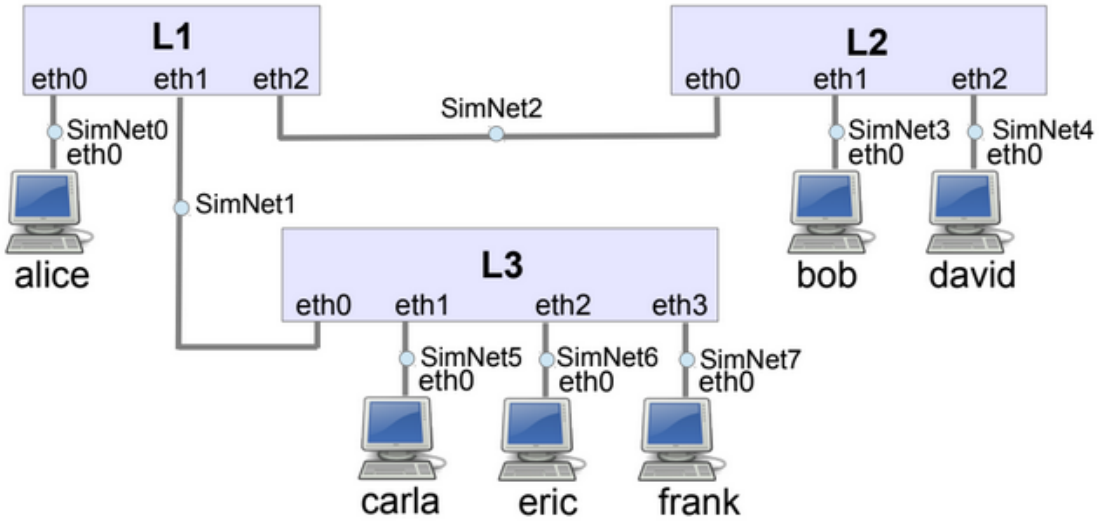


Figure 1.1: Scenario for testing Switching

EXERCISE 1.1

```
telem@phyhost:~$ simctl switching-vlan start
......
Total time elapsed: 294 seconds
```

```
root@frank:~# ifconfig eth0 192.168.100.5/24
```

root@bob:~# ifconfig eth0 192.168.100.4/24

```
root@bob:~# ping -c 1 192.168.100.5
```

SimNet1, SimNet2 y SimNet3

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:02:00	Broadcast	ARP	42	Who has 192.168.100.5? Tell 192.168.100.
2	0.000647914	fe:fd:00:00:06:00	fe:fd:00:00:02:00	ARP	42	192.168.100.5 is at fe:fd:00:00:06:00
3	0.000680782	192.168.100.4	192.168.100.5	ICMP	98	Echo (ping) request id=0x050f, seq=1/25
4	0.000996137	192.168.100.5	192.168.100.4	ICMP	98	Echo (ping) reply id=0x050f, seq=1/25
6	5.012056156	fe:fd:00:00:06:00	fe:fd:00:00:02:00	ARP	42	Who has 192.168.100.4? Tell 192.168.100.
7	5.012126881	fe:fd:00:00:02:00	fe:fd:00:00:06:00	ARP	42	192.168.100.4 is at fe:fd:00:00:02:00

Dos ARP para contactar con el host, se envian los ping y transcurridos 5 secs el host destino envia un ARP a el host inicial src para verificar la MAC y añadirla en su tabla de rutas.

EXERCISE 1.2

```
root@L1:~# ifconfig br1 down
root@L1:~# brctl delbr br1
```

Make the Linux system L1 to behave as router (enable IPv4 packet forwarding):

```
root@L1:~# echo 1 > /proc/sys/net/ipv4/ip_forward
```

If you want to disable IPv4 packet forwarding:

```
# echo 0 > /proc/sys/net/ipv4/ip_forward
```

Interfaces configuration (IP adresses):

```
root@L1:~# ifconfig eth0 192.168.100.1/24
root@L1:~# ifconfig eth1 192.168.101.1/24
root@L1:~# ifconfig eth2 192.168.102.1/24
```

root@alice:~# ifconfig eth0 192.168.100.2/24
root@bob:~# ifconfig eth0 192.168.102.2/24
root@david:~# ifconfig eth0 192.168.102.3/24
root@carla:~# ifconfig eth0 192.168.101.2/24
root@eric:~# ifconfig eth0 192.168.101.3/24
root@frank:~# ifconfig eth0 192.168.101.4/24

To check a routing table type:

```
# route -n
```

```
root@alice:~# route add -net 192.168.101.0/24 gw 192.168.100.1
root@alice:~# route add -net 192.168.102.0/24 gw 192.168.100.1
root@alice:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.100.0   *               255.255.255.0   U     0      0        0 eth0
192.168.101.0   192.168.100.1   255.255.255.0   UG    0      0        0 eth0
192.168.102.0   192.168.100.1   255.255.255.0   UG    0      0        0 eth0
```

```
root@bob:~# route add -net 192.168.101.0/24 gw 192.168.102.1
root@bob:~# route add -net 192.168.100.0/24 gw 192.168.102.1
root@bob:~# rute
-bash: rute: no se encontr  la orden
root@bob:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.100.0   192.168.102.1   255.255.255.0   UG    0      0        0 eth0
192.168.101.0   192.168.102.1   255.255.255.0   UG    0      0        0 eth0
192.168.102.0   *               255.255.255.0   U     0      0        0 eth0
```

```
root@david:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.100.0   192.168.102.1   255.255.255.0   UG    0      0        0 eth0
192.168.101.0   192.168.102.1   255.255.255.0   UG    0      0        0 eth0
192.168.102.0   *               255.255.255.0   U     0      0        0 eth0
```

```
root@frank:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.100.0   192.168.101.1   255.255.255.0   UG    0      0        0 eth0
192.168.101.0   *               255.255.255.0   U     0      0        0 eth0
192.168.102.0   192.168.101.1   255.255.255.0   UG    0      0        0 eth0
```

```
root@carla:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.100.0   192.168.101.1   255.255.255.0   UG    0      0        0 eth0
192.168.101.0   *               255.255.255.0   U     0      0        0 eth0
192.168.102.0   192.168.101.1   255.255.255.0   UG    0      0        0 eth0
```

```
root@eric:~# route
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.100.0   192.168.101.1   255.255.255.0   UG    0      0        0 eth0
192.168.101.0   *               255.255.255.0   U     0      0        0 eth0
192.168.102.0   192.168.101.1   255.255.255.0   UG    0      0        0 eth0
```

Ping de alice a bob:
Vemos tráfico en las SIms correspondientes (SimNet2 y SImNet3)

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:07:02	Broadcast	ARP	42	Who has 192.168.102.2? Tell 192.168.102.
2	0.000285911	fe:fd:00:00:02:00	fe:fd:00:00:07:02	ARP	42	192.168.102.2 is at fe:fd:00:00:02:00
3	0.000327833	192.168.100.2	192.168.102.2	ICMP	98	Echo (ping) request id=0x0521, seq=1/25
4	0.000466579	192.168.102.2	192.168.100.2	ICMP	98	Echo (ping) reply id=0x0521, seq=1/25
5	5.008810921	fe:fd:00:00:02:00	fe:fd:00:00:07:02	ARP	42	Who has 192.168.102.1? Tell 192.168.102.
6	5.009161801	fe:fd:00:00:07:02	fe:fd:00:00:02:00	ARP	42	192.168.102.1 is at fe:fd:00:00:07:02

Ping de bob a frank:
SimNet1:

No.	Time	Source	Destination	Protocol	Length	Info
2	32.539229003	fe:fd:00:00:07:01	Broadcast	ARP	42	Who has 192.168.101.4? Tell 192.168.101.
3	32.539650934	fe:fd:00:00:06:00	fe:fd:00:00:07:01	ARP	42	192.168.101.4 is at fe:fd:00:00:06:00
4	32.539694567	192.168.102.2	192.168.101.4	ICMP	98	Echo (ping) request id=0x0541, seq=1/25
5	32.539828015	192.168.101.4	192.168.102.2	ICMP	98	Echo (ping) reply id=0x0541, seq=1/25
6	37.552513139	fe:fd:00:00:06:00	fe:fd:00:00:07:01	ARP	42	Who has 192.168.101.1? Tell 192.168.101.
7	37.552630925	fe:fd:00:00:07:01	fe:fd:00:00:06:00	ARP	42	192.168.101.1 is at fe:fd:00:00:07:01

SimNet2 y SimNet3:

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.102.2	192.168.101.4	ICMP	98	Echo (ping) request id=0x0541, seq=1/25
2	0.000746887	192.168.101.4	192.168.102.2	ICMP	98	Echo (ping) reply id=0x0541, seq=1/25
3	4.987969489	fe:fd:00:00:02:00	fe:fd:00:00:07:02	ARP	42	Who has 192.168.102.1? Tell 192.168.102.
4	4.988041022	fe:fd:00:00:07:02	fe:fd:00:00:02:00	ARP	42	192.168.102.1 is at fe:fd:00:00:07:02

En este caso bob ya sabe como llegar al router L1 por el pin anterior y es por eso que no vemos el ARP de broadcast inicial y su respuesta correspondiente.

EXERCISE 2.1

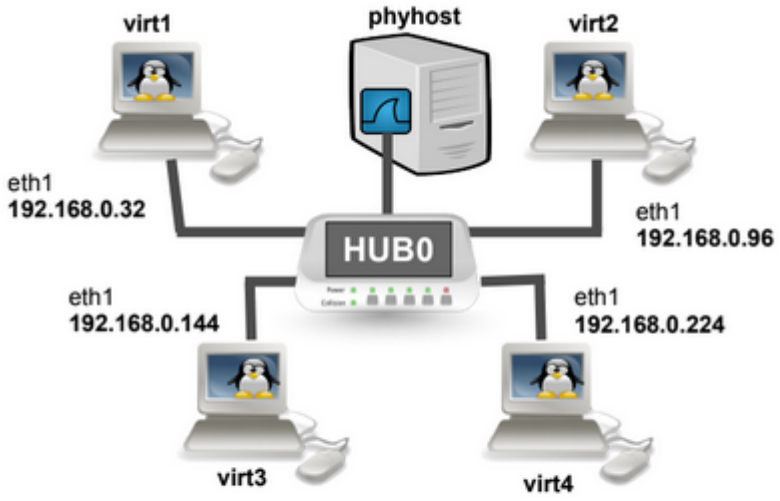


Figure 2: Scenario “subnetting“.

```
phyhost$ simctl ip-subnetting start
```

```
telem@debian:~$ ipcalc 192.168.0.32
Address:   192.168.0.32          11000000.10101000.00000000. 00100000
Netmask:   255.255.255.0 = 24    11111111.11111111.11111111. 00000000
Wildcard:  0.0.0.255             00000000.00000000.00000000. 11111111
=>
Network:   192.168.0.0/24        11000000.10101000.00000000. 00000000
HostMin:   192.168.0.1           11000000.10101000.00000000. 00000001
HostMax:   192.168.0.254         11000000.10101000.00000000. 11111110
Broadcast: 192.168.0.255         11000000.10101000.00000000. 11111111
Hosts/Net: 254                    Class C, Private Internet
```

virt1:~# ifconfig eth1 192.168.0.32/24
virt2:~# ifconfig eth1 192.168.0.96/24
virt3:~# ifconfig eth1 192.168.0.144/24
virt4:~# ifconfig eth1 192.168.0.224/24

EXERCISE 2.2
Mirar memoria cache:

```
virt1$ arp -n
```

Ping desde virt1 a virt2:

```
virt1:~# arp -n
virt1:~# ping -c 1 192.168.0.96
PING 192.168.0.96 (192.168.0.96) 56(84) bytes of data.
64 bytes from 192.168.0.96: icmp_seq=1 ttl=64 time=21.3 ms

--- 192.168.0.96 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 21.303/21.303/21.303/0.000 ms
virt1:~# ping -c 1 192.168.0.96
PING 192.168.0.96 (192.168.0.96) 56(84) bytes of data.
64 bytes from 192.168.0.96: icmp_seq=1 ttl=64 time=0.233 ms

--- 192.168.0.96 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.233/0.233/0.233/0.000 ms
```

SimNet0:

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:01:01	Broadcast	ARP	42	Who has 192.168.0.96? Tell 192.168.0.32
2	0.000165591	fe:fd:00:00:02:01	fe:fd:00:00:01:01	ARP	42	192.168.0.96 is at fe:fd:00:00:02:01
3	0.000263475	192.168.0.32	192.168.0.96	ICMP	98	Echo (ping) request id=0x8804, seq=1/25
4	0.000338771	192.168.0.96	192.168.0.32	ICMP	98	Echo (ping) reply id=0x8804, seq=1/25
5	5.008269554	fe:fd:00:00:02:01	fe:fd:00:00:01:01	ARP	42	Who has 192.168.0.32? Tell 192.168.0.96
6	5.008433422	fe:fd:00:00:01:01	fe:fd:00:00:02:01	ARP	42	192.168.0.32 is at fe:fd:00:00:01:01
7	9.091769774	192.168.0.32	192.168.0.96	ICMP	98	Echo (ping) request id=0x8904, seq=1/25
8	9.091892792	192.168.0.96	192.168.0.32	ICMP	98	Echo (ping) reply id=0x8904, seq=1/25

En el primer proceso de ping vemos las tramas ICMP y los ARP. En la segunda la ruta ya esta definida y virt1 no necesita enviar tales ARP.

Memoria cache de virt2:

```
virt2:~# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.0.32             ether   FE:FD:00:00:01:01   C                     eth1
```

Memoria cache de virt1:

```
virt1:~# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.0.96             ether   FE:FD:00:00:02:01   C                     eth1
```

EXERCISE 2.3

```
virt1# arp -d 192.168.0.96
```

Es tornen a rebre el ARPs.

EXERCISE 2.4

```
virt1# arp -s 192.168.0.96 00:70:48:29:5c:99 temp
```

virt1: ~# ping -c 2 -i 8 192.168.0.96

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.0.32	192.168.0.96	ICMP	98	Echo (ping) request id=0x8a04, seq=1/25
2	4.988896085	fe:fd:00:00:01:01	00:70:48:29:5c:99	ARP	42	Who has 192.168.0.96? Tell 192.168.0.32
3	5.989202514	fe:fd:00:00:01:01	00:70:48:29:5c:99	ARP	42	Who has 192.168.0.96? Tell 192.168.0.32
4	6.988309437	fe:fd:00:00:01:01	00:70:48:29:5c:99	ARP	42	Who has 192.168.0.96? Tell 192.168.0.32
5	8.032611543	fe:fd:00:00:01:01	Broadcast	ARP	42	Who has 192.168.0.96? Tell 192.168.0.32
6	8.032814980	fe:fd:00:00:02:01	fe:fd:00:00:01:01	ARP	42	192.168.0.96 is at fe:fd:00:00:02:01
7	8.033199347	192.168.0.32	192.168.0.96	ICMP	98	Echo (ping) request id=0x8a04, seq=2/51
8	8.033360100	192.168.0.96	192.168.0.32	ICMP	98	Echo (ping) reply id=0x8a04, seq=2/51
9	13.046877878	fe:fd:00:00:02:01	fe:fd:00:00:01:01	ARP	42	Who has 192.168.0.32? Tell 192.168.0.96
10	13.047095126	fe:fd:00:00:01:01	fe:fd:00:00:02:01	ARP	42	192.168.0.32 is at fe:fd:00:00:01:01

Vemos q s hacen varios intentos de envio por el camino q hemos mapeado pero al ser erroneo obviamente no s puede enviar el paquete, asi q tras varios intentos el host envia una trama de broadcast y el ping ya procede como siempre.

EXERCISE 2.5

```
telem@debian:~$ ipcalc 192.168.0.0/25
Address:   192.168.0.0          11000000.10101000.00000000.0 0000000
Netmask:   255.255.255.128 = 25 11111111.11111111.11111111.1 0000000
Wildcard:  0.0.0.127            00000000.00000000.00000000.0 1111111
=>
Network:   192.168.0.0/25       11000000.10101000.00000000.0 0000000
HostMin:   192.168.0.1          11000000.10101000.00000000.0 0000001
HostMax:   192.168.0.126        11000000.10101000.00000000.0 1111110
Broadcast: 192.168.0.127        11000000.10101000.00000000.0 1111111
Hosts/Net: 126                   Class C, Private Internet
```

virt1:~# ifconfig eth1 192.168.0.32/25
virt2:~# ifconfig eth1 192.168.0.96/25
virt3:~# ifconfig eth1 192.168.0.144/25
virt4:~# ifconfig eth1 192.168.0.224/25
EXERCISE 2.6 -> mask 25

EXERCISE 2.7

virt1:~# ifconfig eth1 192.168.0.32/24
virt2:~# ifconfig eth1 192.168.0.96/25
virt3:~# ifconfig eth1 192.168.0.144/24
virt4:~# ifconfig eth1 192.168.0.224/25
Desde virt1 se envian los pings correctamente a todos los hosts, pero desde virt2 solo se podra enviar a virt1 porq la subnet de virt2 esta en la net de virt1 pero, debido a esto no se puede comunicar con virt3 ni con virt4(con usr que no e encuentren en su subnet).

EXERCISE 3.1
To make a Linux machine act as a router:

```
# echo 1 > /proc/sys/net/ipv4/conf/all/forwarding
```

```
virt4:~# route add -net 192.168.0.0/25 gw 192.168.0.144
virt4:~# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.0.0     192.168.0.144   255.255.255.128 UG    0      0        0 eth1
192.168.0.128   0.0.0.0         255.255.255.128 U     0      0        0 eth1
virt4:~#
```

```
virt2:~# route add -net 192.168.0.128/25 gw 192.168.0.32
virt2:~# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.0.0     0.0.0.0         255.255.255.128 U     0      0        0 eth1
                192.168.0.32    255.255.255.128 UG    0      0        0 eth1
```

virt2:~# ping -c 1 192.168.0.224

```
virt4:~# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.0.144            ether   FE:FD:00:00:03:01   C                     eth1
192.168.0.32             ether   FE:FD:00:00:01:01   C                     eth1
virt4:~#
```

```
virt1:~# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.0.96             ether   FE:FD:00:00:02:01   C                     eth1
192.168.0.224            ether   FE:FD:00:00:04:01   C                     eth1
virt1:~#
```

```
virt3:~# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.0.96             ether   FE:FD:00:00:02:01   C                     eth1
192.168.0.224            ether   FE:FD:00:00:04:01   C                     eth1
```

```
ddress                  HWtype  HWaddress           Flags Mask            Iface
92.168.0.144             ether   FE:FD:00:00:03:01   C                     eth1
                         ether   FE:FD:00:00:01:01   C                     eth1
```

Apply a display filter ... <Ctrl-/> Expression... +

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:02:01	Broadcast	ARP	42	Who has 192.168.0.32? Tell 192.168.0.96
2	0.000121511	fe:fd:00:00:01:01	fe:fd:00:00:02:01	ARP	42	192.168.0.32 is at fe:fd:00:00:01:01
3	0.000203554	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9504, seq=1/25
4	0.014605603	fe:fd:00:00:01:01	Broadcast	ARP	42	Who has 192.168.0.224? Tell 192.168.0.32
5	0.014691211	fe:fd:00:00:04:01	fe:fd:00:00:01:01	ARP	42	192.168.0.224 is at fe:fd:00:00:04:01
6	0.014755220	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9504, seq=1/25
7	0.025024907	fe:fd:00:00:04:01	Broadcast	ARP	42	Who has 192.168.0.144? Tell 192.168.0.22
8	0.025089075	fe:fd:00:00:03:01	fe:fd:00:00:04:01	ARP	42	192.168.0.144 is at fe:fd:00:00:03:01
9	0.025157126	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9504, seq=1/25
10	0.025220654	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9504, seq=1/25
11	5.034907603	fe:fd:00:00:03:01	fe:fd:00:00:02:01	ARP	42	Who has 192.168.0.96? Tell 192.168.0.144
12	5.035218996	fe:fd:00:00:02:01	fe:fd:00:00:03:01	ARP	42	192.168.0.96 is at fe:fd:00:00:02:01

El ping viatja d virt2 a virt1 i de virt3 que es comunica amb virt4.

EXERCISE 3.2

```
virt1$ ifconfig eth1 192.168.0.32/25
virt1$ ifconfig eth1:0 192.168.0.232/25
```

```
virt2:~# route add -net 192.168.0.128/25 gw 192.168.0.32
virt2:~# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.0.0     0.0.0.0         255.255.255.128 U     0      0        0 eth1
192.168.0.128   192.168.0.32    255.255.255.128 UG    0      0        0 eth1
```

```
virt4:~# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.0.0     192.168.0.232   255.255.255.128 UG    0      0        0 eth1
192.168.0.128   0.0.0.0         255.255.255.128 U     0      0        0 eth1
```

virt2:~# ping 192.168.0.224

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:02:01	Broadcast	ARP	42	Who has 192.168.0.32? Tell 192.168.0.9
2	0.000126542	fe:fd:00:00:01:01	fe:fd:00:00:02:01	ARP	42	192.168.0.32 is at fe:fd:00:00:01:01
3	0.000207389	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=1/
4	0.018339393	fe:fd:00:00:01:01	Broadcast	ARP	42	Who has 192.168.0.224? Tell 192.168.0.
5	0.018456259	fe:fd:00:00:04:01	fe:fd:00:00:01:01	ARP	42	192.168.0.224 is at fe:fd:00:00:04:01
6	0.018531483	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=1/
7	0.018603145	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9104, seq=1/
8	0.018665520	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9104, seq=1/
9	0.989330609	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=2/
10	0.989783530	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=2/
11	0.990009505	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9104, seq=2/
12	0.990123203	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9104, seq=2/
13	2.000891132	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=3/
14	2.001065821	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=3/
15	2.001112653	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9104, seq=3/
16	2.001218180	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9104, seq=3/
17	3.015709984	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=4/
18	3.016059518	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=4/
19	3.016270419	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9104, seq=4/
20	3.016407087	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9104, seq=4/
21	4.018383401	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=5/
22	4.018481148	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=5/
23	4.018533297	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9104, seq=5/
24	4.018615753	192.168.0.224	192.168.0.96	ICMP	98	Echo (ping) reply id=0x9104, seq=5/
25	5.023127726	fe:fd:00:00:01:01	fe:fd:00:00:02:01	ARP	42	Who has 192.168.0.96? Tell 192.168.0.3
26	5.023358146	fe:fd:00:00:02:01	fe:fd:00:00:01:01	ARP	42	192.168.0.96 is at fe:fd:00:00:02:01
27	5.033739252	fe:fd:00:00:04:01	fe:fd:00:00:01:01	ARP	42	Who has 192.168.0.232? Tell 192.168.0.
28	5.034125207	fe:fd:00:00:01:01	fe:fd:00:00:04:01	ARP	42	192.168.0.232 is at fe:fd:00:00:01:01
29	5.034498603	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=6/
30	5.034797923	192.168.0.96	192.168.0.224	ICMP	98	Echo (ping) request id=0x9104, seq=6/

EXERCISE 4

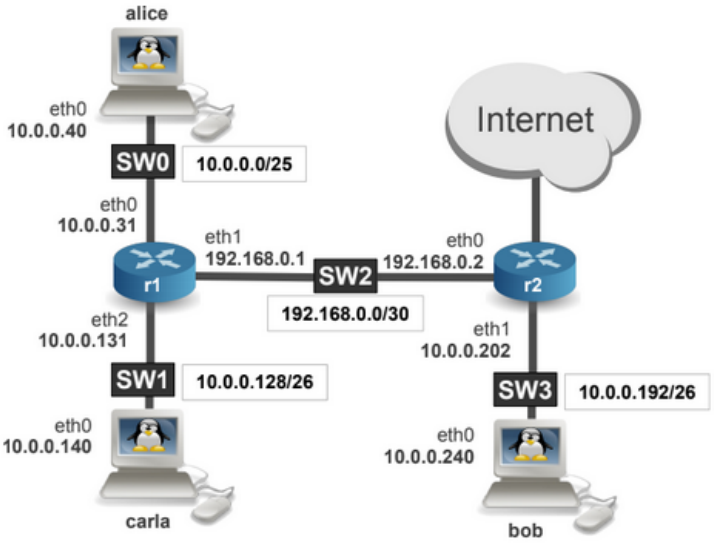


Figure 3: Scenario routing-abc.

telem@debian:~# simctl ip-routing-abc start

```
r1$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Iface
10.0.0.0        0.0.0.0         255.255.255.128 eth0
192.168.0.0     0.0.0.0         255.255.255.252 eth1
10.0.0.128      0.0.0.0         255.255.255.192 eth2
0.0.0.0         192.168.0.2     0.0.0.0         eth1
```

```
r2$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Iface
192.168.0.0     0.0.0.0         255.255.255.252 eth0
10.0.0.192      0.0.0.0         255.255.255.192 eth1
10.0.0.0        192.168.0.1     255.255.255.128 eth0
10.0.0.128      192.168.0.1     255.255.255.192 eth0

alice$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Iface
10.0.0.0        0.0.0.0         255.255.255.128 eth0
192.168.0.0     10.0.0.31       255.255.255.252 eth0
10.0.0.128      10.0.0.31       255.255.255.192 eth0
10.0.0.192      10.0.0.31       255.255.255.192 eth0
```

Las defaults routes son por las q enviaria el host las tramas si el destino no coincide con ninguna otra de la tabla (default route: 0.0.0.0=0):
alice:~# route -n :

```
Destination     Gateway         Genmask         Iface
10.0.0.0        0.0.0.0         255.255.255.128 eth0
0.0.0.0         10.0.0.31       0.0.0.0         eth0
```

ping de alis a bob (SimNet0,2,3):

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:01:00	Broadcast	ARP	42	Who has 10.0.0.31? Tell 10.0.0.40
2	0.000072619	fe:fd:00:00:02:00	fe:fd:00:00:01:00	ARP	42	10.0.0.31 is at fe:fd:00:00:02:00
3	0.000120854	10.0.0.40	10.0.0.240	ICMP	98	Echo (ping) request id=0x9e04, seq=1/25
4	0.022209058	10.0.0.240	10.0.0.40	ICMP	98	Echo (ping) reply id=0x9e04, seq=1/25
5	0.996364731	10.0.0.40	10.0.0.240	ICMP	98	Echo (ping) request id=0x9e04, seq=2/51
6	0.997224606	10.0.0.240	10.0.0.40	ICMP	98	Echo (ping) reply id=0x9e04, seq=2/51
7	2.014884742	10.0.0.40	10.0.0.240	ICMP	98	Echo (ping) request id=0x9e04, seq=3/76
8	2.015730183	10.0.0.240	10.0.0.40	ICMP	98	Echo (ping) reply id=0x9e04, seq=3/76
9	5.036396833	fe:fd:00:00:02:00	fe:fd:00:00:01:00	ARP	42	Who has 10.0.0.40? Tell 10.0.0.31
10	5.036504646	fe:fd:00:00:01:00	fe:fd:00:00:02:00	ARP	42	10.0.0.40 is at fe:fd:00:00:01:00

ping de alis a carla (SimNet1):

1	0.000000000	fe:fd:00:00:02:02	Broadcast	ARP	42	Who has 10.0.0.140? Tell 10.0.0.131
2	0.000061531	fe:fd:00:00:05:00	fe:fd:00:00:02:02	ARP	42	10.0.0.140 is at fe:fd:00:00:05:00
3	0.000100374	10.0.0.40	10.0.0.140	ICMP	98	Echo (ping) request id=0x9b04, seq=1/25
4	0.000137443	10.0.0.140	10.0.0.40	ICMP	98	Echo (ping) reply id=0x9b04, seq=1/25
5	0.992329869	10.0.0.40	10.0.0.140	ICMP	98	Echo (ping) request id=0x9b04, seq=2/51
6	0.992449401	10.0.0.140	10.0.0.40	ICMP	98	Echo (ping) reply id=0x9b04, seq=2/51
7	5.005753267	fe:fd:00:00:05:00	fe:fd:00:00:02:02	ARP	42	Who has 10.0.0.131? Tell 10.0.0.140
8	5.006032285	fe:fd:00:00:02:02	fe:fd:00:00:05:00	ARP	42	10.0.0.131 is at fe:fd:00:00:02:02

EXERCISE 5.1

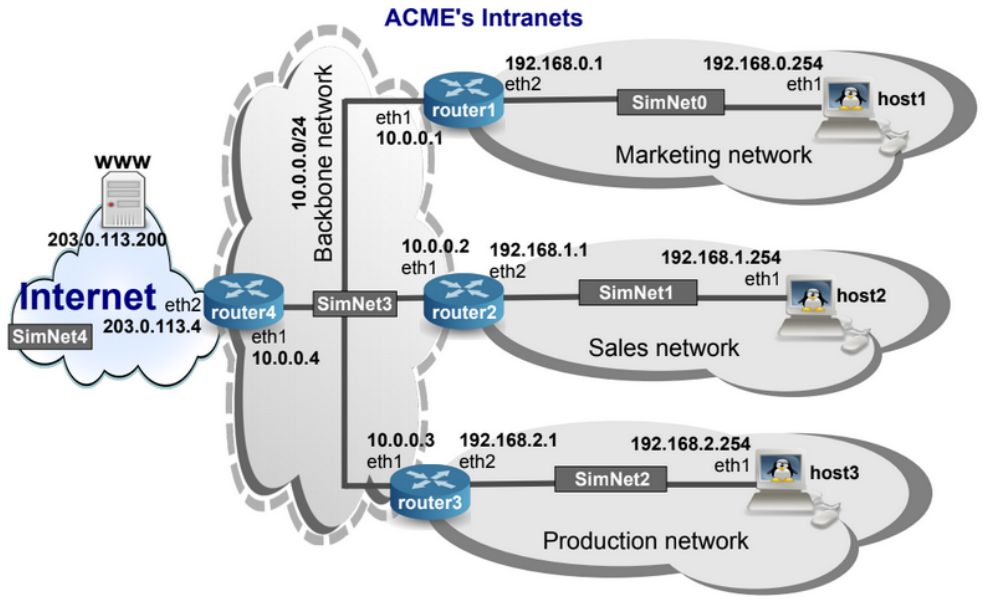


Figure 4: Scenario "routing".

```
phyhost$ simctl ip-routing start
```

router1:~# ifconfig eth1 10.0.0.1/24
router1:~# ifconfig eth2 192.168.0.1/24

host1:~# ifconfig eth1 192.168.0.254/24

router2:~# ifconfig eth1 10.0.0.2/24
router2:~# ifconfig eth2 192.168.1.1/24

host2:~# ifconfig eth1 192.168.1.254/24

-> ping de host1 a rout1 y de host2 a rout2

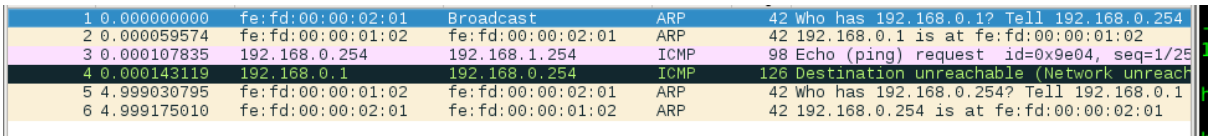
EXERCISE 5.2

host1:~# route add -net 0.0.0.0/0 gw 192.168.0.1

```
host1:~# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.0.0     0.0.0.0         255.255.255.0   U     0      0        0 eth1
0.0.0.0         192.168.0.1     0.0.0.0         UG    0      0        0 eth1
```

host1:~# ping -c 1 192.168.1.254

SImNet0:



1	0.000000000	fe:fd:00:00:02:01	Broadcast	ARP	42 Who has 192.168.0.1? Tell 192.168.0.254
2	0.000059574	fe:fd:00:00:01:02	fe:fd:00:00:02:01	ARP	42 192.168.0.1 is at fe:fd:00:00:01:02
3	0.000107835	192.168.0.254	192.168.1.254	ICMP	98 Echo (ping) request id=0x9e04, seq=1/25
4	0.000143119	192.168.0.1	192.168.0.254	ICMP	126 Destination unreachable (Network unreach
5	4.999030795	fe:fd:00:00:01:02	fe:fd:00:00:02:01	ARP	42 Who has 192.168.0.254? Tell 192.168.0.1
6	4.999175010	fe:fd:00:00:02:01	fe:fd:00:00:01:02	ARP	42 192.168.0.254 is at fe:fd:00:00:02:01

EXERCISE 5.3

```
root@L1:~# echo 1 > /proc/sys/net/ipv4/ip_forward
```

router1:~# route add -net 192.168.1.0/24 gw 10.0.0.2

router1:~# route add -net 192.168.2.0/24 gw 10.0.0.3

```
router1:~# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.0.0.0        0.0.0.0         255.255.255.0   U     0      0        0 eth1
192.168.2.0     10.0.0.3        255.255.255.0   UG    0      0        0 eth1
192.168.1.0     10.0.0.2        255.255.255.0   UG    0      0        0 eth1
192.168.0.0     0.0.0.0         255.255.255.0   U     0      0        0 eth2
```

EXERCISE 5.4

host2:~# route add -net 0.0.0.0/0 gw 192.168.1.1

```
host2:~# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
192.168.1.0     0.0.0.0         255.255.255.0   U     0      0        0 eth1
0.0.0.0         192.168.1.1     0.0.0.0         UG    0      0        0 eth1
```

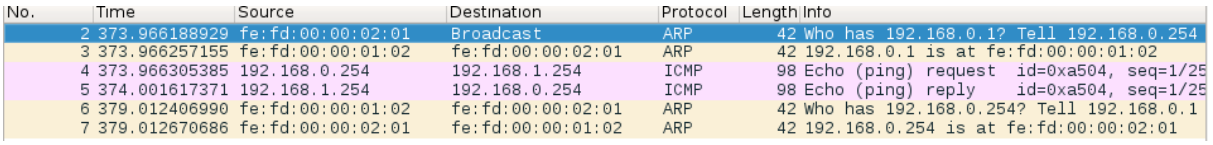
router2:~# route add -net 192.168.0.0/24 gw 10.0.0.1

router2:~# route add -net 192.168.2.0/24 gw 10.0.0.3

```
router2:~# route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
10.0.0.0        0.0.0.0         255.255.255.0   U     0      0        0 eth1
192.168.2.0     10.0.0.3        255.255.255.0   UG    0      0        0 eth1
192.168.1.0     0.0.0.0         255.255.255.0   U     0      0        0 eth2
192.168.0.0     10.0.0.1        255.255.255.0   UG    0      0        0 eth1
```

host1:~# ping -c 1 192.168.1.254

SimNet0



No.	Time	Source	Destination	Protocol	Length	Info
2	373.966188929	fe:fd:00:00:02:01	Broadcast	ARP	42	Who has 192.168.0.1? Tell 192.168.0.254
3	373.966257155	fe:fd:00:00:01:02	fe:fd:00:00:02:01	ARP	42	192.168.0.1 is at fe:fd:00:00:01:02
4	373.966305385	192.168.0.254	192.168.1.254	ICMP	98	Echo (ping) request id=0xa504, seq=1/25
5	374.001617371	192.168.1.254	192.168.0.254	ICMP	98	Echo (ping) reply id=0xa504, seq=1/25
6	379.012406990	fe:fd:00:00:01:02	fe:fd:00:00:02:01	ARP	42	Who has 192.168.0.254? Tell 192.168.0.1
7	379.012670686	fe:fd:00:00:02:01	fe:fd:00:00:01:02	ARP	42	192.168.0.254 is at fe:fd:00:00:02:01

SimNet1

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:03:02	Broadcast	ARP	42	Who has 192.168.1.254? Tell 192.168.1.1
2	0.000063737	fe:fd:00:00:04:01	fe:fd:00:00:03:02	ARP	42	192.168.1.254 is at fe:fd:00:00:04:01
3	0.000116762	192.168.0.254	192.168.1.254	ICMP	98	Echo (ping) request id=0xa504, seq=1/25
4	0.000156550	192.168.1.254	192.168.0.254	ICMP	98	Echo (ping) reply id=0xa504, seq=1/25
5	5.013658990	fe:fd:00:00:04:01	fe:fd:00:00:03:02	ARP	42	Who has 192.168.1.1? Tell 192.168.1.254
6	5.013716800	fe:fd:00:00:03:02	fe:fd:00:00:04:01	ARP	42	192.168.1.1 is at fe:fd:00:00:03:02

SimNet3

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:01:01	Broadcast	ARP	42	Who has 10.0.0.2? Tell 10.0.0.1
2	0.000124590	fe:fd:00:00:03:01	fe:fd:00:00:01:01	ARP	42	10.0.0.2 is at fe:fd:00:00:03:01
3	0.000219651	192.168.0.254	192.168.1.254	ICMP	98	Echo (ping) request id=0xa504, seq=1/25
4	0.021266692	192.168.1.254	192.168.0.254	ICMP	98	Echo (ping) reply id=0xa504, seq=1/25
5	5.032176074	fe:fd:00:00:03:01	fe:fd:00:00:01:01	ARP	42	Who has 10.0.0.1? Tell 10.0.0.2
6	5.032265930	fe:fd:00:00:01:01	fe:fd:00:00:03:01	ARP	42	10.0.0.1 is at fe:fd:00:00:01:01

host1:~# arp -n

```
host1:~# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.0.1              ether   FE:FD:00:00:01:02   C                     eth1
```

router1:~# arp -n

```
router1:~# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.0.254            ether   FE:FD:00:00:02:01   C                     eth2
10.0.0.2                 ether   FE:FD:00:00:03:01   C                     eth1
```

host2:~# arp -n

```
host2:~# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.1.1              ether   FE:FD:00:00:03:02   C                     eth1
```

router2:~# arp -n

```
router2:~# arp -n
Address                  HWtype  HWaddress           Flags Mask            Iface
192.168.1.254            ether   FE:FD:00:00:04:01   C                     eth2
10.0.0.1                 ether   FE:FD:00:00:01:01   C                     eth1
```

EXERCISE 5.5

The ping wouldnt work if the route to the router1 from the host2 wasnt there but I ve already configured the default route in the routing table of host 2 so it should work:

The 2 ways of enabling this ping are:

host2:~# route add -net 0.0.0.0/0 gw 192.168.1.1 or

host2:~# route add -net 10.0.0.0/24 gw 192.168.1.1

```
router1:~# ping -c 1 192.168.1.254
PING 192.168.1.254 (192.168.1.254) 56(84) bytes of data.
64 bytes from 192.168.1.254: icmp_seq=1 ttl=63 time=0.349 ms

--- 192.168.1.254 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 0.349/0.349/0.349/0.000 ms
```

EXERCISE 5.6

Configuration of host3 and router3 is imposed by network administrators.

```
host1$ ping -c1 -r  192.168.0.1  10.0.0.3  192.168.2.254
host1$ ping -c1 10.0.0.3  192.168.2.254
host1$ ping -c1 -r 10.0.0.3  192.168.2.254
```

SImNet0

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.0.254	192.168.2.254	ICMP	110	Echo (ping) request id=0xb104, seq=1/2
2	0.044760283	fe:fd:00:00:01:02	Broadcast	ARP	42	Who has 192.168.0.254? Tell 192.168.0.1
3	0.044819068	fe:fd:00:00:02:01	fe:fd:00:00:01:02	ARP	42	192.168.0.254 is at fe:fd:00:00:02:01
4	0.044855790	192.168.2.254	192.168.0.254	ICMP	110	Echo (ping) reply id=0xb104, seq=1/2
5	373.948891321	fe:fd:00:00:02:01	Broadcast	ARP	42	Who has 192.168.0.1? Tell 192.168.0.254
6	373.948960144	fe:fd:00:00:01:02	fe:fd:00:00:02:01	ARP	42	192.168.0.1 is at fe:fd:00:00:01:02
7	373.949011700	192.168.0.254	192.168.2.254	ICMP	106	Echo (ping) request id=0xb604, seq=1/25

SimNet3

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.0.254	192.168.2.254	ICMP	110	Echo (ping) request id=0xb104, seq=1/25
2	0.034288749	fe:fd:00:00:05:01	Broadcast	ARP	42	Who has 10.0.0.1? Tell 10.0.0.3
3	0.034405578	fe:fd:00:00:01:01	fe:fd:00:00:05:01	ARP	42	10.0.0.1 is at fe:fd:00:00:01:01
4	0.034479734	192.168.2.254	192.168.0.254	ICMP	110	Echo (ping) reply id=0xb104, seq=1/25
5	373.962450052	fe:fd:00:00:01:01	Broadcast	ARP	42	Who has 10.0.0.3? Tell 10.0.0.1
6	373.962643927	fe:fd:00:00:05:01	fe:fd:00:00:01:01	ARP	42	10.0.0.3 is at fe:fd:00:00:05:01
7	373.962810854	192.168.0.254	192.168.2.254	ICMP	106	Echo (ping) request id=0xb604, seq=1/25

SImNet2

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.0.254	192.168.2.254	ICMP	110	Echo (ping) request id=0xb104, seq=1/25
2	0.013687921	fe:fd:00:00:06:01	Broadcast	ARP	42	Who has 192.168.2.1? Tell 192.168.2.254
3	0.013744907	fe:fd:00:00:05:02	fe:fd:00:00:06:01	ARP	42	192.168.2.1 is at fe:fd:00:00:05:02
4	0.013779672	192.168.2.254	192.168.0.254	ICMP	110	Echo (ping) reply id=0xb104, seq=1/25
5	373.980725441	fe:fd:00:00:05:02	Broadcast	ARP	42	Who has 192.168.2.254? Tell 192.168.2.1
6	373.980828110	fe:fd:00:00:06:01	fe:fd:00:00:05:02	ARP	42	192.168.2.254 is at fe:fd:00:00:06:01
7	373.980866856	192.168.0.254	192.168.2.254	ICMP	106	Echo (ping) request id=0xb604, seq=1/25
8	373.980903936	192.168.2.254	192.168.0.254	ICMP	106	Echo (ping) reply id=0xb604, seq=1/25
9	378.993096393	fe:fd:00:00:06:01	fe:fd:00:00:05:02	ARP	42	Who has 192.168.2.1? Tell 192.168.2.254
10	378.993202086	fe:fd:00:00:05:02	fe:fd:00:00:06:01	ARP	42	192.168.2.1 is at fe:fd:00:00:05:02

First ping works, from the second one only arrives the request to host3, last one nothing is sended.

The command -r its used to stablish the current destination IP that has to be used and to store an IP of the reverse path. The second ping only has the last route to return and the last one doesnt have the first step to send the ping so it says “network unreachable”.

EXERCISE 5.7

```
phyhost$ simctl ip-routing exec netconf
```

SimNet4

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:07:02	Broadcast	ARP	42	Who has 203.0.113.200? Tell 203.0.113.4
2	0.000066787	fe:fd:00:00:08:01	fe:fd:00:00:07:02	ARP	42	203.0.113.200 is at fe:fd:00:00:08:01
3	0.000104562	192.168.0.254	203.0.113.200	ICMP	98	Echo (ping) request id=0x9004, seq=1/25

I suppose it is cause host1 has a private address and router4 cannot provide it.

EXERCISE 5.8

```
r4# iptables -t nat -F
r4# iptables -t nat -A POSTROUTING -s 192.168.0.254 -o eth2 -j SNAT --to-source 203.0.113.5
r4# ifconfig eth2:0 203.0.113.5/24
```

```
host1# ping -c1 203.0.113.200
host1# lynx http://203.0.113.200
```

SimNet4

1	0.000000000	fe:fd:00:00:07:02	Broadcast	ARP	42 Who has 203.0.113.200? Tell 203.0.113.5
2	0.000062318	fe:fd:00:00:08:01	fe:fd:00:00:07:02	ARP	42 203.0.113.200 is at fe:fd:00:00:08:01
3	0.000100935	203.0.113.5	203.0.113.200	ICMP	98 Echo (ping) request id=0x9504, seq=1/25
4	0.000138695	203.0.113.200	203.0.113.5	ICMP	98 Echo (ping) reply id=0x9504, seq=1/25
5	5.004301791	fe:fd:00:00:08:01	fe:fd:00:00:07:02	ARP	42 Who has 203.0.113.5? Tell 203.0.113.200
6	5.004442041	fe:fd:00:00:07:02	fe:fd:00:00:08:01	ARP	42 203.0.113.5 is at fe:fd:00:00:07:02
7	68.961906561	203.0.113.5	203.0.113.200	TCP	74 4080 → 80 [SYN] Seq=0 Win=5840 Len=0 MSS
8	68.962012849	203.0.113.200	203.0.113.5	TCP	74 80 → 4080 [SYN, ACK] Seq=0 Ack=1 Win=579
9	68.962275898	203.0.113.5	203.0.113.200	TCP	66 4080 → 80 [ACK] Seq=1 Ack=1 Win=5840 Len
10	68.983278871	203.0.113.5	203.0.113.200	HTTP	287 GET / HTTP/1.0
11	68.983408803	203.0.113.200	203.0.113.5	TCP	66 80 → 4080 [ACK] Seq=1 Ack=222 Win=6864 L
12	69.005100407	203.0.113.200	203.0.113.5	HTTP	419 HTTP/1.1 200 OK (text/html)
13	69.005407646	203.0.113.5	203.0.113.200	TCP	66 4080 → 80 [ACK] Seq=222 Ack=354 Win=6912
14	69.005754730	203.0.113.200	203.0.113.5	TCP	66 80 → 4080 [FIN, ACK] Seq=354 Ack=222 Win
15	69.051778268	203.0.113.5	203.0.113.200	TCP	66 4080 → 80 [ACK] Seq=222 Ack=355 Win=6912
16	69.051968385	203.0.113.5	203.0.113.200	TCP	66 4080 → 80 [FIN, ACK] Seq=222 Ack=355 Win
17	69.052026587	203.0.113.200	203.0.113.5	TCP	66 80 → 4080 [ACK] Seq=355 Ack=223 Win=6864
18	73.961063261	fe:fd:00:00:07:02	fe:fd:00:00:08:01	ARP	42 Who has 203.0.113.200? Tell 203.0.113.4
19	73.961143669	fe:fd:00:00:08:01	fe:fd:00:00:07:02	ARP	42 203.0.113.200 is at fe:fd:00:00:08:01

Lynx is a fully-featured World Wide Web (WWW) client for users running cursor-addressable, character-cell display devices. It will display hypertext markup language (HTML) documents containing links to files residing on the local system, as well as files residing on remote systems running Gopher, HTTP, FTP, WAIS, and NNTP servers.

EXERCISE 6

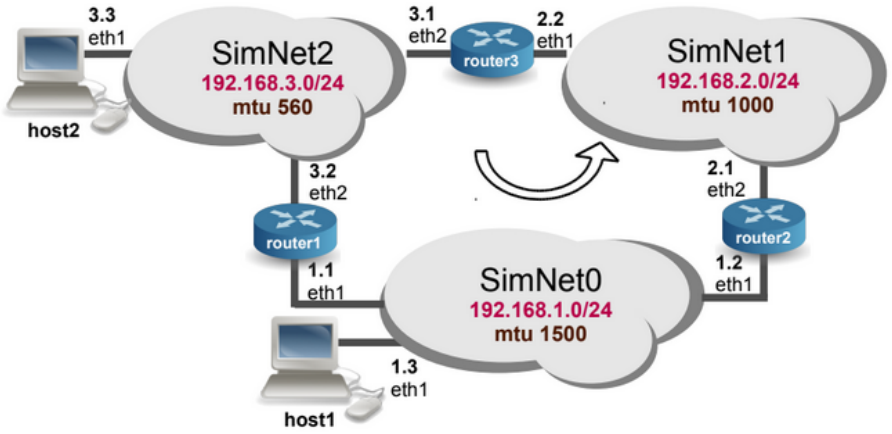


Figure 5: Network Topology for ICMP Testing.

```
phyhost$ simctl icmp start
```

router1:~# ifconfig eth1 192.168.1.1/24 mtu 1500
router1:~# ifconfig eth2 192.168.3.2/24 mtu 560
router2:~# ifconfig eth1 192.168.1.2/24 mtu 1500
router2:~# ifconfig eth2 192.168.2.1/24 mtu 1000
router3:~# ifconfig eth1 192.168.2.2/24 mtu 1000
router3:~# ifconfig eth2 192.168.3.1/24 mtu 560
host1:~# ifconfig eth1 192.168.1.3/24 mtu 1500
host2:~# ifconfig eth1 192.168.3.3/24 mtu 560

router1:~# route add -net 0.0.0.0/0 gw 192.168.1.2
router2:~# route add -net 0.0.0.0/0 gw 192.168.2.2

router3:~# route add -net 0.0.0.0/0 gw 192.168.3.2
host1:~# route add -net 0.0.0.0/0 gw 192.168.1.2
host2:~# route add -net 0.0.0.0/0 gw 192.168.3.2

A.1)
host1->(SimNet0)->router2->(SimNet1)-> router3->(SImNet2)->host2
A.2)
host2->(SimNet2)->router1->(SImNet0)->host1
A.3)

```
host1# ping -c 1 192.168.3.3
```

SimNet0

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:04:01	Broadcast	ARP	42	Who has 192.168.1.2? Tell 192.168.1.3
2	0.000107421	fe:fd:00:00:02:01	fe:fd:00:00:04:01	ARP	42	192.168.1.2 is at fe:fd:00:00:02:01
3	0.000223477	192.168.1.3	192.168.3.3	ICMP	98	Echo (ping) request id=0x8b04, seq=1/25
4	0.068235061	fe:fd:00:00:01:01	Broadcast	ARP	42	Who has 192.168.1.3? Tell 192.168.1.1
5	0.068328070	fe:fd:00:00:04:01	fe:fd:00:00:01:01	ARP	42	192.168.1.3 is at fe:fd:00:00:04:01
6	0.068387818	192.168.3.3	192.168.1.3	ICMP	98	Echo (ping) reply id=0x8b04, seq=1/25

SimNet1

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:02:02	Broadcast	ARP	42	Who has 192.168.2.2? Tell 192.168.2.1
2	0.000106355	fe:fd:00:00:03:01	fe:fd:00:00:02:02	ARP	42	192.168.2.2 is at fe:fd:00:00:03:01
3	0.000166012	192.168.1.3	192.168.3.3	ICMP	98	Echo (ping) request id=0x8b04, seq=1/25

SimNet2

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:03:02	Broadcast	ARP	42	Who has 192.168.3.3? Tell 192.168.3.1
2	0.000099299	fe:fd:00:00:05:01	fe:fd:00:00:03:02	ARP	42	192.168.3.3 is at fe:fd:00:00:05:01
3	0.000182976	192.168.1.3	192.168.3.3	ICMP	98	Echo (ping) request id=0x8b04, seq=1/25
4	0.012118764	fe:fd:00:00:05:01	Broadcast	ARP	42	Who has 192.168.3.2? Tell 192.168.3.3
5	0.012190288	fe:fd:00:00:01:02	fe:fd:00:00:05:01	ARP	42	192.168.3.2 is at fe:fd:00:00:01:02
6	0.012231122	192.168.3.3	192.168.1.3	ICMP	98	Echo (ping) reply id=0x8b04, seq=1/25

A.4)
the icmp paquets size is 98 (26 phy header + 20 IP+ 4 header icmp +48 data).
Its not necessary to fragmentate.

A.5)

```
Internet Protocol Version 4, Src: 192.168.1.3, Dst: 192.168.3.3
    0100 .... = Version: 4
    .... 0101 = Header Length: 20 bytes (5)
  ▸ Differentiated Services Field: 0x00 (DSCP: CS0, ECN: Not-ECT)
    Total Length: 84
    Identification: 0x0000 (0)
  ▸ Flags: 0x4000, Don't fragment
    Time to live: 64
    Protocol: ICMP (1)
    Header checksum: 0xb552 [validation disabled]
    [Header checksum status: Unverified]
    Source: 192.168.1.3
    Destination: 192.168.3.3
Internet Control Message Protocol
```

A.6)

```
host1# ip route flush cache
host1# ping -c 2 -s 900 192.168.3.3
```

First paquet is lost

SImNet0

1	0.000000000	fe:fd:00:00:04:01	Broadcast	ARP	42 Who has 192.168.1.2? Tell 192.168.1.3
2	0.000109937	fe:fd:00:00:02:01	fe:fd:00:00:04:01	ARP	42 192.168.1.2 is at fe:fd:00:00:02:01
3	0.000179504	192.168.1.3	192.168.3.3	ICMP	942 Echo (ping) request id=0x9504, seq=1/25
4	0.037464872	192.168.3.1	192.168.1.3	ICMP	574 Destination unreachable (Fragmentation n
5	0.999669373	192.168.1.3	192.168.3.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, of
6	1.000101121	192.168.1.3	192.168.3.3	ICMP	406 Echo (ping) request id=0x9504, seq=2/51
7	1.041785147	192.168.3.3	192.168.1.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, of
8	1.042535753	192.168.3.3	192.168.1.3	ICMP	406 Echo (ping) reply id=0x9504, seq=2/51
9	5.044499807	fe:fd:00:00:01:01	fe:fd:00:00:04:01	ARP	42 Who has 192.168.1.3? Tell 192.168.1.1
10	5.044868189	fe:fd:00:00:04:01	fe:fd:00:00:01:01	ARP	42 192.168.1.3 is at fe:fd:00:00:04:01

26 phy +20 ip + 4 header+ 892 data

SimNet1

1	0.000000000	fe:fd:00:00:02:02	Broadcast	ARP	42 Who has 192.168.2.2? Tell 192.168.2.1
2	0.000067692	fe:fd:00:00:03:01	fe:fd:00:00:02:02	ARP	42 192.168.2.2 is at fe:fd:00:00:03:01
3	0.000108571	192.168.1.3	192.168.3.3	ICMP	942 Echo (ping) request id=0x9504, seq=1/25
4	0.983537830	192.168.1.3	192.168.3.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, of
5	0.983962665	192.168.1.3	192.168.3.3	ICMP	406 Echo (ping) request id=0x9504, seq=2/51

First paquet doesnt get a reply.

SimNet2

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe:fd:00:00:03:02	Broadcast	ARP	42	Who has 192.168.3.2? Tell 192.168.3.1
2	0.000098387	fe:fd:00:00:01:02	fe:fd:00:00:03:02	ARP	42	192.168.3.2 is at fe:fd:00:00:01:02
3	0.000143078	192.168.3.1	192.168.1.3	ICMP	574	Destination unreachable (Fragmentation n
4	0.983599923	fe:fd:00:00:03:02	Broadcast	ARP	42	Who has 192.168.3.3? Tell 192.168.3.1
5	0.983772344	fe:fd:00:00:05:01	fe:fd:00:00:03:02	ARP	42	192.168.3.3 is at fe:fd:00:00:05:01
6	0.984225635	192.168.1.3	192.168.3.3	IPv4	570	Fragmented IP protocol (proto=ICMP 1, of
7	0.984504067	192.168.1.3	192.168.3.3	ICMP	406	Echo (ping) request id=0x9504, seq=2/51
8	1.003802252	fe:fd:00:00:05:01	Broadcast	ARP	42	Who has 192.168.3.2? Tell 192.168.3.3
9	1.004040525	fe:fd:00:00:01:02	fe:fd:00:00:05:01	ARP	42	192.168.3.2 is at fe:fd:00:00:01:02
10	1.004298655	192.168.3.3	192.168.1.3	IPv4	570	Fragmented IP protocol (proto=ICMP 1, of
11	1.004797927	192.168.3.3	192.168.1.3	ICMP	406	Echo (ping) reply id=0x9504, seq=2/51

Captured the error frame from router3 of the 1st paquet.

A.7) Cause next network has 560 of mtu.
SImNet0

```
▼ Internet Control Message Protocol
    Type: 3 (Destination unreachable)
    Code: 4 (Fragmentation needed)
    Checksum: 0x7e14 [correct]
    [Checksum Status: Good]
    Unused: 0000
    MTU of next hop: 560
```

The first icmp paquet caused this error trying to reach the network with mtu=560. Obviously router3 sended the message. So, the way followed: router3-> (SImNet2)-> router1-> (SImNet0)->host1

A.8)
SimNet0, frame 6:

```
▼ Flags: 0x0043
    0... .... .... .... = Reserved bit: Not set
    .0.. .... .... .... = Don't fragment: Not set
    ..0. .... .... .... = More fragments: Not set
    ...0 0000 0100 0011 = Fragment offset: 67
```

A.9)
SImNet0:
IPv4: 18 phy+20 header+536 data

request:

```
▼ [2 IPv4 Fragments (908 bytes): #5(536), #6(372)]
    [Frame: 5, payload: 0-535 (536 bytes)]
    [Frame: 6, payload: 536-907 (372 bytes)]
    [Fragment count: 2]
    [Reassembled IPv4 length: 908]
    [Reassembled IPv4 data: 0800fa039504000280ce4360950208000809 0a0b0c0d0e0f...]
```

reply:

```
▼ [2 IPv4 Fragments (908 bytes): #7(536), #8(372)]
    [Frame: 7, payload: 0-535 (536 bytes)]
    [Frame: 8, payload: 536-907 (372 bytes)]
    [Fragment count: 2]
    [Reassembled IPv4 length: 908]
    [Reassembled IPv4 data: 0000020495040000280ce4360950208000809 0a0b0c0d0e0f ]
```

SimNet1
4 and 5th frame are the 2nd request paquet sended from host1

SImNet2:
As before, 6 and 7 frame are the request from host1 of the 2nd paquet and it is also captured in 10 and 11th frame the reply from host 2.

B.11)

- `-M do`: prohibits fragmentation (even local).
- `-M want`: does PMTU discovery.
- `-M dont`: does not set the DF flag.

host1:~# ping -c 1 -s 900 -M dont 192.168.3.3

```
host1:~# ping -c 1 -s 900 -M dont 192.168.3.3
PING 192.168.3.3 (192.168.3.3) 900(928) bytes of data.
908 bytes from 192.168.3.3: icmp_seq=1 ttl=63 time=67.9 ms

--- 192.168.3.3 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 67.965/67.965/67.965/0.000 ms
host1:~#
```

SImNet0

→	1	0.000000000	192.168.1.3	192.168.3.3	ICMP	942 Echo (ping) request id=0xa004, seq=1/256,
	2	0.067703665	fe:fd:00:00:01:01	Broadcast	ARP	42 Who has 192.168.1.3? Tell 192.168.1.1
	3	0.067803077	fe:fd:00:00:04:01	fe:fd:00:00:01:01	ARP	42 192.168.1.3 is at fe:fd:00:00:04:01
	4	0.067865654	192.168.3.3	192.168.1.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, off=
←	5	0.067872327	192.168.3.3	192.168.1.3	ICMP	406 Echo (ping) reply id=0xa004, seq=1/256,
	6	5.002425539	fe:fd:00:00:04:01	fe:fd:00:00:02:01	ARP	42 Who has 192.168.1.2? Tell 192.168.1.3
	7	5.002574731	fe:fd:00:00:02:01	fe:fd:00:00:04:01	ARP	42 192.168.1.2 is at fe:fd:00:00:02:01

SImNet1

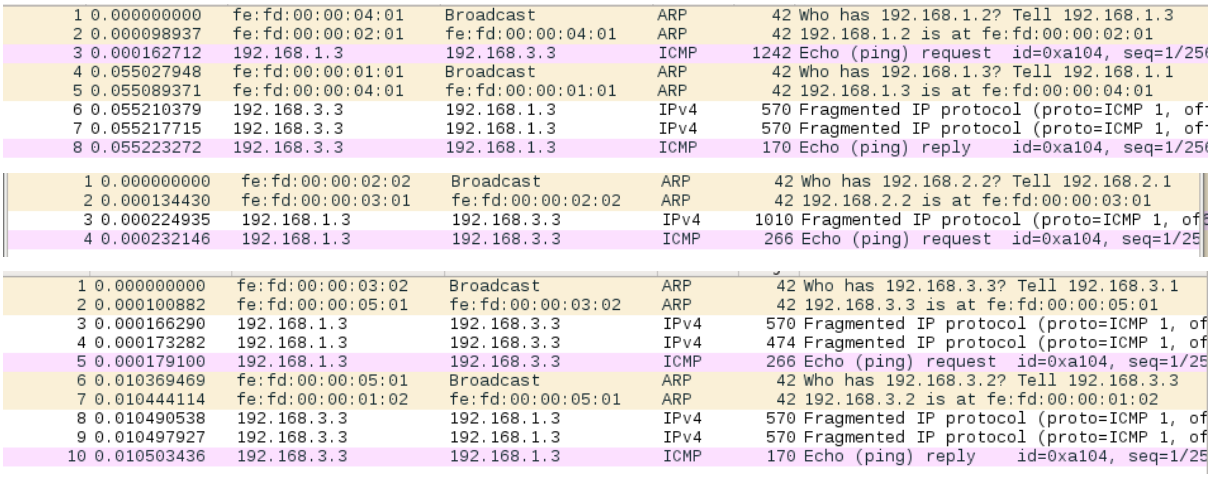
1	0.000000000	fe:fd:00:00:02:02	Broadcast	ARP	42 Who has 192.168.2.2? Tell 192.168.2.1
2	0.000066625	fe:fd:00:00:03:01	fe:fd:00:00:02:02	ARP	42 192.168.2.2 is at fe:fd:00:00:03:01
3	0.000107739	192.168.1.3	192.168.3.3	ICMP	942 Echo (ping) request id=0xa004, seq=1/

SimNet2

1	0.000000000	fe:fd:00:00:03:02	Broadcast	ARP	42 Who has 192.168.3.3? Tell 192.168.3.1
2	0.000143746	fe:fd:00:00:05:01	fe:fd:00:00:03:02	ARP	42 192.168.3.3 is at fe:fd:00:00:05:01
3	0.000222601	192.168.1.3	192.168.3.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, o
4	0.000230096	192.168.1.3	192.168.3.3	ICMP	406 Echo (ping) request id=0xa004, seq=1/2
5	0.020014553	fe:fd:00:00:05:01	Broadcast	ARP	42 Who has 192.168.3.2? Tell 192.168.3.3
6	0.020126492	fe:fd:00:00:01:02	fe:fd:00:00:05:01	ARP	42 192.168.3.2 is at fe:fd:00:00:01:02
7	0.020184163	192.168.3.3	192.168.1.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, o
8	0.020191054	192.168.3.3	192.168.1.3	ICMP	406 Echo (ping) reply id=0xa004, seq=1/2

Fragmentation occurs when needed, in SimNet2. Thats why request its sended in one packet unti it reaches the last network. The reply starts fragmentation and its resended like that to host1 through SimNet2 and 0.

B.12)
The fragmentation will occur when reaching SimNet1 cause its mtu is 1000 bytes. Besides The first packet is fragmented two times to arrive to SimNet2.

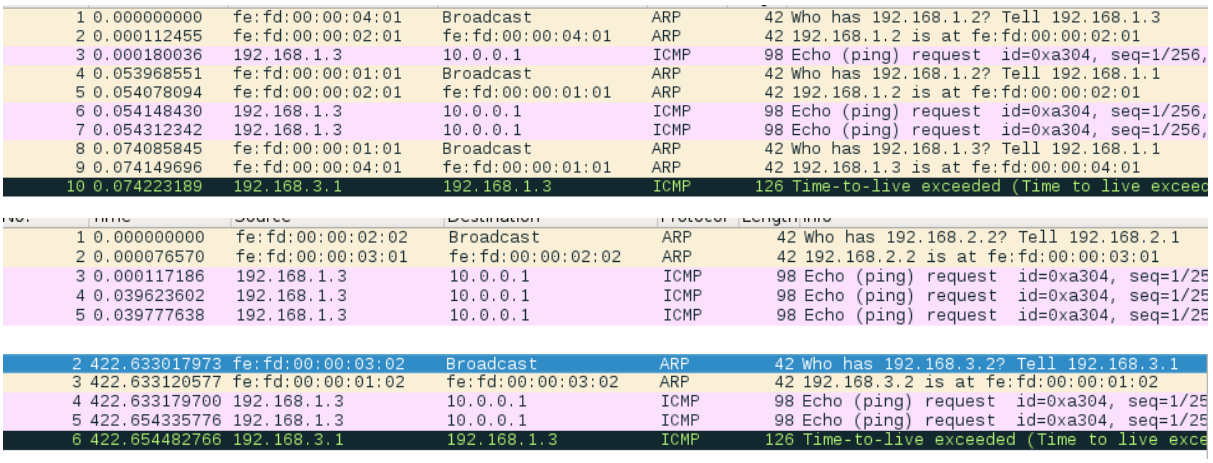


1	0.000000000	fe:fd:00:00:04:01	Broadcast	ARP	42 Who has 192.168.1.2? Tell 192.168.1.3
2	0.000098937	fe:fd:00:00:02:01	fe:fd:00:00:04:01	ARP	42 192.168.1.2 is at fe:fd:00:00:02:01
3	0.000162712	192.168.1.3	192.168.3.3	ICMP	1242 Echo (ping) request id=0xa104, seq=1/256
4	0.055027948	fe:fd:00:00:01:01	Broadcast	ARP	42 Who has 192.168.1.3? Tell 192.168.1.1
5	0.055089371	fe:fd:00:00:04:01	fe:fd:00:00:01:01	ARP	42 192.168.1.3 is at fe:fd:00:00:04:01
6	0.055210379	192.168.3.3	192.168.1.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, of
7	0.055217715	192.168.3.3	192.168.1.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, of
8	0.055223272	192.168.3.3	192.168.1.3	ICMP	170 Echo (ping) reply id=0xa104, seq=1/256

1	0.000000000	fe:fd:00:00:02:02	Broadcast	ARP	42 Who has 192.168.2.2? Tell 192.168.2.1
2	0.000134430	fe:fd:00:00:03:01	fe:fd:00:00:02:02	ARP	42 192.168.2.2 is at fe:fd:00:00:03:01
3	0.000224935	192.168.1.3	192.168.3.3	IPv4	1010 Fragmented IP protocol (proto=ICMP 1, of
4	0.000232146	192.168.1.3	192.168.3.3	ICMP	266 Echo (ping) request id=0xa104, seq=1/25

1	0.000000000	fe:fd:00:00:03:02	Broadcast	ARP	42 Who has 192.168.3.3? Tell 192.168.3.1
2	0.000100882	fe:fd:00:00:05:01	fe:fd:00:00:03:02	ARP	42 192.168.3.3 is at fe:fd:00:00:05:01
3	0.000166290	192.168.1.3	192.168.3.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, of
4	0.000173282	192.168.1.3	192.168.3.3	IPv4	474 Fragmented IP protocol (proto=ICMP 1, of
5	0.000179100	192.168.1.3	192.168.3.3	ICMP	266 Echo (ping) request id=0xa104, seq=1/25
6	0.010369469	fe:fd:00:00:05:01	Broadcast	ARP	42 Who has 192.168.3.2? Tell 192.168.3.3
7	0.010444114	fe:fd:00:00:01:02	fe:fd:00:00:05:01	ARP	42 192.168.3.2 is at fe:fd:00:00:01:02
8	0.010490538	192.168.3.3	192.168.1.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, of
9	0.010497927	192.168.3.3	192.168.1.3	IPv4	570 Fragmented IP protocol (proto=ICMP 1, of
10	0.010503436	192.168.3.3	192.168.1.3	ICMP	170 Echo (ping) reply id=0xa104, seq=1/25

C.13)
Pues npi la verdad yo creo q no va a rechear el network. Supongo q router 3 dira chao chao
C.14)
rout3->rou1->host1



1	0.000000000	fe:fd:00:00:04:01	Broadcast	ARP	42 Who has 192.168.1.2? Tell 192.168.1.3
2	0.000112455	fe:fd:00:00:02:01	fe:fd:00:00:04:01	ARP	42 192.168.1.2 is at fe:fd:00:00:02:01
3	0.000180036	192.168.1.3	10.0.0.1	ICMP	98 Echo (ping) request id=0xa304, seq=1/256,
4	0.053968551	fe:fd:00:00:01:01	Broadcast	ARP	42 Who has 192.168.1.2? Tell 192.168.1.1
5	0.054078094	fe:fd:00:00:02:01	fe:fd:00:00:01:01	ARP	42 192.168.1.2 is at fe:fd:00:00:02:01
6	0.054148430	192.168.1.3	10.0.0.1	ICMP	98 Echo (ping) request id=0xa304, seq=1/256,
7	0.054312342	192.168.1.3	10.0.0.1	ICMP	98 Echo (ping) request id=0xa304, seq=1/256,
8	0.074085845	fe:fd:00:00:01:01	Broadcast	ARP	42 Who has 192.168.1.3? Tell 192.168.1.1
9	0.074149696	fe:fd:00:00:04:01	fe:fd:00:00:01:01	ARP	42 192.168.1.3 is at fe:fd:00:00:04:01
10	0.074223189	192.168.3.1	192.168.1.3	ICMP	126 Time-to-live exceeded (Time to live exceed

1	0.000000000	fe:fd:00:00:02:02	Broadcast	ARP	42 Who has 192.168.2.2? Tell 192.168.2.1
2	0.000076570	fe:fd:00:00:03:01	fe:fd:00:00:02:02	ARP	42 192.168.2.2 is at fe:fd:00:00:03:01
3	0.000117186	192.168.1.3	10.0.0.1	ICMP	98 Echo (ping) request id=0xa304, seq=1/25
4	0.039623602	192.168.1.3	10.0.0.1	ICMP	98 Echo (ping) request id=0xa304, seq=1/25
5	0.039777638	192.168.1.3	10.0.0.1	ICMP	98 Echo (ping) request id=0xa304, seq=1/25

2	422.633017973	fe:fd:00:00:03:02	Broadcast	ARP	42 Who has 192.168.3.2? Tell 192.168.3.1
3	422.633120577	fe:fd:00:00:01:02	fe:fd:00:00:03:02	ARP	42 192.168.3.2 is at fe:fd:00:00:01:02
4	422.633179700	192.168.1.3	10.0.0.1	ICMP	98 Echo (ping) request id=0xa304, seq=1/25
5	422.654335776	192.168.1.3	10.0.0.1	ICMP	98 Echo (ping) request id=0xa304, seq=1/25
6	422.654482766	192.168.3.1	192.168.1.3	ICMP	126 Time-to-live exceeded (Time to live exce

C.15)
The ping is sended to the defaults routes until its ttl is gone. host1->rout2->rout3->rout1-> rout2->rout3->rout1->rout2->rout3->TTL Error-> rout1-> host1

C.16)
The packet ttl error will occur on the next step: router1.