

Práctica 3

Jesús Rodríguez Heras
Arantzazu Otal Alberro

12 de mayo de 2019

1. Instalación de máquinas virtuales mediante Vagrant

En esta primera parte vamos a crear el entorno de trabajo, consiste en dos redes internas, conectadas al exterior mediante un router.

- La primera red tendrá el rango de IPs 192.168.2.0.
- La segunda red tendrá el rango de IPs 192.168.3.0.

Cada red tendrá un par de máquinas virtuales (no hace falta conectarlas todas de forma simultánea). Además, las redes solo tendrán acceso al exterior a través de la máquina que actúa como router.

En este ejercicio se deberá:

- **Crear el entorno de red mediante un único fichero Vagrant.**

```
1 Vagrant.configure("2") do |config|
2   config.vm.box = "debian/jessie64"
3
4   config.vm.define :r do |r|
5     r.vm.box="debian/jessie64"
6     r.vm.hostname="R"
7     r.vm.network "private_network", ip: "192.168.2.1"
8     r.vm.network "private_network", ip: "192.168.3.1"
9   end
10
11  config.vm.define :vm1r1 do |vm1r1|
12    vm1r1.vm.box="debian/jessie64"
13    vm1r1.vm.hostname="VM1"
14    vm1r1.vm.network "private_network", ip: "192.168.2.2"
15  end
16
17  config.vm.define :vm2r1 do |vm2r1|
18    vm2r1.vm.box="debian/jessie64"
19    vm2r1.vm.hostname="VM2"
20    vm2r1.vm.network "private_network", ip: "192.168.2.3"
21  end
22
23  config.vm.define :vm1r2 do |vm1r2|
24    vm1r2.vm.box="debian/jessie64"
25    vm1r2.vm.hostname="VM3"
26    vm1r2.vm.network "private_network", ip: "192.168.3.2"
27  end
28
29  config.vm.define :vm2r2 do |vm2r2|
30    vm2r2.vm.box="debian/jessie64"
31    vm2r2.vm.hostname="VM4"
32    vm2r2.vm.network "private_network", ip: "192.168.3.3"
33  end
34 end
```

- **Configurar el cortafuegos para que de acceso al exterior.**

Para configurar el cortafuegos, primero debemos deshabilitar la interfaz de red que nos permite salir a Internet desde cada una de las máquinas de las redes. Para ello, identificamos la interfaz que queremos deshabilitar (en nuestro caso, `eth0`).

Si deshabilitamos esta interfaz directamente, tendremos el problema de que la terminal se quedará colgada porque estamos conectados por SSH a esa interfaz, entonces debemos habilitar la conexión SSH desde la otra interfaz. Para ello nos dirigimos al fichero `sshd_config` con:

```
sudo nano /etc/ssh/sshd_config
```

Descomentamos la línea que dice `PasswordAuthentication yes`. Luego, reiniciamos el servicio SSH con el siguiente comando:

```
sudo /etc/init.d/ssh restart
```

Después de esto, ya podemos conectarnos desde la máquina que actúa como router/cortafuegos.

Es hora de entrar en la máquina cortafuegos y conectarnos por SSH a cada una de las máquinas. Una vez dentro de las máquinas servidoras usamos el siguiente comando para deshabilitar la interfaz de red externa:

```
sudo ifconfig eth0 down
```

También debemos activar el `ip forward` en el router para tener conectividad entre las máquinas de las diferentes redes. Para ello usamos el comando:

```
sudo echo 1 >/proc/sys/net/ipv4/ip_forward
```

A continuación, establecemos la puerta de enlace como la interfaz que tenemos en la máquina que hace de router. Para ello usamos el comando:

```
sudo route add default gw 192.168.x.1 eth1
```

Siendo `x` la red a la que pertenece cada máquina, y `eth1` la interfaz de la red interna.

Lo siguiente es habilitar el enrutamiento a partir de la máquina router al resto de máquinas. El estado inicial es el siguiente:

```

vagrant@vm3: ~
Archivo Editar Ver Buscar Terminal Ayuda
You have mail.
Last login: Thu Apr 4 11:04:31 2019 from 10.0.2.2
vagrant@vm3:~$ sudo ifconfig eth0 down
vagrant@vm3:~$ sudo ifconfig
eth1      Link encap:Ethernet  HWaddr 08:00:27:18:b9:a3
          inet addr:192.168.3.2  Bcast:192.168.3.255  Mask:255.255.255.0
          inet6 addr: fe80::a00:27ff:fe18:b9a3/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:119 errors:0 dropped:0 overruns:0 frame:0
          TX packets:67 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueue:1000
          RX bytes:12251 (11.9 KiB)  TX bytes:7783 (7.6 KiB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueue:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

vagrant@vm3:~$ sudo route add default gw 192.168.3.1 eth1
SIOCADORT: No such device
vagrant@vm3:~$ sudo route add default gw 192.168.3.1 eth1
vagrant@vm3:~$ []

vagrant@vm1: ~
Archivo Editar Ver Buscar Terminal Ayuda
RX bytes:12563 (12.2 KiB)  TX bytes:8803 (8.5 KiB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueue:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

vagrant@vm1:~$ sudo add default gw 192.168.2.1 eth1
sudo: add: command not found
vagrant@vm1:~$ sudo route add default gw 192.168.2.1 eth1
vagrant@vm1:~$ ping 192.168.3.2
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data.
64 bytes from 192.168.3.2: icmp_seq=1 ttl=63 time=0.834 ms
64 bytes from 192.168.3.2: icmp_seq=2 ttl=63 time=0.866 ms
64 bytes from 192.168.3.2: icmp_seq=3 ttl=63 time=0.805 ms
64 bytes from 192.168.3.2: icmp_seq=4 ttl=63 time=0.882 ms
64 bytes from 192.168.3.2: icmp_seq=5 ttl=63 time=0.866 ms
^C
--- 192.168.3.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4003ms
rtt min/avg/max/mdev = 0.834/0.866/0.885/0.036 ms
vagrant@vm1:~$ []

vagrant@vm4: ~
Archivo Editar Ver Buscar Terminal Ayuda
lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueue:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

vagrant@vm4:~$ sudo route add default gw 192.168.3.1 eth1
vagrant@vm4:~$ ping 192.168.2.3
PING 192.168.2.3 (192.168.2.3) 56(84) bytes of data.
64 bytes from 192.168.2.3: icmp_seq=1 ttl=63 time=0.677 ms
64 bytes from 192.168.2.3: icmp_seq=2 ttl=63 time=0.921 ms
64 bytes from 192.168.2.3: icmp_seq=3 ttl=63 time=0.905 ms
64 bytes from 192.168.2.3: icmp_seq=4 ttl=63 time=0.815 ms
64 bytes from 192.168.2.3: icmp_seq=5 ttl=63 time=0.898 ms
64 bytes from 192.168.2.3: icmp_seq=6 ttl=63 time=0.853 ms
64 bytes from 192.168.2.3: icmp_seq=7 ttl=63 time=0.867 ms
^C
--- 192.168.2.3 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6026ms
rtt min/avg/max/mdev = 0.677/0.848/0.921/0.077 ms
vagrant@vm4:~$ []

vagrant@r: ~
Archivo Editar Ver Buscar Terminal Ayuda
==> r: Configuring and enabling network interfaces...
==> r: Installing rsync to the VM...
==> r: Rsyncing folder: /home/jesus/Documentos/Vagrant/Práctica 3/ => /vagrant
==> r: Machine 'r' has a post 'vagrant up' message. This is a message
==> r: from the creator of the Vagrantfile, and not from Vagrant itself:
==> r:
==> r: Vanilla Debian box. See https://app.vagrantup.com/debian for help
and bug reports

The programs included with the Debian GNU/Linux system are free software
;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/*copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
You have mail.
vagrant@r:~$ sudo echo 1 > /proc/sys
sys/      sysrq-trigger sysvipc/
vagrant@r:~$ sudo echo 1 > /proc/sys/net/ipv4/ip_forward
-bash: /proc/sys/net/ipv4/ip_forward: Permission denied
vagrant@r:~$ sudo nano /proc/sys/net/ipv4/ip_forward
vagrant@r:~$ []

vagrant@vm2: ~
Archivo Editar Ver Buscar Terminal Ayuda
You have mail.
Last login: Thu Apr 4 11:04:30 2019 from 10.0.2.2
vagrant@vm2:~$ sudo ifconfig eth0 down
vagrant@vm2:~$ sudo ifconfig
eth1      Link encap:Ethernet  HWaddr 08:00:27:e1:dc:d4
          inet addr:192.168.2.3  Bcast:192.168.2.255  Mask:255.255.0.0
          inet6 addr: fe80::a00:27ff:fe18:dc:d4/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:136 errors:0 dropped:0 overruns:0 frame:0
          TX packets:75 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueue:1000
          RX bytes:13591 (13.2 KiB)  TX bytes:8599 (8.3 KiB)

lo        Link encap:Local Loopback
          inet addr:127.0.0.1  Mask:255.0.0.0
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueue:1000
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

vagrant@vm2:~$ sudo route add default gw 192.168.2.1 eth1
vagrant@vm2:~$ []
```

Figura 1: En esta imagen se ve como la vm4 (red 2) hace ping a la vm2 (red 1) y la vm1 (red1) hace ping a la vm3 (red 2).

```
vagrant@vm3:~$ sudo ifconfig eth0 down
vagrant@vm3:~$ sudo ifconfig eth1
Link encap:Ethernet  HWaddr 08:00:27:18:b9:a3
inet addr:192.168.3.2  Bcast:192.168.3.255  Mask:255.255.255.0
inet6 addr: fe80::a00:27ff:fe18:b9a3/64 Scope:Link
UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
RX packets:119 errors:0 dropped:0 overruns:0 frame:0
TX packets:67 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:12251 (11.9 KiB)  TX bytes:7783 (7.6 KiB)

lo
Link encap:Local Loopback
inet addr:127.0.0.1  Mask:255.0.0.0
inet6 addr: ::1/128 Scope:Host
UP LOOPBACK RUNNING  MTU:65536  Metric:1
RX packets:0 errors:0 dropped:0 overruns:0 frame:0
TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:0
RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

vagrant@vm3:~$ sudo route add default gw 192.168.3.1 eth1
SIOCADORT: No such device
vagrant@vm3:~$ sudo route add default gw 192.168.3.1 eth1
vagrant@vm3:~$ ping google.es
ping: unknown host google.es
vagrant@vm3:~$ []

vagrant@vm1:~$ sudo add default gw 192.168.2.1 eth1
sudo: add: command not found
vagrant@vm1:~$ sudo route add default gw 192.168.2.1 eth1
vagrant@vm1:~$ ping 192.168.3.2
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data:
64 bytes from 192.168.3.2: icmp_seq=1 ttl=63 time=0.834 ms
64 bytes from 192.168.3.2: icmp_seq=2 ttl=63 time=0.866 ms
64 bytes from 192.168.3.2: icmp_seq=3 ttl=63 time=0.885 ms
64 bytes from 192.168.3.2: icmp_seq=4 ttl=63 time=0.882 ms
64 bytes from 192.168.3.2: icmp_seq=5 ttl=63 time=0.866 ms
^C
--- 192.168.3.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4003ms
rtt min/avg/max/ndev = 0.834/0.866/0.885/0.036 ms
vagrant@vm1:~$ ping google.es
ping: unknown host google.es
vagrant@vm1:~$ []

vagrant@vm4:~$ sudo route add default gw 192.168.3.1 eth1
vagrant@vm4:~$ ping 192.168.2.3
PING 192.168.2.3 (192.168.2.3) 56(84) bytes of data:
64 bytes from 192.168.2.3: icmp_seq=1 ttl=63 time=0.677 ms
64 bytes from 192.168.2.3: icmp_seq=2 ttl=63 time=0.921 ms
64 bytes from 192.168.2.3: icmp_seq=3 ttl=63 time=0.905 ms
64 bytes from 192.168.2.3: icmp_seq=4 ttl=63 time=0.815 ms
64 bytes from 192.168.2.3: icmp_seq=5 ttl=63 time=0.890 ms
64 bytes from 192.168.2.3: icmp_seq=6 ttl=63 time=0.853 ms
64 bytes from 192.168.2.3: icmp_seq=7 ttl=63 time=0.867 ms
^C
--- 192.168.2.3 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6026ms
rtt min/avg/max/ndev = 0.677/0.848/0.921/0.077 ms
vagrant@vm4:~$ ping google.es
ping: unknown host google.es
vagrant@vm4:~$ []

vagrant@r:~$ Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
You have mail.
vagrant@r:~$ sudo echo 1 > /proc/sys
sys/
vagrant@r:~$ sudo echo 1 > /proc/sys/net/ipv4/ip_forward
-bash: /proc/sys/net/ipv4/ip_forward: Permission denied
vagrant@r:~$ sudo nano /proc/sys/net/ipv4/ip_forward
vagrant@r:~$ ping google.es
PING google.es (216.58.214.163) 56(84) bytes of data:
64 bytes from mad01s26-in-f163.1e100.net (216.58.214.163): icmp_seq=1 tt
l=63 time=11.0 ms
64 bytes from mad01s26-in-f163.1e100.net (216.58.214.163): icmp_seq=2 tt
l=63 time=12.5 ms
64 bytes from mad01s26-in-f163.1e100.net (216.58.214.163): icmp_seq=3 tt
l=63 time=12.3 ms
64 bytes from mad01s26-in-f163.1e100.net (216.58.214.163): icmp_seq=4 tt
l=63 time=12.1 ms
64 bytes from mad01s26-in-f163.1e100.net (216.58.214.163): icmp_seq=5 tt
l=63 time=12.4 ms
^C
--- google.es ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 406ms
rtt min/avg/max/ndev = 11.859/12.262/12.512/0.236 ms
vagrant@r:~$ []

vagrant@vm2:~$ sudo ifconfig eth0 down
vagrant@vm2:~$ sudo ifconfig eth1
Link encap:Ethernet  HWaddr 08:00:27:e1:dc:d4
inet addr:192.168.2.3  Bcast:192.168.2.255  Mask:255.255.255.0
inet6 addr: fe80::a00:27ff:fe18:dc4/64 Scope:Link
UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
RX packets:136 errors:0 dropped:0 overruns:0 frame:0
TX packets:75 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:1000
RX bytes:13591 (13.2 KiB)  TX bytes:8599 (8.3 KiB)

lo
Link encap:Local Loopback
inet addr:127.0.0.1  Mask:255.0.0.0
inet6 addr: ::1/128 Scope:Host
UP LOOPBACK RUNNING  MTU:65536  Metric:1
RX packets:0 errors:0 dropped:0 overruns:0 frame:0
TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:0
RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

vagrant@vm2:~$ sudo route add default gw 192.168.2.1 eth1
vagrant@vm2:~$ ping google.es
ping: unknown host google.es
vagrant@vm2:~$ []
```

Figura 2: En esta imagen se ve como todas las máquinas intentan hacer ping a google.es pero la única que lo consigue es la máquina r (router/cortafuegos).

Para habilitar el enrutamiento usamos el comando en la máquina router/cortafuegos:

```
sudo iptables -t nat -A
POSTROUTING -o eth0 -j MASQUERADE
```

Una vez hecho eso, el resultado es el siguiente:

```
Archivo Editar Ver Buscar Terminal Ayuda
to
Link encap:Local Loopback
inet addr:127.0.0.1 Mask:255.0.0.0
inet6 addr: ::1/128 Scope:Host
UP LOOPBACK RUNNING MTU:65536 Metric:1
RX packets:0 errors:0 dropped:0 overruns:0 frame:0
TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:0
RX bytes:0 (0.0 B) TX bytes:0 (0.0 B)

vagrant@vm3:~$ sudo route add default gw 192.168.3.1 eth1
SIOCADDRT: No such device
vagrant@vm3:~$ sudo route add default gw 192.168.3.1 eth1
vagrant@vm3:~$ ping google.es
ping: unknown host google.es
vagrant@vm3:~$ ping google.es
PING google.es (172.217.17.3) 56(84) bytes of data.
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=1 ttl=61 time=12.0 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=2 ttl=61 time=12.8 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=3 ttl=61 time=12.0 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=4 ttl=61 time=12.9 ms
^C
--- google.es ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 12.051/12.477/12.912/0.435 ms
vagrant@vm3:~$

vagrant@vm1:~$ sudo route add default gw 192.168.2.1 eth1
vagrant@vm1:~$ ping 192.168.3.2
PING 192.168.3.2 (192.168.3.2) 56(84) bytes of data.
64 bytes from 192.168.3.2: icmp_seq=1 ttl=63 time=0.834 ms
64 bytes from 192.168.3.2: icmp_seq=2 ttl=63 time=0.866 ms
64 bytes from 192.168.3.2: icmp_seq=3 ttl=63 time=0.885 ms
64 bytes from 192.168.3.2: icmp_seq=4 ttl=63 time=0.882 ms
64 bytes from 192.168.3.2: icmp_seq=5 ttl=63 time=0.866 ms
^C
--- 192.168.3.2 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4003ms
rtt min/avg/max/mdev = 0.834/0.866/0.885/0.036 ms
vagrant@vm1:~$ ping google.es
ping: unknown host google.es
vagrant@vm1:~$ ping google.es
PING google.es (216.58.201.163) 56(84) bytes of data.
64 bytes from mad08s06-in-f3.1e100.net (216.58.201.163): icmp_seq=1 ttl=61 time=12.4 ms
64 bytes from mad08s06-in-f3.1e100.net (216.58.201.163): icmp_seq=2 ttl=61 time=12.8 ms
64 bytes from mad08s06-in-f3.1e100.net (216.58.201.163): icmp_seq=3 ttl=61 time=12.0 ms
64 bytes from mad08s06-in-f3.1e100.net (216.58.201.163): icmp_seq=4 ttl=61 time=12.5 ms
^C
--- google.es ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3002ms
rtt min/avg/max/mdev = 12.067/12.479/12.852/0.286 ms
vagrant@vm1:~$

vagrant@vm4:~$
64 bytes from 192.168.2.3: icmp_seq=4 ttl=63 time=0.815 ms
64 bytes from 192.168.2.3: icmp_seq=5 ttl=63 time=0.898 ms
64 bytes from 192.168.2.3: icmp_seq=6 ttl=63 time=0.853 ms
64 bytes from 192.168.2.3: icmp_seq=7 ttl=63 time=0.867 ms
^C
--- 192.168.2.3 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6026ms
rtt min/avg/max/mdev = 0.677/0.848/0.921/0.077 ms
vagrant@vm4:~$ ping google.es
ping: unknown host google.es
vagrant@vm4:~$ ping google.es
PING google.es (172.217.17.3) 56(84) bytes of data.
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=1 ttl=61 time=11.9 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=2 ttl=61 time=12.1 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=3 ttl=61 time=12.2 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=4 ttl=61 time=12.4 ms
^C
--- google.es ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3005ms
rtt min/avg/max/mdev = 11.949/12.201/12.469/0.201 ms
vagrant@vm4:~$

vagrant@r:~$
64 bytes from mad01s26-in-f163.1e100.net (216.58.214.163): icmp_seq=4 tt
l=63 time=12.1 ms
64 bytes from mad01s26-in-f163.1e100.net (216.58.214.163): icmp_seq=5 tt
l=63 time=12.4 ms
^C
--- google.es ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4006ms
rtt min/avg/max/mdev = 11.859/12.262/12.512/0.236 ms
vagrant@r:~$ sudo iptables -t nat -A POSTROUTING -o eth0 -j MASQUERADE
vagrant@r:~$ sudo iptables -t nat -A POSTROUTING -o eth0 -j MASQUERADE
vagrant@r:~$ ping google.es
PING google.es (172.217.17.3) 56(84) bytes of data.
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=1 ttl=63
time=11.8 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=2 ttl=63
time=11.7 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=3 ttl=63
time=11.6 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=4 ttl=63
time=12.3 ms
^C
--- google.es ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 11.680/11.916/12.330/0.201 ms
vagrant@r:~$

vagrant@vm2:~$ sudo route add default gw 192.168.2.1 eth1
vagrant@vm2:~$ ping google.es
ping: unknown host google.es
vagrant@vm2:~$ ping google.es
PING google.es (172.217.17.3) 56(84) bytes of data.
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=1
ttl=61 time=13.2 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=2
ttl=61 time=12.6 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=3
ttl=61 time=12.4 ms
64 bytes from mad07s09-in-f3.1e100.net (172.217.17.3): icmp_seq=4
ttl=61 time=12.4 ms
^C
--- google.es ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3004ms
rtt min/avg/max/mdev = 12.407/12.678/13.206/0.321 ms
vagrant@vm2:~$
```

Figura 3: Una vez habilitado el enrutamiento, todas las máquinas tienen acceso a Internet.

- **Configurar manualmente los clientes de las redes para que se puedan conectar al servidor.**
Solo con poner la puerta de enlace y el ip forwarding estaría hecho y ya se ha hecho en el apartado anterior.

2. Servidor DHCP

Instalar un servidor DHCP en el cortafuegos. Además, se deberá modificar el fichero Vagrant, para que en lugar de establecer una IP privada, la IP se asigne mediante DHCP.

También se puede probar dejando la IP privada y comprobando el funcionamiento del servidor DHCP mediante el cliente DHCP.

El servidor DHCP deberá asignar direcciones IP a cada una de las redes internas. Además, una máquina de la segunda red tendrá que tener una dirección fija.

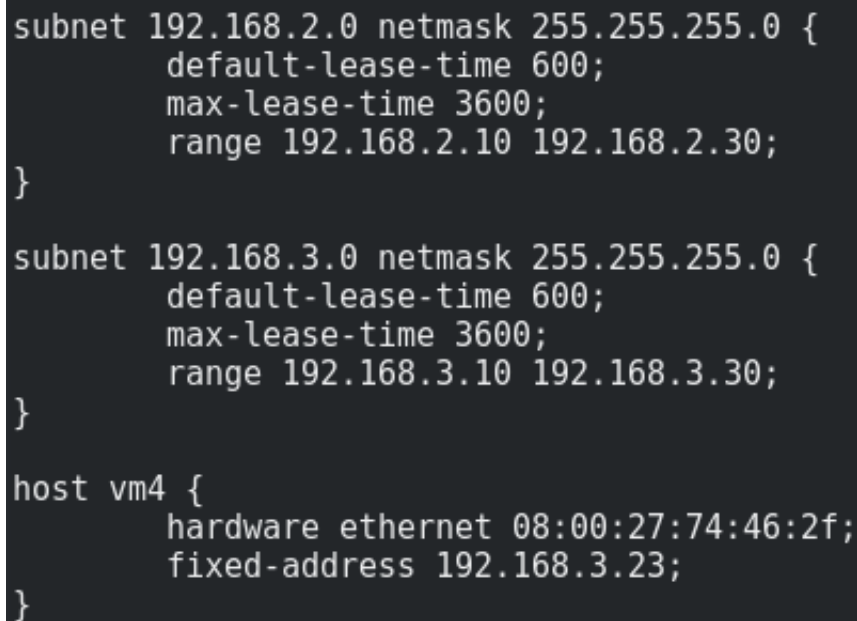
Tras la configuración, mostrar el estado de los prestamos realizados por el servidor DHCP.

Para instalar el servidor DHCP introducimos el siguiente comando:

```
sudo apt-get install isc-dhcp-server
```

Configuramos las subredes en el archivo `/etc/dhcp/dhcpd.conf` abriendolo con el comando:

```
sudo nano /etc/dhcp/dhcpd.conf
```



```
subnet 192.168.2.0 netmask 255.255.255.0 {
    default-lease-time 600;
    max-lease-time 3600;
    range 192.168.2.10 192.168.2.30;
}

subnet 192.168.3.0 netmask 255.255.255.0 {
    default-lease-time 600;
    max-lease-time 3600;
    range 192.168.3.10 192.168.3.30;
}

host vm4 {
    hardware ethernet 08:00:27:74:46:2f;
    fixed-address 192.168.3.23;
}
```

Figura 4: Configuración de las subredes del DNS

Ahora, reiniciamos el servidor dhcp con:

```
sudo /etc/init.d/isc-dhcp-server restart
```

Para comprobar el estado del servidor dhcp usaremos el siguiente comando:

```
sudo /etc/init.d/isc-dhcp-server status
```

A continuación, pedimos una IP al servidor DHCP desde las otras máquinas con:

```
sudo dhclient -v
```

```
Archivo Editor Ver Buscar Terminal Ayuda
Killed old client process
Internet Systems Consortium DHCP Client 4.3.1
Copyright 2004-2014 Internet Systems Consortium.
All rights reserved.
For info, please visit https://www.isc.org/software/dhcp/

Listening on LPF/eth0/08:00:27:8d:c0:4d
Sending on LPF/eth0/08:00:27:8d:c0:4d
Sending on Socket/fallback
DHCPRELEASE on eth0 to 10.0.2.2 port 67
vagrant@vm3:~$ sudo route add default gw 192.168.3.1 eth1
vagrant@vm3:~$ sudo dhclient -v
Internet Systems Consortium DHCP Client 4.3.1
Copyright 2004-2014 Internet Systems Consortium.
All rights reserved.
For info, please visit https://www.isc.org/software/dhcp/

Listening on LPF/eth1/08:00:27:16:12:b1
Sending on LPF/eth1/08:00:27:16:12:b1
Sending on Socket/fallback
DHCPDISCOVER on eth1 to 255.255.255.255 port 67 interval 3
DHCPREQUEST on eth1 to 255.255.255.255 port 67
DHCPOFFER from 192.168.3.1
DHCPACK from 192.168.3.1
bound to 192.168.3.10 -- renewal in 244 seconds.
vagrant@vm3:~$

Archivo Editor Ver Buscar Terminal Ayuda
--- google.es ping statistics ---
4 packets transmitted, 0 received, 100% packet loss, time 3006ms

vagrant@vm1:~$ ping google.es
PING google.es (216.58.210.163) 56(84) bytes of data.
64 bytes from mad06s10-in-f3.1e100.net (216.58.210.163): icmp_seq=1 ttl=61 time=23.4 ms
64 bytes from mad06s10-in-f3.1e100.net (216.58.210.163): icmp_seq=2 ttl=61 time=28.1 ms
64 bytes from mad06s10-in-f3.1e100.net (216.58.210.163): icmp_seq=3 ttl=61 time=23.3 ms
^C
--- google.es ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2007ms
rtt min/avg/max/mdev = 23.319/24.989/28.157/2.244 ms
vagrant@vm1:~$ sudo dhclient -v
Internet Systems Consortium DHCP Client 4.3.1
Copyright 2004-2014 Internet Systems Consortium.
All rights reserved.
For info, please visit https://www.isc.org/software/dhcp/

Listening on LPF/eth1/08:00:27:3d:fc:63
Sending on LPF/eth1/08:00:27:3d:fc:63
Sending on Socket/fallback
DHCPDISCOVER on eth1 to 255.255.255.255 port 67 interval 7
DHCPREQUEST on eth1 to 255.255.255.255 port 67
DHCPOFFER from 192.168.2.1
DHCPACK from 192.168.2.1
vagrant@vm1:~$

Archivo Editor Ver Buscar Terminal Ayuda
vagrant@vm4:~$ sudo ifdown eth0
Killed old client process
Internet Systems Consortium DHCP Client 4.3.1
Copyright 2004-2014 Internet Systems Consortium.
All rights reserved.
For info, please visit https://www.isc.org/software/dhcp/

Listening on LPF/eth0/08:00:27:8d:c0:4d
Sending on LPF/eth0/08:00:27:8d:c0:4d
Sending on Socket/fallback
DHCPRELEASE on eth0 to 10.0.2.2 port 67
vagrant@vm4:~$ sudo route add default gw 192.168.3.1 eth1
vagrant@vm4:~$ sudo dhclient -v
Internet Systems Consortium DHCP Client 4.3.1
Copyright 2004-2014 Internet Systems Consortium.
All rights reserved.
For info, please visit https://www.isc.org/software/dhcp/

Listening on LPF/eth1/08:00:27:74:46:2f
Sending on LPF/eth1/08:00:27:74:46:2f
Sending on Socket/fallback
DHCPDISCOVER on eth1 to 255.255.255.255 port 67 interval 3
DHCPREQUEST on eth1 to 255.255.255.255 port 67
DHCPOFFER from 192.168.3.1
DHCPACK from 192.168.3.1
bound to 192.168.3.23 -- renewal in 284 seconds.
vagrant@vm4:~$

Archivo Editor Ver Buscar Terminal Ayuda
binding state active;
next binding state free;
rewind binding state free;
hardware ethernet 08:00:27:3d:fc:63;
client-hostname "vm1";
}
lease 192.168.3.10 {
starts 3 2019/04/10 10:19:21;
ends 3 2019/04/10 10:29:21;
cltt 3 2019/04/10 10:19:21;
binding state active;
next binding state free;
rewind binding state free;
hardware ethernet 08:00:27:16:12:b1;
client-hostname "vm3";
}
lease 192.168.2.11 {
starts 3 2019/04/10 10:20:52;
ends 3 2019/04/10 10:30:52;
cltt 3 2019/04/10 10:20:52;
binding state active;
next binding state free;
rewind binding state free;
hardware ethernet 08:00:27:3a:5d:0d;
client-hostname "vm2";
}
}

vagrant@r:~$

Archivo Editor Ver Buscar Terminal Ayuda
RX bytes:51196 (49.9 KiB) TX bytes:43075 (42.0 KiB)
lo
Link encap:Local Loopback
inet addr:127.0.0.1 Mask:255.0.0.0
inet6 addr: ::1/128 Scope:Host
UP LOOPBACK RUNNING MTU:65536 Metric:1
RX packets:0 errors:0 dropped:0 overruns:0 frame:0
TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:0
RX bytes:0 (0.0 B) TX bytes:0 (0.0 B)

vagrant@vm2:~$ sudo dhclient
RTNETLINK answers: File exists
vagrant@vm2:~$ sudo dhclient -v
Internet Systems Consortium DHCP Client 4.3.1
Copyright 2004-2014 Internet Systems Consortium.
All rights reserved.
For info, please visit https://www.isc.org/software/dhcp/

Listening on LPF/eth1/08:00:27:3a:5d:0d
Sending on LPF/eth1/08:00:27:3a:5d:0d
Sending on Socket/fallback
DHCPREQUEST on eth1 to 255.255.255.255 port 67
DHCPACK from 192.168.2.1
RTNETLINK answers: File exists
bound to 192.168.2.11 -- renewal in 268 seconds.
vagrant@vm2:~$
```

Figura 5: Petición de IP desde las máquinas al servidor DHCP

Para ver las direcciones IP cedidas por el servidor DHCP usamos:

```
sudo cat /var/lib/dhcp/dhcpd.leases
```



```

lease 192.168.2.10 {
  starts 3 2019/04/10 10:23:39;
  ends 3 2019/04/10 10:33:39;
  cltt 3 2019/04/10 10:23:39;
  binding state active;
  next binding state free;
  rewind binding state free;
  hardware ethernet 08:00:27:3d:fc:63;
  client-hostname "vm1";
}
lease 192.168.2.11 {
  starts 3 2019/04/10 10:24:40;
  ends 3 2019/04/10 10:34:40;
  cltt 3 2019/04/10 10:24:40;
  binding state active;
  next binding state free;
  rewind binding state free;
  hardware ethernet 08:00:27:3a:5d:0d;
  client-hostname "vm2";
}
lease 192.168.3.10 {
  starts 3 2019/04/10 10:28:13;
  ends 3 2019/04/10 10:38:13;
  cltt 3 2019/04/10 10:28:13;
  binding state active;
  next binding state free;
  rewind binding state free;
  hardware ethernet 08:00:27:16:12:b1;
  client-hostname "vm3";
}

```

Figura 6: Vista de las direcciones IP cedidas por el servidor DHCP

3. Servidor DNS

Configurar la máquina central (router) para que actúe como DNS. Para ello, volveremos a configurar las máquinas con IP fijas, bien por DHCP o bien a mano.

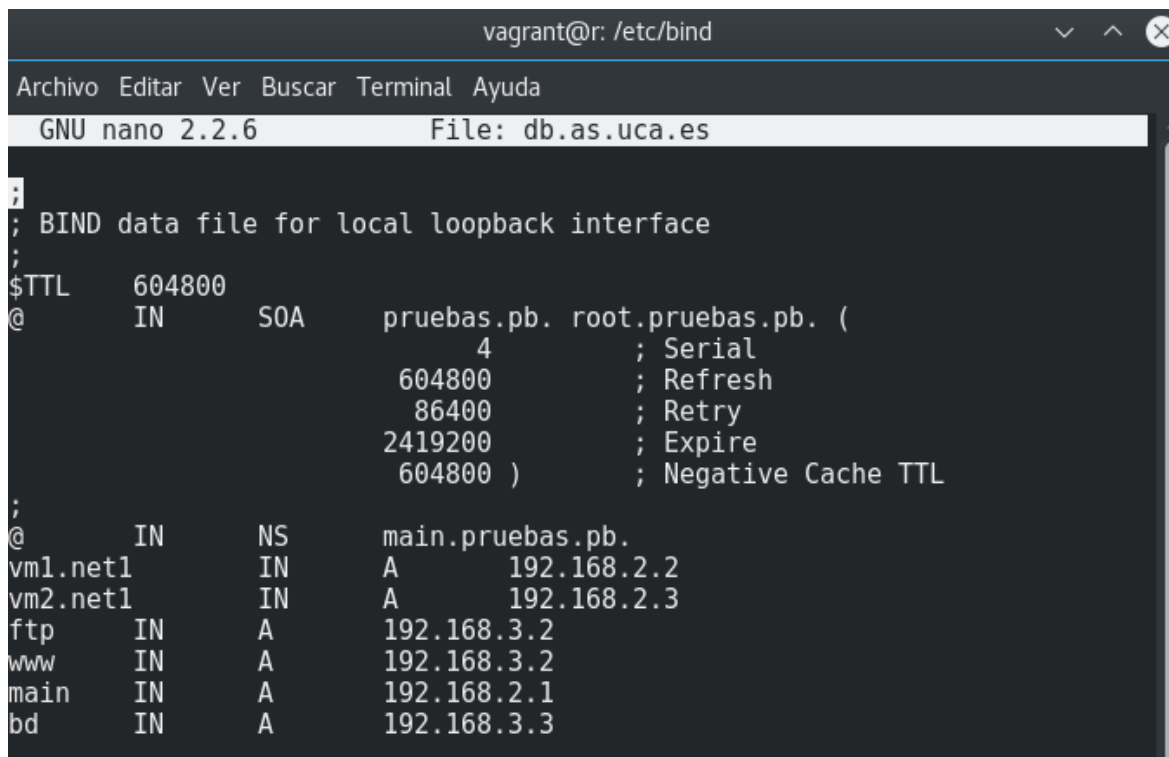
- La máquina 1 de la red 1 tendrá por nombre `vm1.net1.uca.es`.
- La máquina 2 de la red 1 tendrá por nombre `vm2.net1.uca.es`.
- La máquina 1 de la red 2 tendrá por nombre `www.as.uca.es`, además, tendrá que responder bajo el nombre de `ftp.as.uca.es`.
- La máquina 2 de la red 2 tendrá por nombre `bd.as.uca.es`.

Ahora cambiamos el servidor de zona y el fichero de zona:

```
/etc/bind/named.conf.default-zones
```

```
zone "as.uca.es" {  
    type master;  
    file "/etc/bind/db.as.uca.es";  
};
```

Figura 7: Fichero de zona



The screenshot shows a terminal window titled 'vagrant@r: /etc/bind'. The window contains the GNU nano 2.2.6 editor with the file 'db.as.uca.es' open. The file content is as follows:

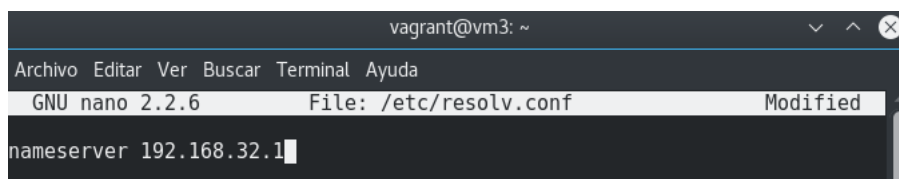
```
;
; BIND data file for local loopback interface
;
$TTL      604800
@          IN      SOA      pruebas.pb. root.pruebas.pb. (
                        4              ; Serial
                        604800         ; Refresh
                        86400          ; Retry
                        2419200        ; Expire
                        604800 )       ; Negative Cache TTL
;
@          IN      NS       main.pruebas.pb.
vm1.net1   IN      A        192.168.2.2
vm2.net1   IN      A        192.168.2.3
ftp        IN      A        192.168.3.2
www        IN      A        192.168.3.2
main       IN      A        192.168.2.1
bd         IN      A        192.168.3.3
```

Figura 8: Archivo db.as.uca.es

Por último, cambiamos el servidor DNS del resto de máquinas en el fichero `/etc/resolv.conf` con el siguiente comando:

```
sudo nano /etc/resolv.conf
```

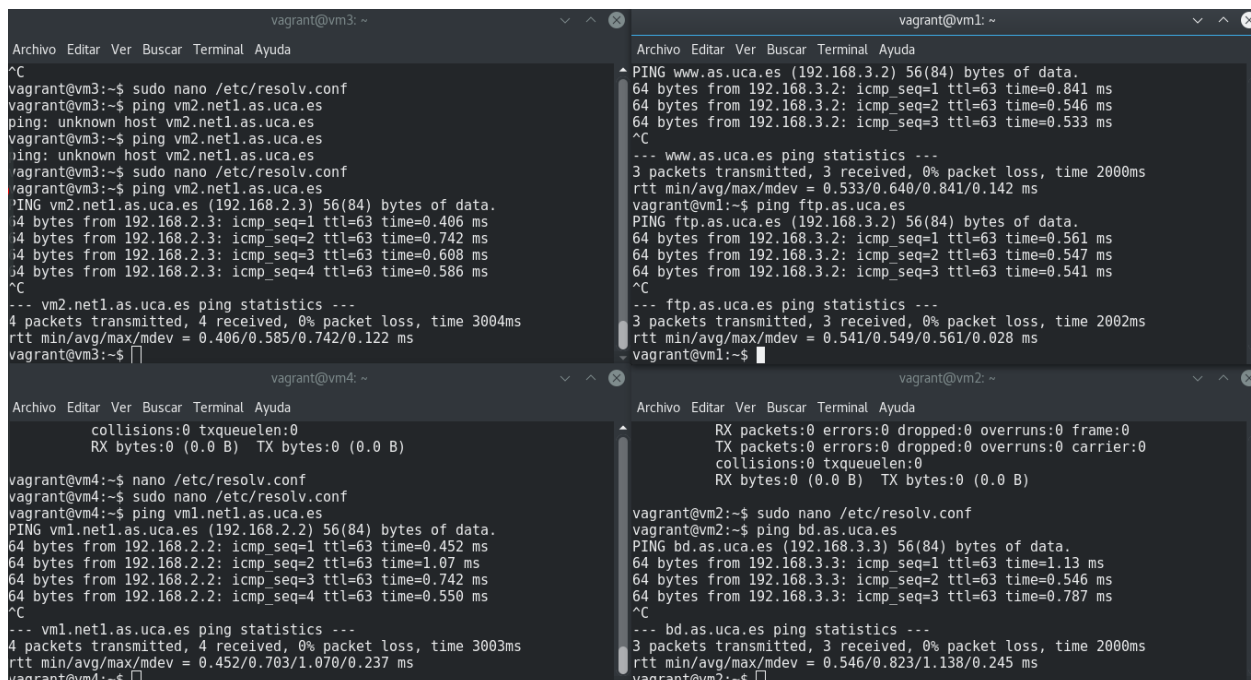
Y cambiamos el servidor DNS por `192.168.2.1`.



```
vagrant@vm3: ~  
Archivo Editar Ver Buscar Terminal Ayuda  
GNU nano 2.2.6 File: /etc/resolv.conf Modified  
nameserver 192.168.32.1
```

Figura 9: Archivo `/etc/resolv.conf` de las máquinas servidoras

Una vez realizados los cambios necesarios en el archivo de zona y en el archivo DNS, probamos a hacer ping a los nombres de dominio, para que el servidor DNS sea el que resuelva la dirección:



```
vagrant@vm3: ~  
^C  
vagrant@vm3:~$ sudo nano /etc/resolv.conf  
vagrant@vm3:~$ ping vm2.net1.as.uca.es  
ping: unknown host vm2.net1.as.uca.es  
vagrant@vm3:~$ ping vm2.net1.as.uca.es  
ping: unknown host vm2.net1.as.uca.es  
vagrant@vm3:~$ sudo nano /etc/resolv.conf  
vagrant@vm3:~$ ping vm2.net1.as.uca.es  
PING vm2.net1.as.uca.es (192.168.2.3) 56(84) bytes of data.  
64 bytes from 192.168.2.3: icmp_seq=1 ttl=63 time=0.406 ms  
64 bytes from 192.168.2.3: icmp_seq=2 ttl=63 time=0.742 ms  
64 bytes from 192.168.2.3: icmp_seq=3 ttl=63 time=0.608 ms  
64 bytes from 192.168.2.3: icmp_seq=4 ttl=63 time=0.586 ms  
^C  
--- vm2.net1.as.uca.es ping statistics ---  
4 packets transmitted, 4 received, 0% packet loss, time 3004ms  
rtt min/avg/max/mdev = 0.406/0.585/0.742/0.122 ms  
vagrant@vm3:~$  
  
vagrant@vm4: ~  
Archivo Editar Ver Buscar Terminal Ayuda  
collisions:0 txqueuelen:0  
RX bytes:0 (0.0 B) TX bytes:0 (0.0 B)  
  
vagrant@vm4:~$ nano /etc/resolv.conf  
vagrant@vm4:~$ sudo nano /etc/resolv.conf  
vagrant@vm4:~$ ping vm1.net1.as.uca.es  
PING vm1.net1.as.uca.es (192.168.2.2) 56(84) bytes of data.  
64 bytes from 192.168.2.2: icmp_seq=1 ttl=63 time=0.452 ms  
64 bytes from 192.168.2.2: icmp_seq=2 ttl=63 time=1.07 ms  
64 bytes from 192.168.2.2: icmp_seq=3 ttl=63 time=0.742 ms  
64 bytes from 192.168.2.2: icmp_seq=4 ttl=63 time=0.550 ms  
^C  
--- vm1.net1.as.uca.es ping statistics ---  
4 packets transmitted, 4 received, 0% packet loss, time 3003ms  
rtt min/avg/max/mdev = 0.452/0.703/1.070/0.237 ms  
vagrant@vm4:~$  
  
vagrant@vm1: ~  
Archivo Editar Ver Buscar Terminal Ayuda  
PING www.as.uca.es (192.168.3.2) 56(84) bytes of data.  
64 bytes from 192.168.3.2: icmp_seq=1 ttl=63 time=0.841 ms  
64 bytes from 192.168.3.2: icmp_seq=2 ttl=63 time=0.546 ms  
64 bytes from 192.168.3.2: icmp_seq=3 ttl=63 time=0.533 ms  
^C  
--- www.as.uca.es ping statistics ---  
3 packets transmitted, 3 received, 0% packet loss, time 2000ms  
rtt min/avg/max/mdev = 0.533/0.640/0.841/0.142 ms  
vagrant@vm1:~$ ping ftp.as.uca.es  
PING ftp.as.uca.es (192.168.3.2) 56(84) bytes of data.  
64 bytes from 192.168.3.2: icmp_seq=1 ttl=63 time=0.561 ms  
64 bytes from 192.168.3.2: icmp_seq=2 ttl=63 time=0.547 ms  
64 bytes from 192.168.3.2: icmp_seq=3 ttl=63 time=0.541 ms  
^C  
--- ftp.as.uca.es ping statistics ---  
3 packets transmitted, 3 received, 0% packet loss, time 2002ms  
rtt min/avg/max/mdev = 0.541/0.549/0.561/0.028 ms  
vagrant@vm1:~$  
  
vagrant@vm2: ~  
Archivo Editar Ver Buscar Terminal Ayuda  
RX packets:0 errors:0 dropped:0 overruns:0 frame:0  
TX packets:0 errors:0 dropped:0 overruns:0 carrier:0  
collisions:0 txqueuelen:0  
RX bytes:0 (0.0 B) TX bytes:0 (0.0 B)  
  
vagrant@vm2:~$ sudo nano /etc/resolv.conf  
vagrant@vm2:~$ ping bd.as.uca.es  
PING bd.as.uca.es (192.168.3.3) 56(84) bytes of data.  
64 bytes from 192.168.3.3: icmp_seq=1 ttl=63 time=1.13 ms  
64 bytes from 192.168.3.3: icmp_seq=2 ttl=63 time=0.546 ms  
64 bytes from 192.168.3.3: icmp_seq=3 ttl=63 time=0.787 ms  
^C  
--- bd.as.uca.es ping statistics ---  
3 packets transmitted, 3 received, 0% packet loss, time 2000ms  
rtt min/avg/max/mdev = 0.546/0.823/1.138/0.245 ms  
vagrant@vm2:~$
```

Figura 10: Máquinas servidoras haciendo ping a los dominios