:28:27 PM UTC 2022

System load: 0.00390625      Users logged in:      2
Usage of /: 56.9% of 9.75GB  IPv4 address for enp0s3: 192.168.0.200
Memory usage: 14%           IPv4 address for enp0s8: 10.87.7.2
Swap usage: 0%              IPv4 address for enp0s9: 10.7.87.2
Processes: 120

 * Strictly confined Kubernetes makes edge and IoT secure. Learn how MicroK8s
   just raised the bar for easy, resilient and secure K8s cluster deployment.

https://ubuntu.com/engage/secure-kubernetes-at-the-edge

3 updates can be applied immediately.
To see these additional updates run: apt list --upgradable

*** System restart required ***
Last login: Fri Nov 18 21:54:52 2022 from 192.168.0.103
nik@Server-1:~$
```

7 Напаштуйте на Server_1 iptables

Iptables -L

table of input trafic

Chain INPUT (policy ACCEPT)

target prot opt source destination

table of passing trafic

Chain FORWARD (policy ACCEPT)

target prot opt source destination

trafic that create uor Server

Chain OUTPUT (policy ACCEPT)

target prot opt source destination

ACCEPT – allow

DROP – refuse

ADD RULES. RULES ADD in chain order !!!!

Allow all connections that were before

iptables -A INPUT -m state --state ESTABLISHED,RELATED -j ACCEPT

Allow ssh access to 22 port

iptables -A INPUT -p tcp --dport ssh -j ACCEPT

Refuse ALL traffic

iptables -A INPUT -j DROP

If we forget to add some rule! Add icmp in chain before ssh rule!

iptables -I INPUT 2 -p icmp -j ACCEPT

Delete or Drop rules

iptables -D INPUT 2

iptables -D INPUT -p icmp -j ACCEPT

7.1 Дозволено підключатись через SSH з Client_1 та заборонено з Client_2

```
root@Server-1:/home/nik# iptables -I INPUT 2 -p tcp --dport 22 -s 10.87.7.0/24 -j ACCEPT
root@Server-1:/home/nik# iptables -L
Chain INPUT (policy ACCEPT)
target     prot opt source                destination          state RELATED,ESTABLISHED
ACCEPT     tcp  --  anywhere              anywhere             tcp dpt:ssh
ACCEPT     tcp  --  10.87.7.0/24          anywhere
DROP       all  --  anywhere              anywhere

Chain FORWARD (policy ACCEPT)
target     prot opt source                destination

Chain OUTPUT (policy ACCEPT)
target     prot opt source                destination
root@Server-1:/home/nik#
```

7.2 З Client_2 на 172.17.D+10.1 ping проходив, а на 172.17.D+20.1 не проходив

```
Server-1 (Snapshot 4) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help

DROP      all  --  anywhere              anywhere

Chain FORWARD (policy ACCEPT)
target     prot opt source                destination          state RELATED,ESTABLISHED
ACCEPT     tcp  --  anywhere              anywhere             tcp dpt:ssh
ACCEPT     icmp --  172.17.17.0/24         anywhere
ACCEPT     icmp --  10.87.7.0/24           anywhere
ACCEPT     icmp --  10.7.87.0/24           anywhere
DROP       icmp --  172.17.27.1            anywhere
DROP       all  --  anywhere              anywhere

Chain OUTPUT (policy ACCEPT)
target     prot opt source                destination
DROP       all  --  anywhere              anywhere
root@Server-1:~# nano /etc/netplan/00-installer-config.yaml ^C
root@Server-1:~# ^C
root@Server-1:~# ^C
root@Server-1:~# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default    192.168.0.1 0.0.0.0 UG 0 0 0 enp0s3
10.7.87.0  0.0.0.0 255.255.255.0 U 0 0 0 enp0s9
10.87.7.0  0.0.0.0 255.255.255.0 U 0 0 0 enp0s8
172.17.17.0 10.87.7.101 255.255.255.0 UG 0 0 0 enp0s8
172.17.27.0 10.87.7.101 255.255.255.0 UG 0 0 0 enp0s8
192.168.0.0 0.0.0.0 255.255.255.0 U 0 0 0 enp0s3
root@Server-1:~# ip route del 172.17.27.0/24 via 10.87.7.101
root@Server-1:~# route
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
default    192.168.0.1 0.0.0.0 UG 0 0 0 enp0s3
10.7.87.0  0.0.0.0 255.255.255.0 U 0 0 0 enp0s9
10.87.7.0  0.0.0.0 255.255.255.0 U 0 0 0 enp0s8
172.17.17.0 10.87.7.101 255.255.255.0 UG 0 0 0 enp0s8
192.168.0.0 0.0.0.0 255.255.255.0 U 0 0 0 enp0s3
root@Server-1:~#
```

Any rules in iptables can't help!

Only separate routes on two subnets:

172.17.17.0/24

172.17.27.0/24

And then delete forward route to second one!

8 Якщо в п.3 була налаштована маршрутизація для доступу Client_1 та Client_2 до мережі Інтернет – видалити відповідні записи. На Server_1 налаштувати NAT сервіс таким чином, щоб з Client_1 та Client_2 проходив ping в мережу Інтернет

```

GNU nano 6.2 /etc/netplan/00-installer-config.yaml
# This is the network config written by 'subiquity'
network:
  ethernets:
    enp0s3:
      addresses:
      - 192.168.0.200/24
      dhcp4: true
      gateway4: 192.168.0.1
      nameservers:
        addresses:
        - 192.168.0.1
        - 8.8.8.8
        - 8.8.4.4
        search: []
      routes:
      - to: default
        via: 192.168.0.1
        metric: 300
    enp0s8:
      addresses:
      - 10.87.7.2/24
      dhcp4: false
      gateway4: 10.87.7.1
      nameservers:
        addresses:
        - 8.8.8.8
        - 8.8.4.4
        search: []
      routes:
      - to: default
        via: 10.87.7.1
        metric: 200
    enp0s9:

```

```
Server-1 (Snapshot 4) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help

    valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
    valid_lft forever preferred_lft forever
2: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:05:74:86 brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 metric 100 brd 10.0.2.255 scope global dynamic enp0s3
        valid_lft 85455sec preferred_lft 85455sec
    inet6 fe80::a00:27ff:fe05:7486/64 scope link
        valid_lft forever preferred_lft forever
3: enp0s8: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:bf:50:07 brd ff:ff:ff:ff:ff:ff
    inet 10.87.7.2/24 brd 10.87.7.255 scope global enp0s8
        valid_lft forever preferred_lft forever
    inet6 fe80::a00:27ff:febf:5007/64 scope link
        valid_lft forever preferred_lft forever
4: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:4e:2f:af brd ff:ff:ff:ff:ff:ff
    inet 10.7.87.2/24 brd 10.7.87.255 scope global enp0s9
        valid_lft forever preferred_lft forever
    inet6 fe80::a00:27ff:fe4e:2faf/64 scope link
        valid_lft forever preferred_lft forever
root@Server-1:/home/nik# ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data.
64 bytes from 8.8.8.8: icmp_seq=1 ttl=116 time=33.0 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=116 time=32.9 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=116 time=30.4 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=116 time=32.8 ms
^C64 bytes from 8.8.8.8: icmp_seq=5 ttl=116 time=32.4 ms
^C64 bytes from 8.8.8.8: icmp_seq=6 ttl=116 time=32.4 ms
^C
--- 8.8.8.8 ping statistics ---
6 packets transmitted, 6 received, 0% packet loss, time 5009ms
rtt min/avg/max/mdev = 30.378/32.323/33.028/0.896 ms
root@Server-1:/home/nik# _
```

Iptables -t nat -L

Iptables -t nat -A POSTROUTING -s 10.0.0.0/16 -j SNAT --to-source 10.0.2.15

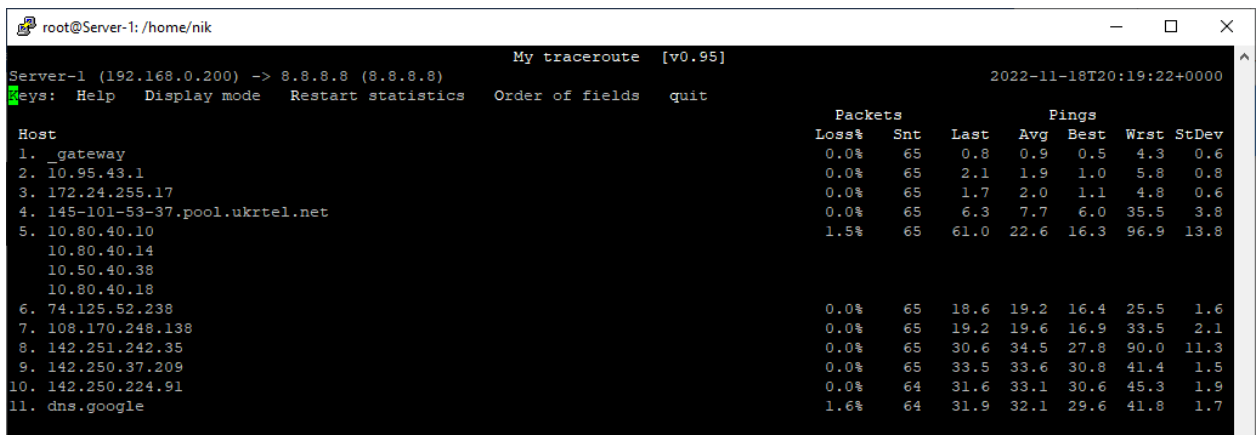
To add a permanent route in Ubuntu use Netplan.

```
network:
  version: 2
  renderer: NetworkManager
  ethernets:
    enp0s3:
      # addresses: [10.0.4.2/24]
      dhcp4: true
      # routes:
      #   - to: 10.0.3.0/24
      #     via: 10.0.5.2
      #     metric: 50
    enp0s8:
      addresses: [10.0.5.1/24]
      routes:
        - to: 10.0.3.0/24
          via: 10.0.5.2
          metric: 50
```

cli

Troubleshooting or find out of problems

Apt install -y mtr



Host		Packets		Pings				
		Loss%	Snt	Last	Avg	Best	Wrst	StDev
1.	_gateway	0.0%	65	0.8	0.9	0.5	4.3	0.6
2.	10.95.43.1	0.0%	65	2.1	1.9	1.0	5.8	0.8
3.	172.24.255.17	0.0%	65	1.7	2.0	1.1	4.8	0.6
4.	145-101-53-37.pool.ukrtel.net	0.0%	65	6.3	7.7	6.0	35.5	3.8
5.	10.80.40.10	1.5%	65	61.0	22.6	16.3	96.9	13.8
6.	74.125.52.238	0.0%	65	18.6	19.2	16.4	25.5	1.6
7.	108.170.248.138	0.0%	65	19.2	19.6	16.9	33.5	2.1
8.	142.251.242.35	0.0%	65	30.6	34.5	27.8	90.0	11.3
9.	142.250.37.209	0.0%	65	33.5	33.6	30.8	41.4	1.5
10.	142.250.224.91	0.0%	64	31.6	33.1	30.6	45.3	1.9
11.	dns.google	1.6%	64	31.9	32.1	29.6	41.8	1.7

Traceroute

```
root@Server-1:/home/nik# traceroute 8.8.8.8
traceroute to 8.8.8.8 (8.8.8.8), 30 hops max, 60 byte packets
 1 _gateway (192.168.0.1) 0.482 ms 0.526 ms 0.477 ms
 2 10.95.43.1 (10.95.43.1) 1.133 ms 1.512 ms 1.264 ms
 3 172.24.255.17 (172.24.255.17) 1.311 ms 0.894 ms 1.492 ms
 4 145-101-53-37.pool.ukrtel.net (37.53.101.145) 8.422 ms 8.168 ms 7.661 ms
 5 10.80.40.2 (10.80.40.2) 19.741 ms 10.80.40.6 (10.80.40.6) 19.231 ms 10.50.40.38 (10.50.40.38) 17.037 ms
 6 74.125.52.238 (74.125.52.238) 16.775 ms 20.263 ms 20.007 ms
 7 108.170.248.138 (108.170.248.138) 18.820 ms 18.568 ms 23.801 ms
 8 142.251.224.82 (142.251.224.82) 33.738 ms 31.052 ms 142.251.242.35 (142.251.242.35) 30.103 ms
 9 142.251.77.181 (142.251.77.181) 32.865 ms 142.251.224.76 (142.251.224.76) 33.256 ms 108.170.250.209 (108.170.250.209) 32.822 ms
10 142.251.228.25 (142.251.228.25) 32.808 ms 74.125.242.241 (74.125.242.241) 32.560 ms 142.250.37.209 (142.250.37.209) 31.443 ms
11 * * 172.253.68.29 (172.253.68.29) 31.245 ms
12 * *
13 * *
14 * *
15 * *
16 * *
17 * *
18 * *
19 * *
20 * *
21 * *
22 * *
23 * *
24 * *
25 * *
26 * *
27 * *
28 * *
29 * *
30 * *
```

- Не разрешает себя проверять сеть или подсеть (не возвращает некрологи)

Ping – Network layer

```
root@Server-1:/home/nik# ping 8.8.8.8
PING 8.8.8.8 (8.8.8.8) 56(84) bytes of data.
64 bytes from 8.8.8.8: icmp_seq=1 ttl=117 time=33.0 ms
64 bytes from 8.8.8.8: icmp_seq=2 ttl=117 time=32.7 ms
64 bytes from 8.8.8.8: icmp_seq=3 ttl=117 time=32.9 ms
64 bytes from 8.8.8.8: icmp_seq=4 ttl=117 time=33.4 ms
64 bytes from 8.8.8.8: icmp_seq=5 ttl=117 time=32.7 ms
^C
--- 8.8.8.8 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4007ms
rtt min/avg/max/mdev = 32.671/32.942/33.402/0.267 ms
root@Server-1:/home/nik#
```

Netstat -at -n show tcp

```
root@Server-1:/home/nik# netstat -at -n
Active Internet connections (servers and established)


| Proto | Recv-Q | Send-Q | Local Address    | Foreign Address     | State       |
|-------|--------|--------|------------------|---------------------|-------------|
| tcp   | 0      | 0      | 127.0.0.53:53    | 0.0.0.0:*           | LISTEN      |
| tcp   | 0      | 0      | 0.0.0.0:22       | 0.0.0.0:*           | LISTEN      |
| tcp   | 0      | 0      | 192.168.0.200:22 | 192.168.0.105:65408 | ESTABLISHED |
| tcp   | 0      | 64     | 192.168.0.200:22 | 192.168.0.105:65409 | ESTABLISHED |
| tcp6  | 0      | 0      | :::22            | :::*                | LISTEN      |


root@Server-1:/home/nik#
```

Port 22 – SSH

Port 53 – DNS

Netstat -au -n show udp

```
root@Server-1:/home/nik# netstat -au -n
Active Internet connections (servers and established)


| Proto | Recv-Q | Send-Q | Local Address | Foreign Address | State |
|-------|--------|--------|---------------|-----------------|-------|
| udp   | 0      | 0      | 127.0.0.53:53 | 0.0.0.0:*       |       |
| udp   | 0      | 0      | 0.0.0.0:67    | 0.0.0.0:*       |       |


root@Server-1:/home/nik#
```

Port 67 - DHCP

Nslookup

```
root@Server-1:/home/nik# nslookup 8.8.8.8
8.8.8.8.in-addr.arpa    name = dns.google.

Authoritative answers can be found from:

root@Server-1:/home/nik# nslookup google.com
Server:                127.0.0.53
Address:               127.0.0.53#53

Non-authoritative answer:
Name:   google.com
Address: 142.250.186.206
Name:   google.com
Address: 2a00:1450:401b:800::200e

root@Server-1:/home/nik#
```

Dig

```
root@Server-1:/home/nik# dig google.com

; <<>> DiG 9.18.1-lubuntu1.2-Ubuntu <<>> google.com
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 62413
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags;; udp: 65494
;; QUESTION SECTION:
;google.com.                IN      A

;; ANSWER SECTION:
google.com.                151     IN      A      142.250.186.206

;; Query time: 0 msec
;; SERVER: 127.0.0.53#53(127.0.0.53) (UDP)
;; WHEN: Fri Nov 18 20:52:55 UTC 2022
;; MSG SIZE  rcvd: 55

root@Server-1:/home/nik#
```

Arp

Для внутренних сетей. Просмотреть соответствие между IP и MAC адресами!

```
root@Server-1:/home/nik# arp -a
? (172.17.17.1) at 08:00:27:da:65:7b [ether] on enp0s8
? (10.7.87.102) at 08:00:27:f5:9b:5c [ether] on enp0s9
? (192.168.0.105) at d4:5d:64:b2:b8:f5 [ether] on enp0s3
? (192.168.0.104) at b0:be:76:bf:c2:85 [ether] on enp0s3
? (10.87.7.1) at <incomplete> on enp0s8
? (10.87.7.101) at 08:00:27:da:65:7b [ether] on enp0s8
_gateway (192.168.0.1) at b0:be:76:bf:c2:84 [ether] on enp0s3
root@Server-1:/home/nik#
```

Nmap

```
root@Server-1:/home/nik# nmap 8.8.8.8
Starting Nmap 7.80 ( https://nmap.org ) at 2022-11-18 21:03 UTC
Nmap scan report for dns.google (8.8.8.8)
Host is up (0.031s latency).
Not shown: 998 filtered ports
PORT      STATE SERVICE
53/tcp    open  domain
443/tcp   open  https

Nmap done: 1 IP address (1 host up) scanned in 4.21 seconds
root@Server-1:/home/nik#
```

Tcpdump – менеджер пакетов внутренней сети

```

0 packets dropped by kernel
root@Server-1:/home/nik# tcpdump -i enp0s9
tcpdump: verbose output suppressed, use -v[v]... for full protocol decode
listening on enp0s9, link-type EN10MB (Ethernet), snapshot length 262144 bytes
21:08:24.088721 IP 10.7.87.102 > 172.17.17.1: ICMP echo request, id 9768, seq 29, length 64
21:08:24.089259 IP 172.17.17.1 > 10.7.87.102: ICMP echo reply, id 9768, seq 29, length 64
21:08:25.090228 IP 10.7.87.102 > 172.17.17.1: ICMP echo request, id 9768, seq 30, length 64
21:08:25.090797 IP 172.17.17.1 > 10.7.87.102: ICMP echo reply, id 9768, seq 30, length 64
21:08:26.092368 IP 10.7.87.102 > 172.17.17.1: ICMP echo request, id 9768, seq 31, length 64
21:08:26.093003 IP 172.17.17.1 > 10.7.87.102: ICMP echo reply, id 9768, seq 31, length 64
21:08:27.094666 IP 10.7.87.102 > 172.17.17.1: ICMP echo request, id 9768, seq 32, length 64
21:08:27.095187 IP 172.17.17.1 > 10.7.87.102: ICMP echo reply, id 9768, seq 32, length 64
21:08:28.092595 ARP, Request who-has Server-1 tell 10.7.87.102, length 46
21:08:28.092610 ARP, Reply Server-1 is-at 08:00:27:4e:2f:af (oui Unknown), length 28
21:08:28.096243 IP 10.7.87.102 > 172.17.17.1: ICMP echo request, id 9768, seq 33, length 64
21:08:28.096766 IP 172.17.17.1 > 10.7.87.102: ICMP echo reply, id 9768, seq 33, length 64
^C
12 packets captured
12 packets received by filter
0 packets dropped by kernel
root@Server-1:/home/nik#

```

net.ipv4.ip_forward=1

cd /etc/sysconfig/network-scripts

systemctl restart network

lshw -class network

sudo nano /etc/dhcp/dhcpd.conf

sudo systemctl restart NetworkManager.service

sudo systemctl status NetworkManager.service

nano /etc/netplan/00-installer-config.yaml

netplan apply

sudo netplan --debug apply

systemctl restart isc-dhcp-server

systemctl status isc-dhcp-server

--- route

ip route show

root@Server-1:/home/nik# route

Kernel IP routing table

Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
default	_gateway	0.0.0.0	UG	0	0	0	enp0s3
10.7.87.0	0.0.0.0	255.255.255.0	U	0	0	0	enp0s9
10.87.7.0	0.0.0.0	255.255.255.0	U	0	0	0	enp0s8
192.168.0.0	0.0.0.0	255.255.255.0	U	0	0	0	enp0s3

--- transit route on server MUST BE ENABLED !!!!!!!!!!!!!!!

nano /proc/sys/net/ipv4/ip_forward

1

Work immediately

nano /etc/sysctl.conf

net.ipv4.ip_forward=1

net.ipv6.conf.all.forwarding=1

work after reboot

traceroute 8.8.8.8

tcpdump -i enp0s8

iptables -L

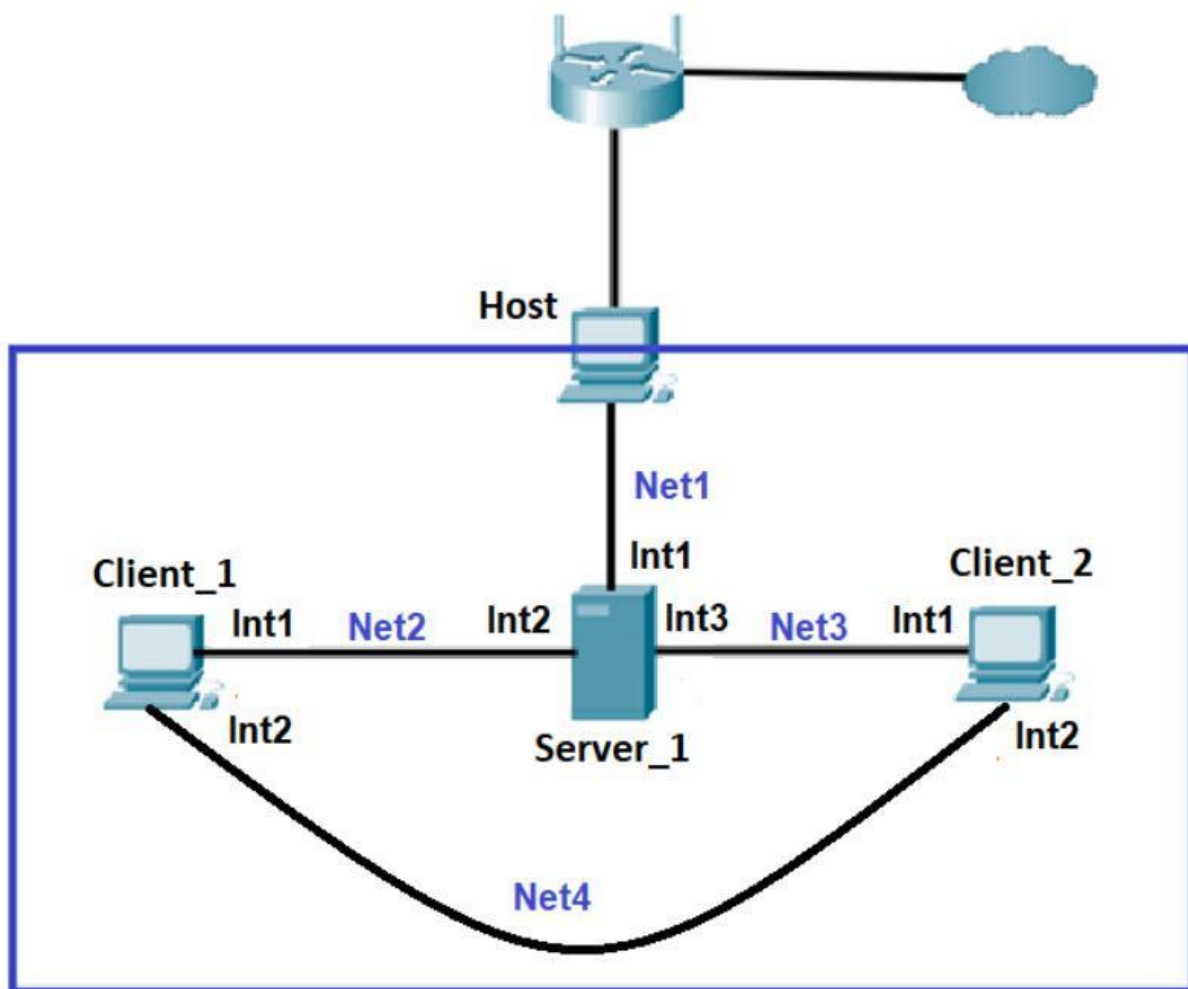


Рисунок 1