

Linux Ağ Yönetimi 2020 Bahar Final Projesi

Abdulhamit Kumru 170202020

Kullanılan yazılımların versiyonları Ubuntu Desktop / Server 18, Virtual Box 6.1

Makinelerin Klonlanması

Base olarak kullanacağımız makineyi oluşturduktan sonra klon makineyi menüden sağ tıklayıp istediğimiz şekilde oluşturabiliyoruz. Biz daha az yer kullanmak ve ortak networklere bağlanacağımız için **Linked Clone** ve **Generate new MAC addresses for all network adapters** seçeneğini kullanacağız.

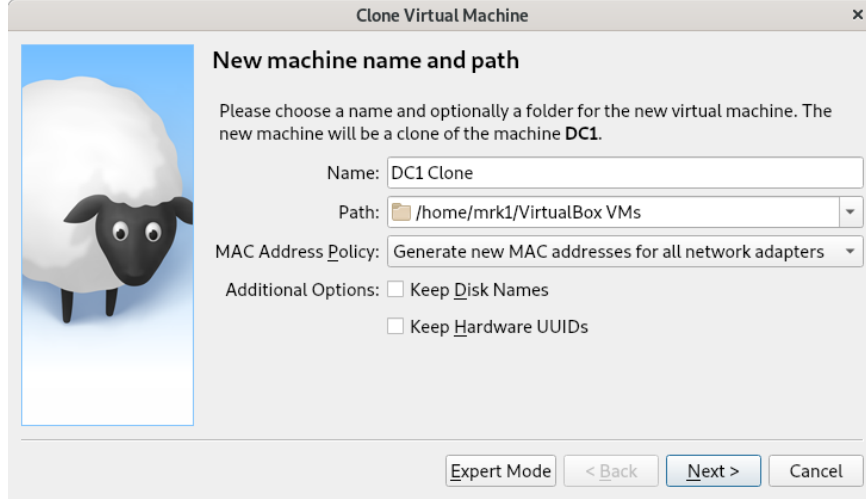


Figure 1: Klonlama

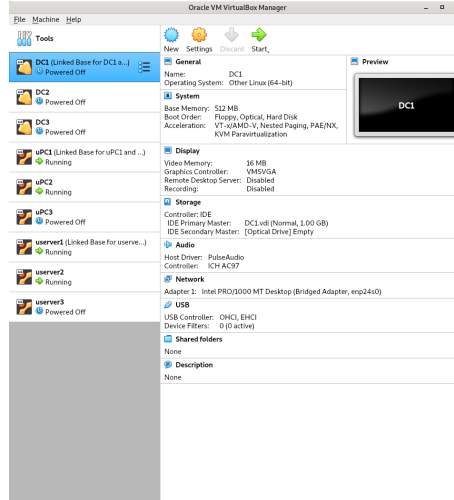


Figure 2: Klonlanmış Makineler

Senaryo 1

NAT ile Host-Guest Ubuntu PC Bağlantısı

Başlangıç olarak guest makinenin Network Adapterini NAT olarak seçiyoruz

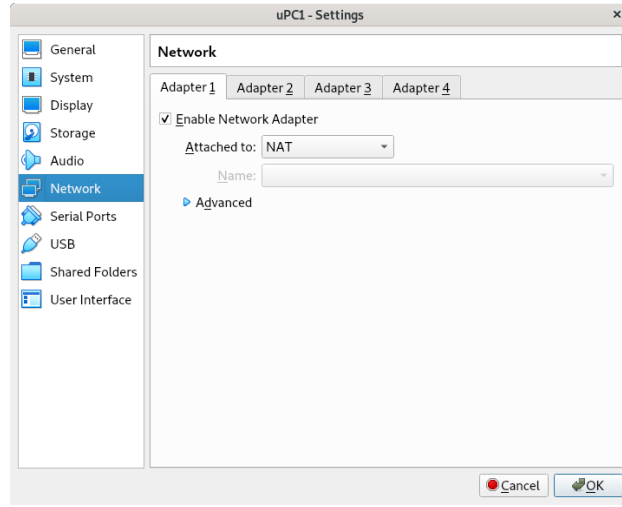


Figure 3: NAT adapter ayarı

SSH

host makineye NAT bağlantı ile erişebilmek için öncelikle gerekli gerekli portu yönlendiriyoruz daha sonra gueste ssh ile bağlanabilmek için open-ssh serveri apt ile yüklüyoruz.

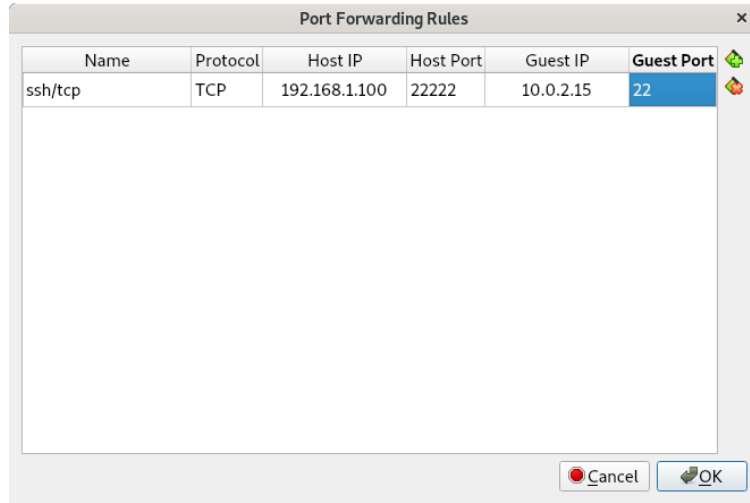


Figure 4: Port forwarding

```
$ apt install opessh-server
```

ssh server servisinin ayarlarını dosyasından 22 numaralı portu ve parolayı kabul edecek şekilde yapıyoruz.

```
$ echo "Port 22" >> /etc/ssh/sshd_config
```

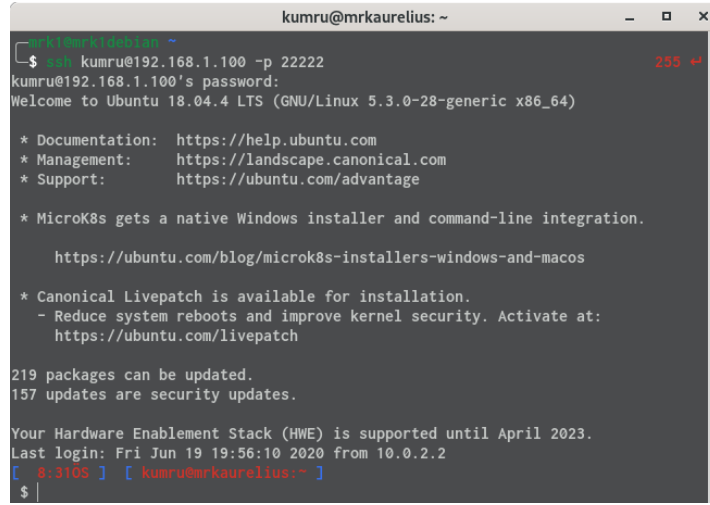
```
$ echo "PasswordAuthentication yes" >> /etc/ssh/sshd_config
```

Ayarların aktif olması için ssh servisimizi yeniden başlatıyoruz.

```
$ sudo service ssh restart
```

Forward ettiğimiz port üzerinden guest'e bağlanabiliriz.

```
$ ssh kumru@192.168.1.100 -p 22222 # hostun ip adresi
```

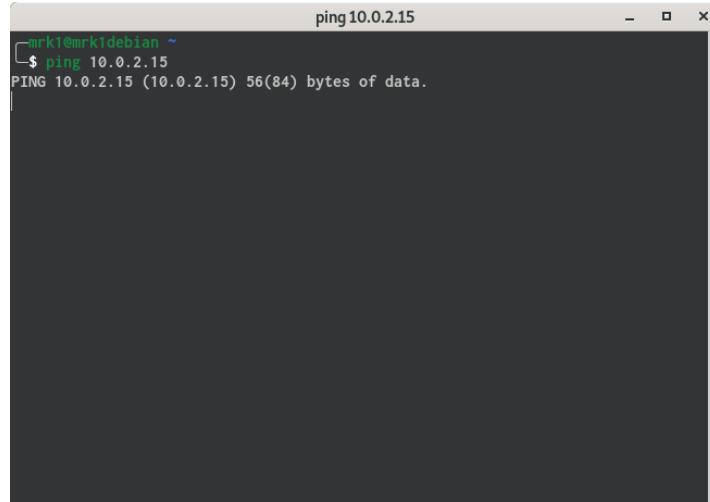


```
kumru@mrkaurelius: ~  
$ ssh kumru@192.168.1.100 -p 22222  
kumru@192.168.1.100's password:  
Welcome to Ubuntu 18.04.4 LTS (GNU/Linux 5.3.0-28-generic x86_64)  
  
* Documentation:  https://help.ubuntu.com  
* Management:    https://landscape.canonical.com  
* Support:       https://ubuntu.com/advantage  
  
* MicroK8s gets a native Windows installer and command-line integration.  
https://ubuntu.com/blog/microk8s-installers-windows-and-macos  
  
* Canonical Livepatch is available for installation.  
- Reduce system reboots and improve kernel security. Activate at:  
https://ubuntu.com/livepatch  
  
219 packages can be updated.  
157 updates are security updates.  
  
Your Hardware Enablement Stack (HWE) is supported until April 2023.  
Last login: Fri Jun 19 19:56:10 2020 from 10.0.2.2  
[ 8:31OS ] [ kumru@mrkaurelius:~ ]  
$
```

Figure 5: Gueste ssh ile baglanma

Ping

Eğer ICMP port ile çalışsaydı aynı şekilde onunda portunu yönlendirip gueste ping atabilirdik fakat ICMP TCP/UDP portları üzerinden çalışmıyor.



```
ping 10.0.2.15  
mrkl@mrkldebian ~  
$ ping 10.0.2.15  
PING 10.0.2.15 (10.0.2.15) 56(84) bytes of data.  
  
$
```

Figure 6: Gueste ping gönderilemiyor

Misafir Eklentileri

Misafir eklentilerini guest makineye sanal disk takarak yükleyebiliyoruz bu sayade hosttan gueste veya guestten hosta kopyala yapıştır ve dosya sürükleyip bırak yapabiliyoruz. Eklentiği yüklemek zor değil sanal makine penceresinden **Devices > Insert Guest Additions CD...** seçeneğini seçince bize `autorun.sh`'ı çalıştırıyım mı diye soruyor evet diyip parolamızı girince eklentiler yükleniyor

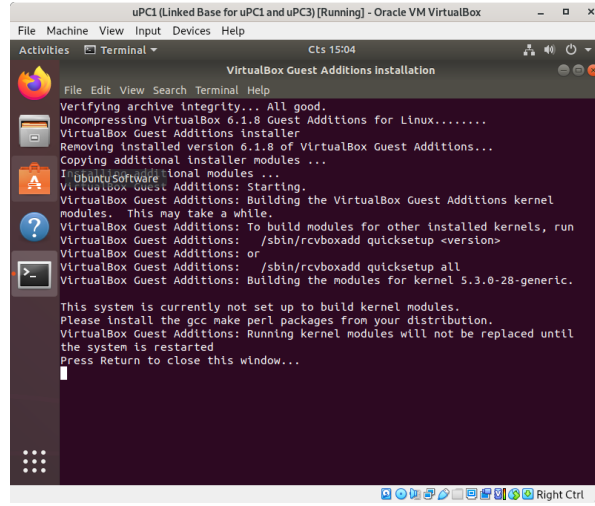


Figure 7: autorun.sh çıktısı

Sanal makinenin penceresinden **Devices > Drag and Drop**, **Devices > Shared Clipboard** seçeneklerinden detaylı ayar yapılabilir.

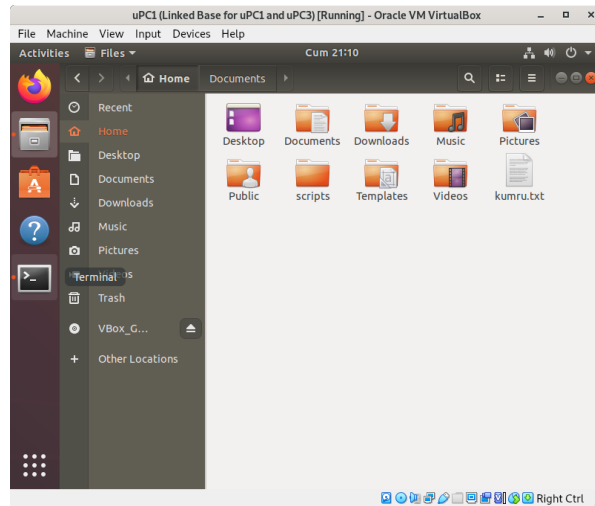


Figure 8: Gueste eklentileri ile sürükleyip bırak

Network Bridge ile Host, TinyCore Guest Bağlantısı

Guestin network adapter ayarını Bridge Adapter olarak seçiyoruz

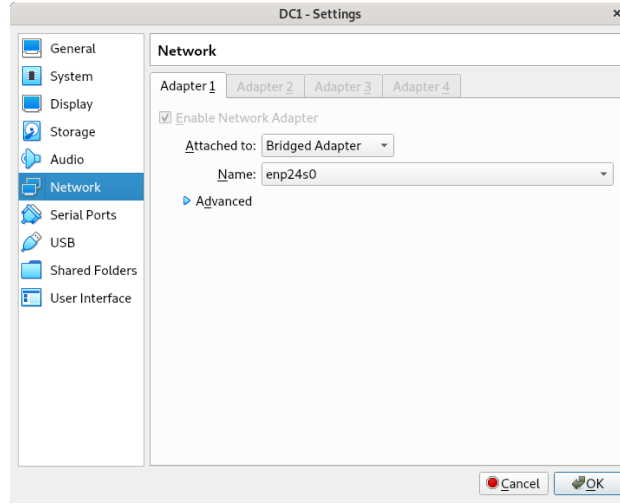


Figure 9: Network Bridge Ayarı

TinyCore'da IP'mizi ifconfig komutu ile kontrol edebiliyoruz.

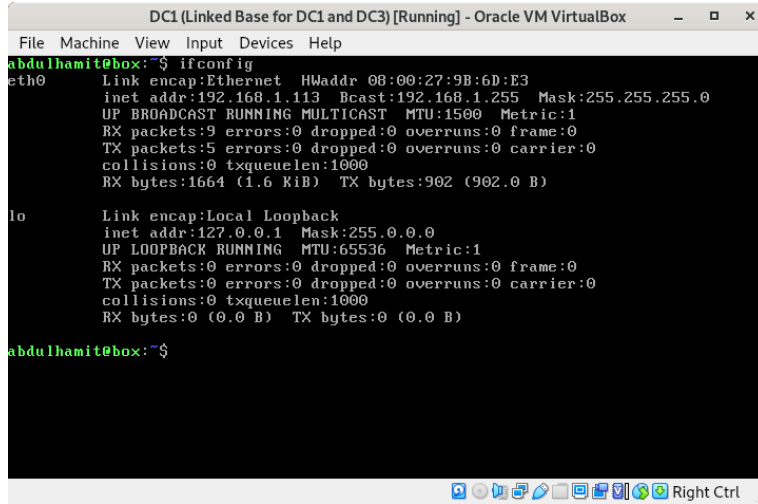


Figure 10: ifconfig çıktısı

Network Bridge ile Guest LAN'daki makine gibi kullanılabilir.

SSH

tce-load programı ile TinyCore'da program yükleyebiliyoruz.

```
# openssh client/server paketini yükleme
tce-load -w -i openssh.tcz
# ssh/sshd ayarları
cp /usr/local/etc/ssh/ssh_config.orig /usr/local/etc/ssh/ssh_config
cp /usr/local/etc/ssh/sshd_config.orig /usr/local/etc/ssh/sshd_config
echo "Port 22" >> /usr/local/etc/ssh/sshd_config
echo "PasswordAuthentication yes" >> /usr/local/etc/ssh/sshd_config
# servisi calistirma
/usr/local/etc/init.d/openssh start
```

```
ssh abdulhamit@192.168.1.113
mrklmrkldebian ~
$ uname -a
Linux mrklmrkldebian 4.19.0-9-amd64 #1 SMP Debian 4.19.118-2+deb10u1 (2020-06-07) x86_64 GNU/Linux
mrklmrkldebian ~
$ ssh abdulhamit@192.168.1.113
abdulhamit@192.168.1.113's password:
( '>')
/) TC (\   Core is distributed with ABSOLUTELY NO WARRANTY.
(/_--_\)   www.tinycorelinux.net

abdulhamit@box:~$ uname -a
Linux box 5.4.3-tinycore #2020 SMP Tue Dec 17 17:00:50 UTC 2019 i686 GNU/Linux
abdulhamit@box:~$
```

Figure 11: Gueste ssh bağlantısı

Ping

```
ping 192.168.1.113
mrklmrkldebian ~
$ ping 192.168.1.113
PING 192.168.1.113 (192.168.1.113) 56(84) bytes of data.
64 bytes from 192.168.1.113: icmp_seq=1 ttl=64 time=0.244 ms
64 bytes from 192.168.1.113: icmp_seq=2 ttl=64 time=0.237 ms
```

Figure 12: Gueste ping gönderebiliyoruz

Host only Adapter ile Host, Ubuntu Server Guest Bağlantısı

Host only Adapter kullanabilmek için öncelikle Host Network oluşturmak gerekli. Ana Menüden **File > Host Network Manager...**i seçip create tıklıyoruz ve Network Oluşuyor.

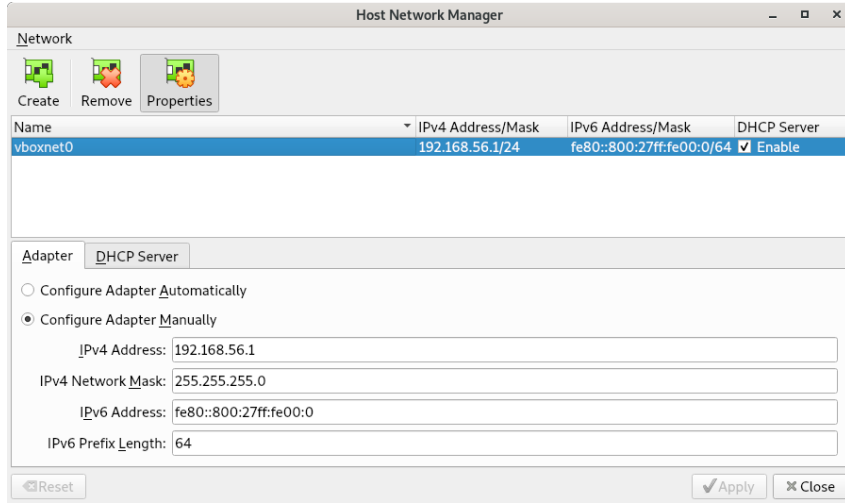


Figure 13: Host Network

Guestimizin Network adapterini Host only Adapter seçip alt seçenekten oluşturduğumuz Host Network'ü seçiyoruz.

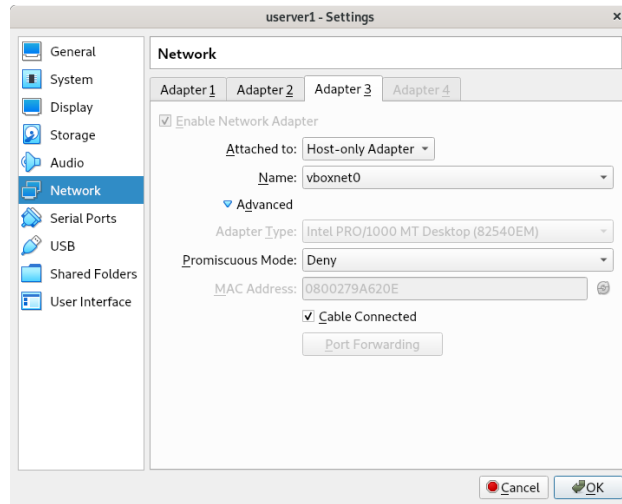


Figure 14: Host Only Adapter Ayarı

yaml formatındaki `/etc/netplan/50-cloud-init.yaml` dosyasını Network Interfacemizi DHCP ile yönetilmesi için ayarlıyoruz

```
# /etc/netplan/50-cloud-init.yaml
network:
  version: 2
  renderer: networkd
  ethernets:
    enp0s9:
      dhcp4: yes
```

Yeni ayarların kullanması için netplan komutunu çalıştırıyoruz.

```
$ sudo netplan --debug apply
```

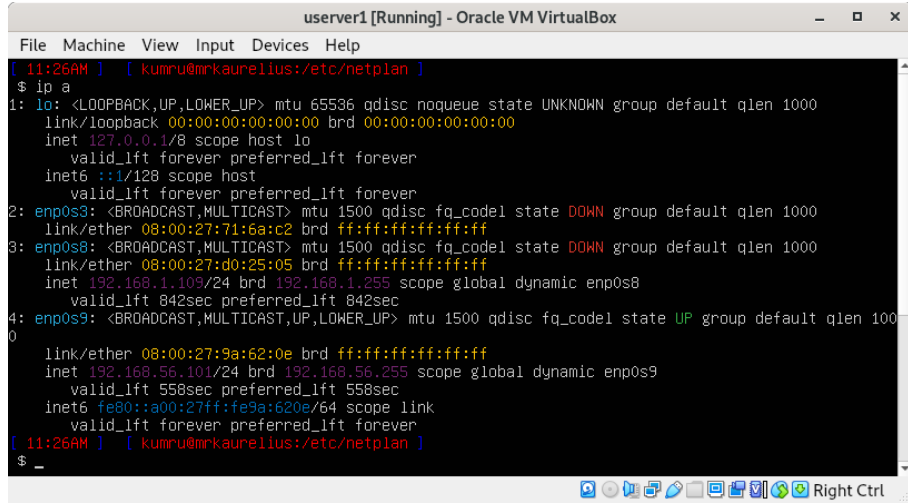



Figure 15: Host-only Adapterin Host Networkten aldığı IP.

SSH

NAT ile Host, Guest Ubuntu PC Bağlantısı bölümünde yaptığımız komutları burada tekrar ediyoruz.

```
$ apt install opessh-server
$ echo "Port 22" >> /etc/ssh/sshd_config
$ echo "PasswordAuthentication yes" >> /etc/ssh/sshd_config
$ sudo service ssh restart
```

userver1'e SSH ile bağlanıyoruz.

```
$ ssh kumru@192.168.56.101
```

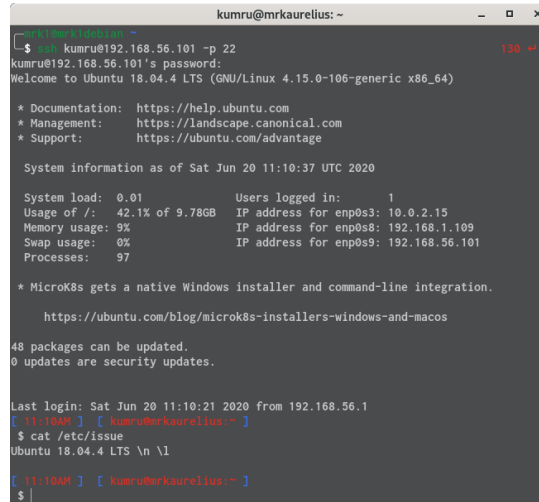


Figure 16: Gueste ssh ile bağlanma

Ping

```
mrk1@mrk1debian: ~  
$ ping 192.168.56.101  
PING 192.168.56.101 (192.168.56.101) 56(84) bytes of data.  
64 bytes from 192.168.56.101: icmp_seq=1 ttl=64 time=0.322 ms  
64 bytes from 192.168.56.101: icmp_seq=2 ttl=64 time=0.267 ms  
64 bytes from 192.168.56.101: icmp_seq=3 ttl=64 time=0.320 ms  
64 bytes from 192.168.56.101: icmp_seq=4 ttl=64 time=0.255 ms  
^C  
--- 192.168.56.101 ping statistics ---  
4 packets transmitted, 4 received, 0% packet loss, time 82ms  
rtt min/avg/max/mdev = 0.255/0.291/0.322/0.030 ms  
mrk1@mrk1debian: ~  
$
```

Figure 17: Gueste Ping gönderme

Senaryo 2

Internal Network ile Host-Guest, Guest-Guest Bağlatısı

Internal Network Ayarı

Senaryo gereği ip Ubuntu Serverların ipleri

host: 192.168.0.1 userver1: 192.168.0.2 userver2: 192.168.0.3 userver3: 192.168.0.4

Internal network için Network Adapterin modunu seçmek yeterli.

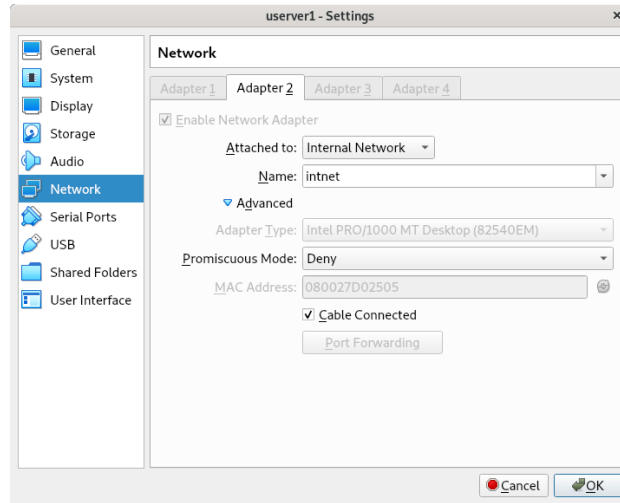


Figure 18: Internal Network Ayarları

Netplan Ayarları

netplan ayarlarını Senaryo 1 de yaptığımız gibi yapıyoruz. Farklı olarak dhcp olmadan statik bir şekilde IP alıyoruz

```
# /etc/netplan/50-cloud-init.yaml
# S:0 R:2
network:
  version: 2
  renderer: networkd
  ethernets:
    enp0s8:
      dhcp4: no
      addresses:
        - 192.168.0.2/24 # userver1 için
      gateway4: 192.168.0.1
      nameservers:
        # aslında nameserver ayarlamasının anlamı yok ama adet yerini bulsun
        addresses: [8.8.8.8, 1.1.1.1]
```

SSH

SSH server yüklediğimiz için ve diğer makineler klon olduğu için bir daha SSH yükleme ve ayarlamaya gerek yok. Guestler arasında SSH bağlantısı yapılabilir.

```
userver2 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
6:34PM | kumru@userver2:~$ ssh 192.168.0.2
The authenticity of host '192.168.0.2 (192.168.0.2)' can't be established.
ECDSA key fingerprint is SHA256:fEn1Q2McENj2KX0SFukg3Y1nByRk8X4MAYQ3bn2c0Y.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '192.168.0.2' (ECDSA) to the list of known hosts.
kumru@192.168.0.2's password:
Welcome to Ubuntu 18.04.4 LTS (GNU/Linux 4.15.0-106-generic x86_64)

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

System information as of Sun Jun 21 18:34:51 UTC 2020

System load: 0.0          Processes:           93
Usage of /:  43.9% of 9.7GB Users logged in:       1
Memory usage: 6%         IP address for enp0s8: 192.168.0.2
Swap usage:  0%

48 packages can be updated.
0 updates are security updates.

Failed to connect to https://changelogs.ubuntu.com/meta-release-lts. Check your Internet connection or proxy settings

Last login: Sun Jun 21 18:28:54 2020
zsh: corrupt history file /home/kumru/.zsh_history
6:34PM | kumru@userver1:~$
```

Figure 19: Guestler Arasında SSH

```
userver1 (Linked Base for userver1 and userver3) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
6:40PM | kumru@userver1:~$ ssh 192.168.0.4
The authenticity of host '192.168.0.4 (192.168.0.4)' can't be established.
ECDSA key fingerprint is SHA256:fEn1Q2McENj2KX0SFukg3Y1nByRk8X4MAYQ3bn2c0Y.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '192.168.0.4' (ECDSA) to the list of known hosts.
kumru@192.168.0.4's password:
Welcome to Ubuntu 18.04.4 LTS (GNU/Linux 4.15.0-106-generic x86_64)

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

System information as of Sun Jun 21 18:41:55 UTC 2020

System load: 0.08         Processes:           88
Usage of /:  43.9% of 9.7GB Users logged in:       1
Memory usage: 7%         IP address for enp0s8: 192.168.0.4
Swap usage:  0%

48 packages can be updated.
0 updates are security updates.

Failed to connect to https://changelogs.ubuntu.com/meta-release-lts. Check your Internet connection or proxy settings

Last login: Sun Jun 21 18:30:25 2020
zsh: corrupt history file /home/kumru/.zsh_history
6:41PM | kumru@userver3:~$
```

Figure 20: Guestler Arasında SSH

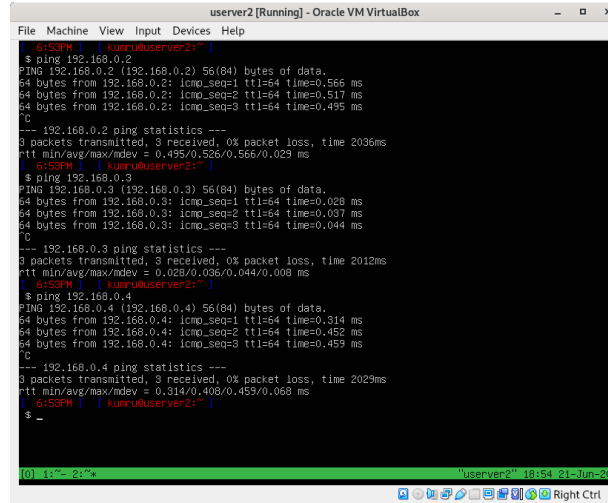
Internal Networkte hostdan guestlere ulaşmak mümkün değil.

```
mrk1@mrk1debian: ~$ ssh kumru@192.168.0.3
ssh: connect to host 192.168.0.3 port 22: No route to host
mrk1@mrk1debian: ~$
```

Figure 21: Hosttan Geste SSH denemesi

Ping

Guestler birbirlerine ulaşabildiği için birbirlerine ping göndermeleri mümkün.



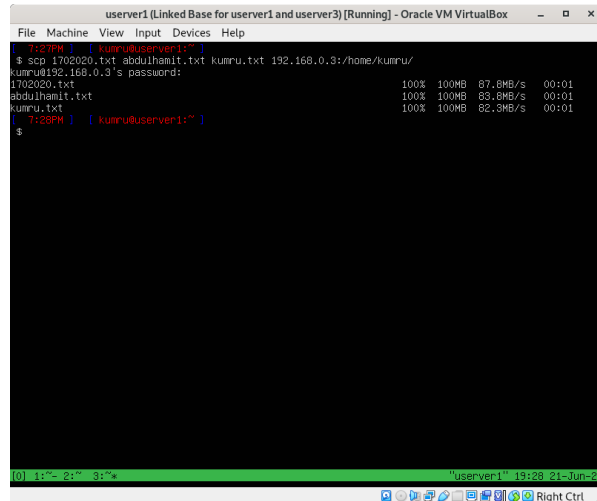
```
userver2 [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
$ ping 192.168.0.2
PING 192.168.0.2 (192.168.0.2) 56(84) bytes of data:
64 bytes from 192.168.0.2: icmp_seq=1 ttl=64 time=0.566 ms
64 bytes from 192.168.0.2: icmp_seq=2 ttl=64 time=0.517 ms
64 bytes from 192.168.0.2: icmp_seq=3 ttl=64 time=0.495 ms
--- 192.168.0.2 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2036ms
rtt min/avg/max/mdev = 0.495/0.526/0.566/0.029 ms
$ ping 192.168.0.3
PING 192.168.0.3 (192.168.0.3) 56(84) bytes of data:
64 bytes from 192.168.0.3: icmp_seq=1 ttl=64 time=0.028 ms
64 bytes from 192.168.0.3: icmp_seq=2 ttl=64 time=0.037 ms
64 bytes from 192.168.0.3: icmp_seq=3 ttl=64 time=0.044 ms
--- 192.168.0.3 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2012ms
rtt min/avg/max/mdev = 0.028/0.036/0.044/0.008 ms
$ ping 192.168.0.4
PING 192.168.0.4 (192.168.0.4) 56(84) bytes of data:
64 bytes from 192.168.0.4: icmp_seq=1 ttl=64 time=0.314 ms
64 bytes from 192.168.0.4: icmp_seq=2 ttl=64 time=0.452 ms
64 bytes from 192.168.0.4: icmp_seq=3 ttl=64 time=0.459 ms
--- 192.168.0.4 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2029ms
rtt min/avg/max/mdev = 0.314/0.408/0.459/0.068 ms
$ _
```

Figure 22: Guestler Arası Ping

SCP

Gerek olmasada boş dosya göndermek yerine sıfır yazılmış 100M büyüklüğünde dosyalar gönderelim.

```
# dosyaları hazırlama
$ dd if=/dev/zero of=abdulhamit.txt count=100 bs=1M
$ cat abdulhamit.txt > kumru.txt > 1702020.txt
# scp komutu
$ scp *.txt 192.168.0.3:/home/kumru/
```



```
userver1 (Linked Base for userver1 and userver3) [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
$ scp 1702020.txt abdulhamit.txt kumru.txt 192.168.0.3:/home/kumru/
kumru192.168.0.3's password:
1702020.txt          100% 100MB 87.8MB/s   00:01
abdulhamit.txt       100% 100MB 83.8MB/s   00:01
kumru.txt            100% 100MB 82.3MB/s   00:01
$
```

Figure 23: scp Komutu Çıktısı

Senaryo 3

Bu senaryoda bir ağdan diğer ağa routing yapmamız istenmekte. Router yazılımı olarak Quagga'yı kullanacağız.

Network Ayarları

Virtual Box Network Ayarları

Serverlardaki adapter4 hariç diğer adaptörler senaryo gerekleri için kullandık. Adapter4 ü ise sunucuları yönetmek için kullandık.

Network

Adapter 1: Intel PRO/1000 MT Desktop (NAT)
Adapter 2: Intel PRO/1000 MT Desktop (Internal Network, 'dahili1')

Figure 24: uPC1

Network

Adapter 1: Intel PRO/1000 MT Desktop (NAT)
Adapter 2: Intel PRO/1000 MT Desktop (Internal Network, 'dahili2')

Figure 25: uPC2

Network

Adapter 1: Intel PRO/1000 MT Desktop (NAT)
Adapter 2: Intel PRO/1000 MT Desktop (Internal Network, 'dahili1')
Adapter 3: Intel PRO/1000 MT Desktop (Internal Network, 'dahili100')
Adapter 4: Intel PRO/1000 MT Desktop (Bridged Adapter, enp24s0)

Figure 26: userver1

Network

Adapter 1: Intel PRO/1000 MT Desktop (NAT)
Adapter 2: Intel PRO/1000 MT Desktop (Internal Network, 'dahili2')
Adapter 3: Intel PRO/1000 MT Desktop (Internal Network, 'dahili100')
Adapter 4: Intel PRO/1000 MT Desktop (Bridged Adapter, enp24s0)

Figure 27: userver2

PC'lerin netplan Ayarları

uPC1 netplan ayarları

```
# uPC1
network:
  version: 2
```

```

renderer: networkd
ethernets:
  enp0s3:
    dhcp4: yes
  enp0s8:
    dhcp4: no
    addresses:
      - 192.168.1.1/24
    gateway4: 192.168.1.254
    nameservers:
      addresses: [8.8.8.8, 1.1.1.1]
    routes:
      - to: 192.168.0.0/16
        via: 192.168.1.254

```

uPC2 netplan ayarları

```

# uPC2
network:
  version: 2
  renderer: networkd
  ethernets:
    enp0s3:
      dhcp4: yes
    enp0s8:
      dhcp4: no
      addresses:
        - 192.168.2.1/24
      gateway4: 192.168.2.254
      nameservers:
        addresses: [8.8.8.8, 1.1.1.1]
      routes:
        - to: 192.168.0.0/16
          via: 192.168.1.254

```

Server'lerin Network Ayarları

Serverlerin nat ayarları

```

# serverler için ortak nat ayarı
network:
  ethernets:
    enp0s3:
      dhcp4: true
  version: 2

```

userver2

```

# userver2
network:
  version: 2
  renderer: networkd
  ethernets:
    enp0s8:
      dhcp4: no
      addresses:
        - 192.168.0.1/24
      #gateway4: 192.168.0.1
      nameservers:
        addresses: [8.8.8.8, 8.8.4.4]
    enp0s9:

```

```

    dhcp4: no
    addresses:
      - 192.168.100.2/24
    #gateway4: 192.168.0.1
    nameservers:
      addresses: [8.8.8.8, 8.8.4.4]
  enp0s10:
    dhcp4: no
    addresses:
      - 192.168.1.201/24
    #gateway4: 192.168.0.1
    nameservers:
      addresses: [8.8.8.8, 8.8.4.4]

userver1
# userver1
network:
  version: 2
  renderer: networkd
  ethernet:
    enp0s8:
      dhcp4: no
      addresses:
        - 192.168.0.1/24
      #gateway4: 192.168.0.1
      nameservers:
        addresses: [8.8.8.8, 8.8.4.4]
    enp0s9:
      dhcp4: no
      addresses:
        - 192.168.100.1/24
      #gateway4: 192.168.0.1
      nameservers:
        addresses: [8.8.8.8, 8.8.4.4]
    enp0s10:
      dhcp4: no
      addresses:
        - 192.168.1.200/24
      #gateway4: 192.168.0.1
      nameservers:
        addresses: [8.8.8.8, 8.8.4.4]

```

Serverlere Quagga Kurulumu ve Ayarları

Network Şeması

Her bilgisayarın NAT bağlantısı var - dahili1

uPC1 192.168.1.1

userver1 192.168.1.254

- dahili2
uPC2 192.168.2.1
userver2 192.168.2.254
- dahili 3, serverların kendi aralarındaki bağlantı
userver1 192.168.100.1
userver2 192.168.100.2


```
userver1[prequagga][Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
0: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:71:6a:c2 brd ffff:ffff:ffff:ffff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic enp0s3
        valid_lft 75501sec preferred_lft 75501sec
    inet6 fe80::a00:27ff:fe71:6ac2/64 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:d0:25:05 brd ffff:ffff:ffff:ffff
    inet 192.168.0.1/24 brd 192.168.0.255 scope global enp0s8
        valid_lft forever preferred_lft forever
    inet 192.168.1.254/24 brd 192.168.1.255 scope global enp0s8
        valid_lft forever preferred_lft forever
    inet6 fe80::a00:27ff:fe80:2505/64 scope link
        valid_lft forever preferred_lft forever
5: enp0s9: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:9a:62:0e brd ffff:ffff:ffff:ffff
    inet 192.168.100.1/24 brd 192.168.100.255 scope global enp0s9
        valid_lft forever preferred_lft forever
    inet6 fe80::a00:27ff:fe9a:620e/64 scope link
        valid_lft forever preferred_lft forever
5: enp0s10: <BROADCAST,MULTICAST> mtu 1500 qdisc fq_codel state DOWN group default qlen 1000
    link/ether 08:00:27:74:d4:4f brd ffff:ffff:ffff:ffff
    inet6 fe80::a00:27ff:fe74:d44f/64 scope link
        valid_lft forever preferred_lft forever
$ ip route
default via 10.0.2.2 dev enp0s3 proto dhcp src 10.0.2.15 metric 100
10.0.2.0/24 dev enp0s3 proto kernel scope link src 10.0.2.15
10.0.2.2 dev enp0s3 proto dhcp scope link src 10.0.2.15 metric 100
192.168.0.0/24 dev enp0s8 proto kernel scope link src 192.168.0.1
192.168.1.0/24 dev enp0s8 proto kernel scope link src 192.168.1.254
192.168.2.0/24 via 192.168.100.2 dev enp0s9 proto zebra metric 20
192.168.100.0/24 dev enp0s9 proto kernel scope link src 192.168.100.1
$
[0] 1:~ 2:~ 3:service "userver1" 14:49 28-Jun-20
```

Figure 28: Ubuntu Server1 ip a, ip route Komut çıktısı

```
userver2[Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
0: enp0s3: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000
    link/ether 08:00:27:99:ed:10 brd ffff:ffff:ffff:ffff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic enp0s3
        valid_lft 75346sec preferred_lft 75346sec
    inet6 fe80::a00:27ff:fe99:ed10/64 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 08:00:27:01:09:d4 brd ffff:ffff:ffff:ffff
    inet 192.168.0.1/24 brd 192.168.0.255 scope global enp0s8
        valid_lft forever preferred_lft forever
    inet 192.168.2.0/24 brd 192.168.2.255 scope global enp0s8
        valid_lft forever preferred_lft forever
    inet6 fe80::a00:27ff:fe01:09d4/64 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 08:00:27:11:64:fd brd ffff:ffff:ffff:ffff
    inet 192.168.100.2/24 brd 192.168.100.255 scope global enp0s9
        valid_lft forever preferred_lft forever
    inet6 fe80::a00:27ff:fe11:64fd/64 scope link
        valid_lft forever preferred_lft forever
5: enp0s10: <CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc fq_codel state DOWN group default qlen 1000
    link/ether 08:00:27:06:bb:fa brd ffff:ffff:ffff:ffff
    inet6 fe80::a00:27ff:fe06:bbfa/64 scope link
        valid_lft forever preferred_lft forever
$ ip route
default via 10.0.2.2 dev enp0s3 proto dhcp src 10.0.2.15 metric 100
10.0.2.0/24 dev enp0s3 proto kernel scope link src 10.0.2.15
10.0.2.2 dev enp0s3 proto dhcp scope link src 10.0.2.15 metric 100
192.168.0.0/24 dev enp0s8 proto kernel scope link src 192.168.0.1
192.168.1.0/24 via 192.168.100.1 dev enp0s9 proto zebra metric 20
192.168.2.0/24 dev enp0s8 proto kernel scope link src 192.168.2.0
192.168.100.0/24 dev enp0s9 proto kernel scope link src 192.168.100.2
$
[0] 1:~ 2:service 3:service "userver2" 14:53 28-Jun-20
```

Figure 29: Ubuntu Server2 ip a, ip route Komut çıktısı

```
tmux
File Edit View Search Terminal Help
[ 5:505 ] [ kunrugupci~ ]
$ 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 ::::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:a0:ee:e9 brd ffff:ffff:ffff:ffff
    inet 10.0.2.1/24 brd 10.0.2.255 scope global dynamic enp0s3
        valid_lft 76857sec preferred_lft 76857sec
    inet6 fe80::a00:27ff:fe00:eeee/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:f0:4b:99 brd ffff:ffff:ffff:ffff
    inet 192.168.1.1/24 brd 192.168.1.255 scope global enp0s8
        valid_lft forever preferred_lft forever
    inet6 fe80::a00:27ff:fe00:4b99/64 scope link
        valid_lft forever preferred_lft forever
$ ip route
default via 192.168.1.254 dev enp0s8 proto static
default via 10.0.2.2 dev enp0s3 proto dhcp src 10.0.2.15 metric 100
10.0.2.0/24 dev enp0s3 proto kernel scope link src 10.0.2.15
10.0.2.2 dev enp0s3 proto dhcp scope link src 10.0.2.15 metric 100
192.168.0.0/16 via 192.168.1.254 dev enp0s8 proto static
192.168.1.0/24 dev enp0s8 proto kernel scope link src 192.168.1.1
$
[ 5:505 ] [ kunrugupci~ ]
```

Figure 30: Ubuntu Desktop1 (uPC1) ip a, ip route Komut çıktısı

```
tmux
File Edit View Search Terminal Help
[ 3:5605 ] [ kumru@upc2:~ ]
$ 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 08:00:27:18:31:69:dd brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic enp0s3
        valid_lft 76562sec preferred_lft 76562sec
    inet6 fe80::2718:3169:dd64: 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 08:00:27:18:c4:e4 brd ff:ff:ff:ff:ff:ff
    inet 192.168.2.1/24 brd 192.168.2.255 scope global enp0s8
        valid_lft forever preferred_lft forever
    inet6 fe80::2718:c4e4: scope link
        valid_lft forever preferred_lft forever
[ 3:5605 ] [ kumru@upc2:~ ]
$ ip route
default via 192.168.2.254 dev enp0s8 proto static
default via 10.0.2.2 dev enp0s3 proto dhcp src 10.0.2.15 metric 100
10.0.2.0/24 dev enp0s3 proto kernel scope link src 10.0.2.15
10.0.2.2 dev enp0s3 proto dhcp scope link src 10.0.2.15 metric 100
192.168.2.0/24 dev enp0s8 proto kernel scope link src 192.168.2.1
[ 3:5605 ] [ kumru@upc2:~ ]
$
```

Figure 31: Ubuntu Desktop2 (uPC2) ip a, ip route Komut çıktısı

traceroute

Traceroute komutu ile paketlerin izlediği yolun takibini yapabiliriz.

```
tmux
File Edit View Search Terminal Help
[ 3:4705 ] [ kumru@upc1:~ ]
$ ip a | grep "inet "
    inet 127.0.0.1/8 scope host lo
    inet 10.0.2.15/24 brd 10.0.2.255 scope global dynamic enp0s3
    inet 192.168.1.1/24 brd 192.168.1.255 scope global enp0s8
[ 3:4705 ] [ kumru@upc1:~ ]
$ traceroute 192.168.2.1
traceroute to 192.168.2.1 (192.168.2.1), 30 hops max, 60 byte packets
 1 _gateway (192.168.1.254)  0.378 ms  0.325 ms  0.234 ms
 2 192.168.100.2 (192.168.100.2)  0.818 ms  0.693 ms  0.599 ms
 3 192.168.2.1 (192.168.2.1)  1.165 ms  1.166 ms  1.093 ms
[ 3:4805 ] [ kumru@upc1:~ ]
$ traceroute 192.168.1.254
traceroute to 192.168.1.254 (192.168.1.254), 30 hops max, 60 byte packets
 1 _gateway (192.168.1.254)  0.389 ms  0.334 ms  0.317 ms
[ 3:5605 ] [ kumru@upc1:~ ]
$ traceroute 192.168.2.254
traceroute to 192.168.2.254 (192.168.2.254), 30 hops max, 60 byte packets
 1 _gateway (192.168.1.254)  0.333 ms  0.275 ms  0.255 ms
 2 192.168.2.254 (192.168.2.254)  0.788 ms  0.757 ms  0.730 ms
[ 3:5605 ] [ kumru@upc1:~ ]
$
```

Figure 32: uPC1 -> uPC2, uPC1 -> userver1, uPC1 -> userver2