

1. Use already created internal-network for three VMs (VM1-VM3).
VM1 has NAT and internal, VM2, VM3 – internal only interfaces.

GW [Запущено] - Oracle VM VirtualBox

Файл Машина Перегляд Введення Пристрої Довідка

root@gw:/home/master# route

Kernel IP routing table

Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
default	_gateway	0.0.0.0	UG	100	0	0	enp0s3
10.7.0.0	0.0.0.0	255.255.0.0	U	100	0	0	enp0s3
_gateway	0.0.0.0	255.255.255.255	UH	100	0	0	enp0s3
10.7.101.254	0.0.0.0	255.255.255.255	UH	100	0	0	enp0s3
172.16.1.0	0.0.0.0	255.255.255.0	U	0	0	0	enp0s8

root@gw:/home/master# _

vm1 [Запущено] - Oracle VM VirtualBox

Файл Машина Перегляд Введення Пристрої Довідка

root@vm1:/home/master# route

Kernel IP routing table

Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
default	_gateway	0.0.0.0	UG	0	0	0	enp0s3
172.16.1.0	0.0.0.0	255.255.255.0	U	0	0	0	enp0s3
172.16.2.0	0.0.0.0	255.255.255.0	U	0	0	0	enp0s8

root@vm1:/home/master#

vm2 [Запущено] - Oracle VM VirtualBox

Файл Машина Перегляд Введення Пристрої Довідка

oot@vn2:/home/master# route

Kernel IP routing table

oot@vn2:/home/master#

vm3 [Запущено] - Oracle VM VirtualBox

Файл Машина Перегляд Введення Пристрої Довідка

root@vm3:/home/master# route

Kernel IP routing table

root@vm3:/home/master#

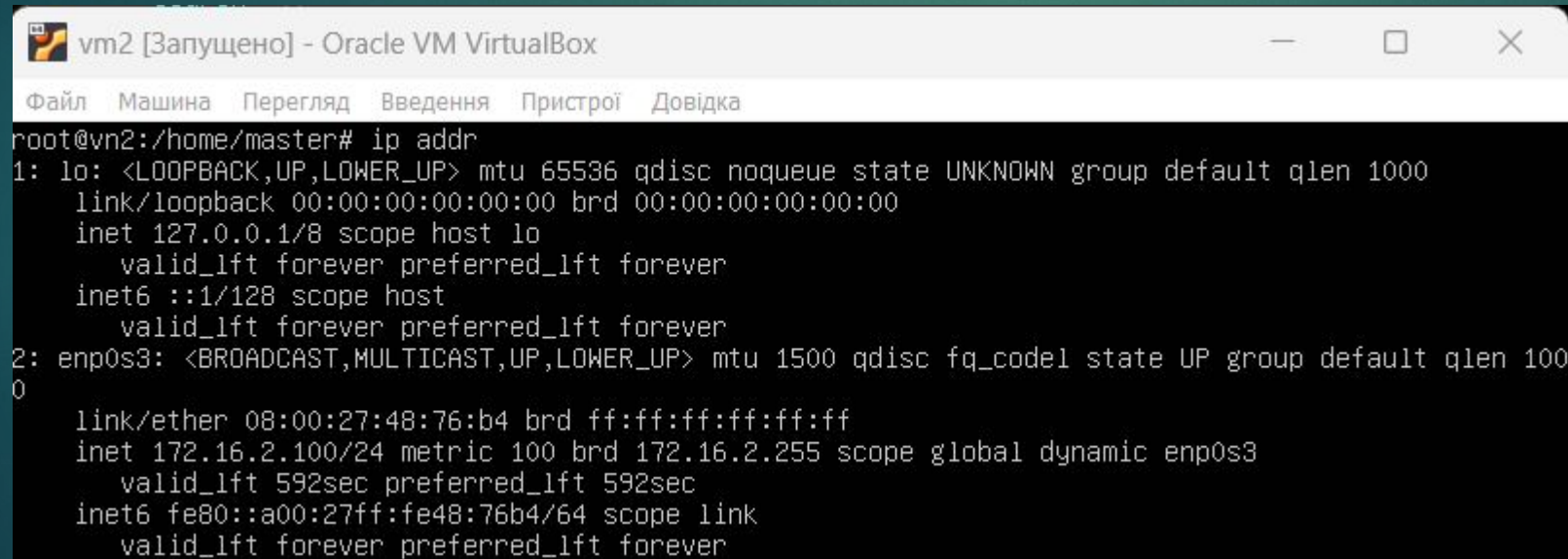
2. Install and configure DHCP server on VM1. (3 ways: using VBoxManage, DNSMASQ and ISC-DHSPSERVER).

```
vm1 [Запущено] - Oracle VM VirtualBox
Файл  Машина  Перегляд  Введення  Пристрої  Довідка
# A slightly different configuration for an internal subnet.
subnet 172.16.2.0 netmask 255.255.255.0 {
range 172.16.2.100 172.16.2.200;
option domain-name-servers ns1.demo.internal;
option domain-name "demo.internal";
option subnet-mask 255.255.255.0;
option routers 172.16.2.1;
option broadcast-address 172.16.2.255;
default-lease-time 600;
max-lease-time 7200;
}
```

```
vm1 [Запущено] - Oracle VM VirtualBox
Файл  Машина  Перегляд  Введення  Пристрої  Довідка
root@vm1:/home/master# systemctl status isc-dhcp-server
• isc-dhcp-server.service - ISC DHCP IPv4 server
   Loaded: loaded (/lib/systemd/system/isc-dhcp-server.service; enabled; vendor preset: enabled)
   Active: active (running) since Mon 2023-08-21 08:47:23 UTC; 2min 29s ago
     Docs: man:dhcpd(8)
   Main PID: 3940 (dhcpd)
    Tasks: 4 (limit: 2241)
   Memory: 4.5M
      CPU: 9ms
   CGroup: /system.slice/isc-dhcp-server.service
           └─3940 dhcpd -user dhcpd -group dhcpd -f -4 -pf /run/dhcp-server/dhcpd.pid -cf /etc/d
```

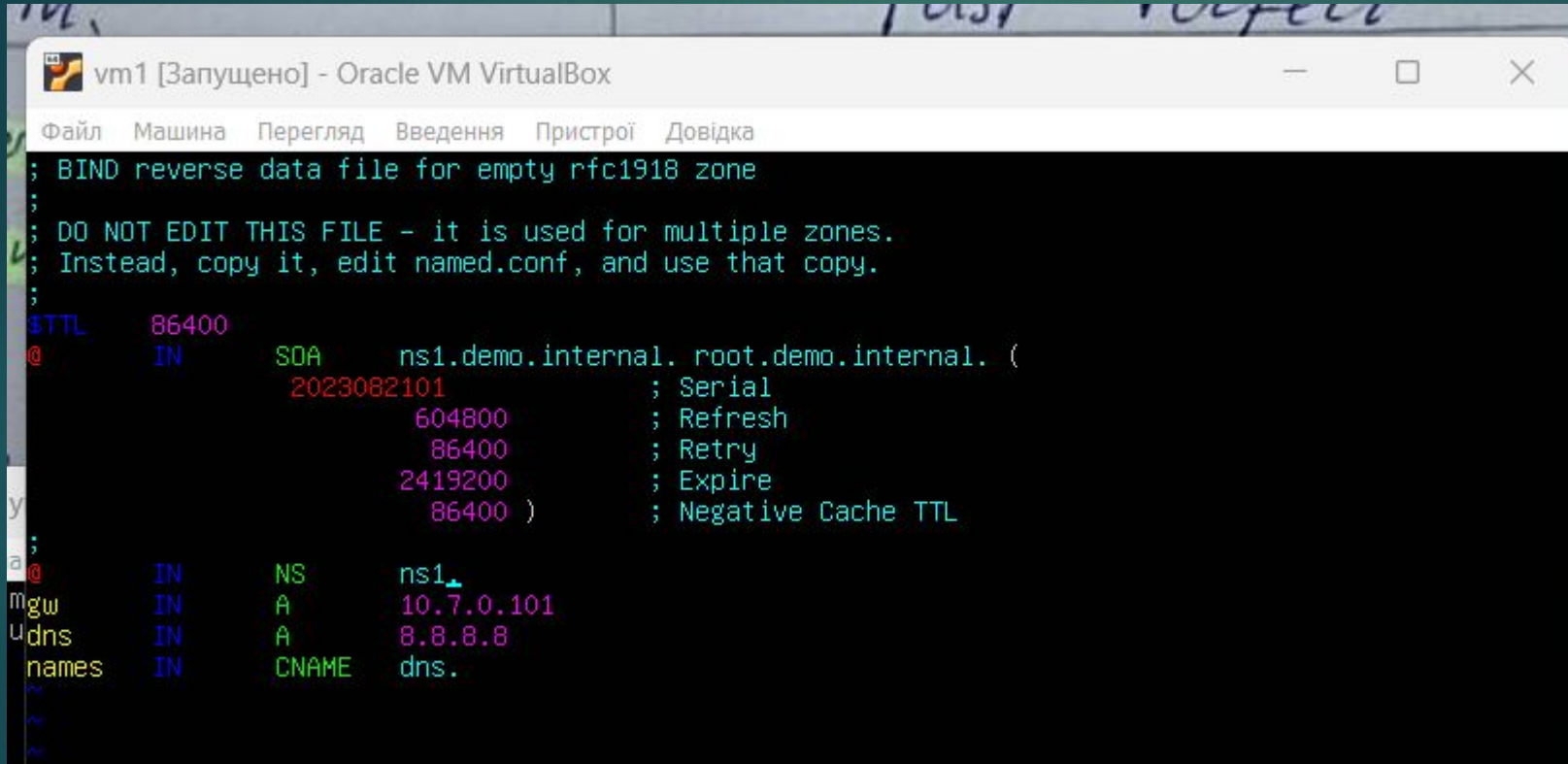
3. Check VM2 and VM3 for obtaining network addresses from DHCP server.

```
Aug 21 08:47:23 vm1 dhcpcd[3940]: Sending on Socket/fallback/fallback-net
Aug 21 08:47:23 vm1 sh[3940]: Sending on Socket/fallback/fallback-net
Aug 21 08:47:23 vm1 dhcpcd[3940]: Server starting service.
Aug 21 08:48:23 vm1 dhcpcd[3940]: DHCPDISCOVER from 08:00:27:48:76:b4 via enp0s8
Aug 21 08:48:24 vm1 dhcpcd[3940]: ns1.demo.internal: host unknown.
Aug 21 08:48:24 vm1 dhcpcd[3940]: DHCPOFFER on 172.16.2.100 to 08:00:27:48:76:b4 (vn2) via enp0s8
Aug 21 08:48:27 vm1 dhcpcd[3940]: DHCPDISCOVER from 08:00:27:48:76:b4 (vn2) via enp0s8
Aug 21 08:48:27 vm1 dhcpcd[3940]: DHCPOFFER on 172.16.2.100 to 08:00:27:48:76:b4 (vn2) via enp0s8
Aug 21 08:48:27 vm1 dhcpcd[3940]: DHCPREQUEST for 172.16.2.100 (172.16.2.1) from 08:00:27:48:76:b4 (
Aug 21 08:48:27 vm1 dhcpcd[3940]: DHCPACK on 172.16.2.100 to 08:00:27:48:76:b4 (vn2) via enp0s8
root@vm1:/home/master# _
```



```
vm2 [Запущено] - Oracle VM VirtualBox
Файл  Машина  Перегляд  Введення  Пристрої  Довідка
root@vn2:/home/master# ip addr
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 08:00:27:48:76:b4 brd ff:ff:ff:ff:ff:ff
    inet 172.16.2.100/24 metric 100 brd 172.16.2.255 scope global dynamic enp0s3
        valid_lft 592sec preferred_lft 592sec
    inet6 fe80::a00:27ff:fe48:76b4/64 scope link
        valid_lft forever preferred_lft forever
```


4. Using existed network for three VMs (from p.1) install and configure DNS server on VM1. (You can use DNSMASQ, BIND9 or something else).



```
vm1 [Запущено] - Oracle VM VirtualBox
Файл  Машина  Перегляд  Введення  Пристрої  Довідка
; BIND reverse data file for empty rfc1918 zone
;
; DO NOT EDIT THIS FILE - it is used for multiple zones.
; Instead, copy it, edit named.conf, and use that copy.
;
$TTL      86400
@         IN      SOA      ns1.demo.internal. root.demo.internal. (
                        2023082101      ; Serial
                        604800      ; Refresh
                        86400      ; Retry
                        2419200      ; Expire
                        86400 )      ; Negative Cache TTL
;
@         IN      NS       ns1.
mgw       IN      A        10.7.0.101
dns       IN      A        8.8.8.8
names     IN      CNAME    dns.
```

Файл: машина - перевод: введенный - прибор: доводка

```
root@vm1:/etc/bind# dig dns.demo.internal A

; <<>> DiG 9.18.12-0ubuntu0.22.04.2-Ubuntu <<>> dns.demo.internal A
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 37242
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1232
; COOKIE: f80e018c3a54a60d0100000064e33a9b6d92ed7f4bc52728 (good)
;; QUESTION SECTION:
;dns.demo.internal.                IN      A

;; ANSWER SECTION:
dns.demo.internal.  86400   IN      A      8.8.8.8

;; Query time: 4 msec
;; SERVER: 127.0.0.1#53(127.0.0.1) (UDP)
;; WHEN: Mon Aug 21 10:21:15 UTC 2023
;; MSG SIZE  rcvd: 90
```

```
// be authoritative for the localhost forward
// broadcast zones as per RFC 1912

zone "localhost" {
    type master;
    file "/etc/bind/db.local";
};

zone "demo.internal" IN {
    type master;
    file "/etc/bind/db.demo.internal";
};
```

5. Check VM2 and VM3 for gaining access to DNS server (naming services).

```
vm2 [Запущено] - Oracle VM VirtualBox
Файл  Машина  Перегляд  Введення  Пристрої  Довідка
root@vn2:/home/master# dig gw.demo.internal A

; <<>> DiG 9.18.1-1ubuntu1-Ubuntu <<>> gw.demo.internal A
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 10193
;; flags: qr aa rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1232
; COOKIE: f77a7705fdf5f05901000000064e33b5752226c4030f722b6 (good)
;; QUESTION SECTION:
;gw.demo.internal.          IN      A

;; ANSWER SECTION:
gw.demo.internal.          86400   IN      A      10.7.0.101

;; Query time: 0 msec
;; SERVER: 172.16.2.1#53(172.16.2.1) (UDP)
;; WHEN: Mon Aug 21 10:20:58 UTC 2023
;; MSG SIZE rcvd: 89

root@vn2:/home/master# _
```


6. ***Using the scheme which follows, configure dynamic routing using OSPF protocol.

```
GW [Запущено] - Oracle VM VirtualBox
Файл Машина Перегляд Введення Пристрої Довідка
root@gw:/home/master/frr/frr# vtysh -c "show ip route"
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

K>* 0.0.0.0/0 [0/100] via 10.7.0.101, enp0s3, src 10.7.150.40, 00:21:24
C>* 10.7.0.0/16 [0/100] is directly connected, enp0s3, 00:21:24
K>* 10.7.0.101/32 [0/100] is directly connected, enp0s3, 00:21:24
K>* 10.7.101.254/32 [0/100] is directly connected, enp0s3, 00:21:24
O 172.16.1.0/24 [110/100] is directly connected, enp0s8, weight 1, 00:21:24
C>* 172.16.1.0/24 is directly connected, enp0s8, 00:21:24
O>* 172.16.2.0/24 [110/200] via 172.16.1.20, enp0s8, weight 1, 00:21:07
O>* 172.16.3.0/24 [110/300] via 172.16.1.20, enp0s8, weight 1, 00:01:27
root@gw:/home/master/frr/frr#

vm2 [Запущено] - Oracle VM VirtualBox
Файл Машина Перегляд Введення Пристрої Довідка
root@vn2:/home/master# vtysh -c "show ip route"
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

O 0.0.0.0/0 [110/10] via 172.16.2.1, enp0s3 inactive, weight 1, 00:06:56
>* 0.0.0.0/0 [0/100] via 172.16.2.1, enp0s3, src 172.16.2.100, 00:07:16
172.16.1.0/24 [110/200] via 172.16.2.1, enp0s3 inactive, weight 1, 00:06:57
172.16.2.0/24 [110/100] is directly connected, enp0s3, weight 1, 00:07:07
>* 172.16.2.0/24 [0/100] is directly connected, enp0s3, 00:07:16
>* 172.16.2.1/32 [0/100] is directly connected, enp0s3, 00:07:16
172.16.3.0/24 [110/100] is directly connected, enp0s8, weight 1, 00:07:16
>* 172.16.3.0/24 is directly connected, enp0s8, 00:07:16
root@vn2:/home/master#

vm1 [Запущено] - Oracle VM VirtualBox
Файл Машина Перегляд Введення Пристрої Довідка
root@vm1:/home/master# vtysh -c "show ip route"
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

O>* 0.0.0.0/0 [110/10] via 172.16.1.10, enp0s3, weight 1, 00:21:38
O 172.16.1.0/24 [110/100] is directly connected, enp0s3, weight 1, 00:24:59
C>* 172.16.1.0/24 is directly connected, enp0s3, 00:24:59
O 172.16.2.0/24 [110/100] is directly connected, enp0s8, weight 1, 00:24:59
C>* 172.16.2.0/24 is directly connected, enp0s8, 00:24:59
O>* 172.16.3.0/24 [110/200] via 172.16.2.100, enp0s8, weight 1, 00:01:49
root@vm1:/home/master#

vm3 [Запущено] - Oracle VM VirtualBox
Файл Машина Перегляд Введення Пристрої Довідка
root@vm3:/home/master# vtysh -c "show ip route"
Codes: K - kernel route, C - connected, S - static, R - RIP,
       O - OSPF, I - IS-IS, B - BGP, E - EIGRP, N - NHRP,
       T - Table, v - VNC, V - VNC-Direct, A - Babel, F - PBR,
       f - OpenFabric,
       > - selected route, * - FIB route, q - queued, r - rejected, b - backup
       t - trapped, o - offload failure

K>* 0.0.0.0/0 [0/100] via 10.7.0.101, enp0s8, src 10.7.150.6, 00:00:14
C>* 10.7.0.0/16 [0/100] is directly connected, enp0s8, 00:00:14
K>* 10.7.0.101/32 [0/100] is directly connected, enp0s8, 00:00:14
K>* 10.7.101.254/32 [0/100] is directly connected, enp0s8, 00:00:14
O 172.16.3.0/24 [110/100] is directly connected, enp0s3, weight 1, 00:00:03
C>* 172.16.3.0/24 is directly connected, enp0s3, 00:00:14
root@vm3:/home/master#
```

```
GW [Запущено] - Oracle VM VirtualBox
Файл  Машина  Перегляд  Введення  Пристрої  Довідка
root@gw:/home/master/frr/frr# vtysh -c "show ip ospf neighbor"

Neighbor ID     Pri State           Dead Time Address           Interface           RXmtL
RqstL DBsmL
1.2.2.2         1 Full/DR           32.384s 172.16.1.20         enp0s8:172.16.1.10  0
0 0

root@gw:/home/master/frr/frr# _
```

```
vm1 [Запущено] - Oracle VM VirtualBox
Файл  Машина  Перегляд  Введення  Пристрої  Довідка
root@vm1:/home/master# vtysh -c "show ip ospf neighbor"

Neighbor ID     Pri State           Dead Time Address           Interface           RXmtL
RqstL DBsmL
1.1.1.1         1 Full/Backup       38.191s 172.16.1.10         enp0s3:172.16.1.20  0
0 0
3.3.3.3         1 Full/Backup       38.615s 172.16.2.100        enp0s8:172.16.2.1  0
0 0

root@vm1:/home/master#
```

```
vm2 [Запущено] - Oracle VM VirtualBox
Файл  Машина  Перегляд  Введення  Пристрої  Довідка
root@vn2:/home/master# vtysh -c "show ip ospf neighbor"

Neighbor ID     Pri State           Dead Time Address           Interface           RXmtL
RqstL DBsmL
1.2.2.2         1 Full/DR           32.091s 172.16.2.1          enp0s3:172.16.2.100  0
0 0
1.4.4.4         1 Full/Backup       34.103s 172.16.3.10         enp0s8:172.16.3.1   0
0 0

root@vn2:/home/master#
```

```
vm3 [Запущено] - Oracle VM VirtualBox
Файл  Машина  Перегляд  Введення  Пристрої  Довідка
root@vm3:/home/master# vtysh -c "show ip ospf neighbor"

Neighbor ID     Pri State           Dead Time Address           Interface           RXmtL
RqstL DBsmL
3.3.3.3         1 Full/DR           38.567s 172.16.3.1          enp0s3:172.16.3.10  0
0 0

root@vm3:/home/master# _
```



```
vm2 [Запущено] - Oracle VM VirtualBox
Файл  Машина  Перегляд  Введення  Пристрої  Довідка

root@vn2:/home/master# traceroute 8.8.8.8
traceroute to 8.8.8.8 (8.8.8.8), 30 hops max, 60 byte packets
 1  _gateway (172.16.2.1)  0.395 ms  0.354 ms  0.341 ms
 2  172.16.1.10 (172.16.1.10)  0.639 ms  0.628 ms  0.617 ms
 3  10.7.0.101 (10.7.0.101)  1.807 ms  1.726 ms  1.692 ms
 4  192.168.101.1 (192.168.101.1)  1.795 ms  1.961 ms  1.930 ms
 5  172.17.58.6 (172.17.58.6)  1.918 ms  1.803 ms  2.009 ms
 6  core321-v1999.uar.net (194.44.212.153)  13.193 ms  6.819 ms  6.887 ms
 7  209.85.168.96 (209.85.168.96)  7.069 ms  6.652 ms  6.482 ms
 8  108.170.248.155 (108.170.248.155)  17.989 ms  108.170.248.138 (108.170.248.138)  14.899 ms  17.97
2 ms
 9  72.14.239.111 (72.14.239.111)  7.999 ms  142.251.242.35 (142.251.242.35)  20.642 ms  26.635 ms
10  142.250.37.193 (142.250.37.193)  20.685 ms  142.251.77.181 (142.251.77.181)  21.686 ms  142.250.46
.55 (142.250.46.55)  21.674 ms
11  72.14.237.17 (72.14.237.17)  20.631 ms  142.250.238.1 (142.250.238.1)  21.618 ms  74.125.242.225 (
74.125.242.225)  21.612 ms
12  142.250.239.81 (142.250.239.81)  20.342 ms  108.170.234.101 (108.170.234.101)  20.834 ms  209.85.2
53.225 (209.85.253.225)  20.666 ms
13  dns.google (8.8.8.8)  20.642 ms  20.767 ms  20.768 ms
root@vn2:/home/master#
```