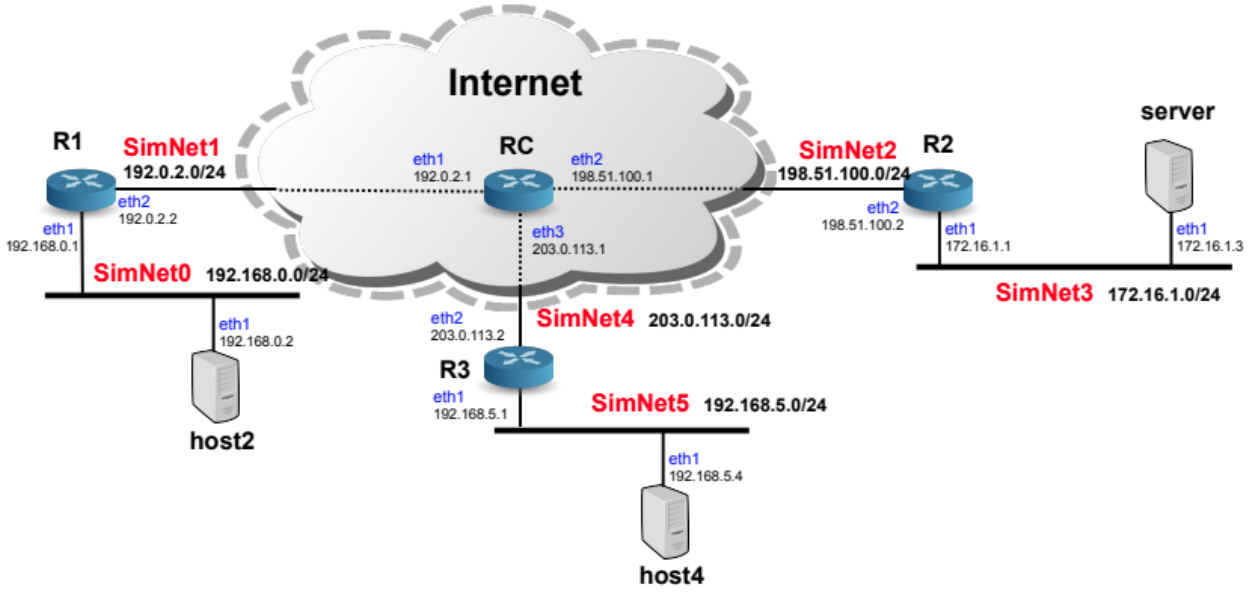
P10: Multicast



0.3 Starting the scenario using simctl

//from terminal
simctl ipmulticast sh
start

//from terminal
host all-systems.mcast.net
estamos preguntando al DNS la dirección que corresponde al nombre all-system.mcast.net.

host 224.0.0.22
esta dirección concuerda con el nombre igmp.mcast.net que será usado para identificar router cuando se use IGMP**.**

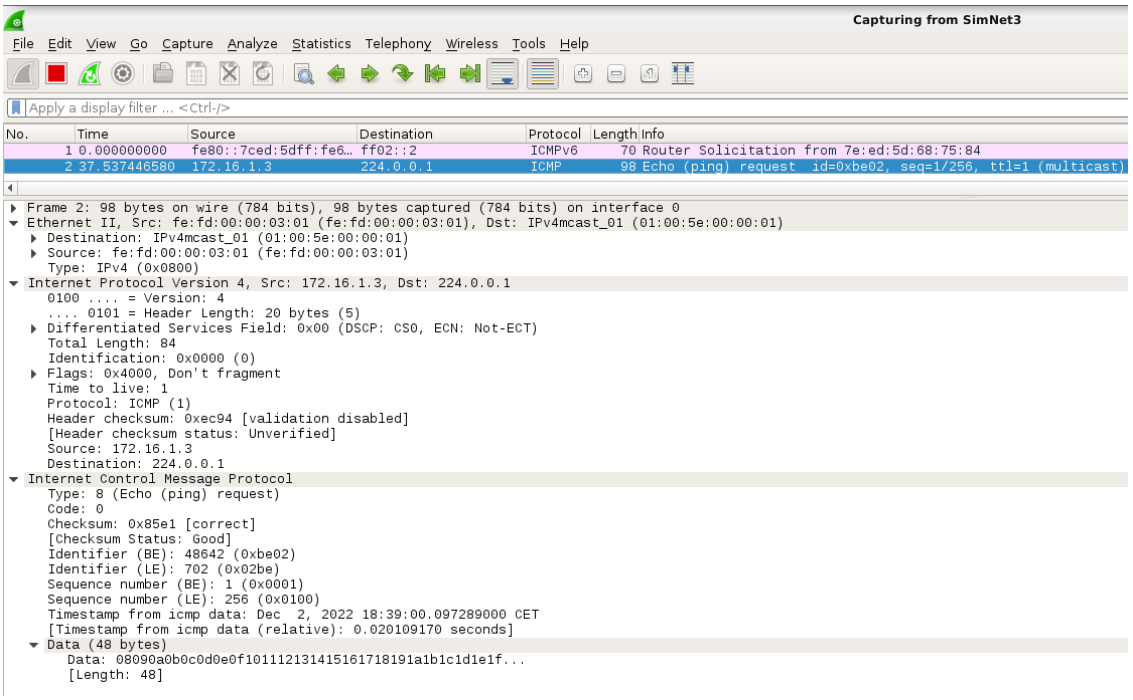
```
telem@debian:~$ host all-systems.mcast.net
all-systems.mcast.net has address 224.0.0.1
telem@debian:~$ host 224.0.0.22
22.0.0.224.in-addr.arpa domain name pointer igmp.mcast.net.
```

0.5 MAC multicast addresses

//from server
ping -c1 224.0.0.1

```
server:~# ping -c1 224.0.0.1
PING 224.0.0.1 (224.0.0.1) 56(84) bytes of data.

--- 224.0.0.1 ping statistics ---
1 packets transmitted, 0 received, 100% packet loss, time 0ms
```



1. How many ICMP packets can you see in SimNet3? What type of messages?
Un echo request multicast.

2. In the IP header, which is the TTL of this packets? What does this mean?
ttl=1, solo llega hasta R2 y ahi se pierde.

3. In the IP header, which are the source and destination addresses?
ip.src == 172.16.1.3, ip.dst == 224.0.0.1 (de server al multicast).

4. In the Ethernet header, which are the source and destination addresses?
eth.src == fe:fd:00:00:03:01, eth.dst == 01:00:5e:00:00:01.

5. Can you see the direct mapping in the MAC destination address?
Si porque direct mapping es dado la ip obtengo la dirección mac.
Entonces veo que el MAC se obtiene con la ip.

As you can see, the destination MAC address is constructed by using the prefix 01:00:5E (in hex). The 24 remaining bits correspond to 0+23 least significant bits of the multicast IP

address. In the particular case of the IP address 224.0.0.1, this corresponds to the MAC address 01:00:5E:00:00:01.
Put a wireshark listening in SimNet3.
• Execute the following command in the server:
//from server
ping -c1 232.0.0.1

1. In this ICMP packet, which is the destination MAC addresses?
eth.dst == 01:00:5e:00:00:01

2. Can you see any ambiguity in this mapping? Which other addresses cause also this ambiguity?
eth.dst == 01:00:5e:00:00:01. tienen la misma mac que el apartado anterior.

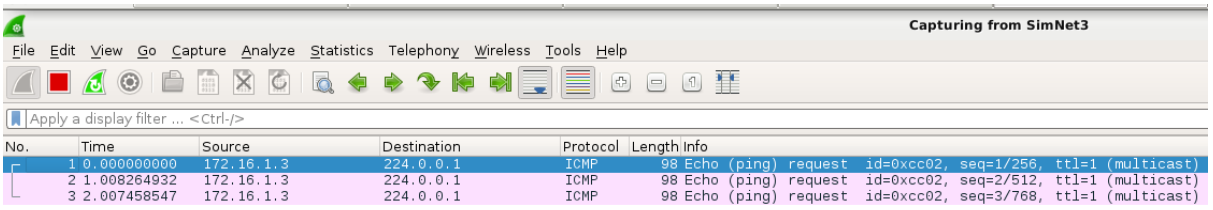
3. How can the system resolve this ambiguity?
Se resuelve porque la ip son distintas, da igual que sea la misma mac.
ip.dst == 232.0.0.1.

• Put a wireshark listening in SimNet3.
• Execute the following commands in the server:
//from server
echo 0 > /proc/sys/net/ipv4/icmp_echo_ignore_broadcasts
si esto esta en 1 no recibes el ping replay
descativar el flag del icmp_echo_ignore_broadcasts

ping -c3 224.0.0.1

```
server:~# ping -c3 224.0.0.1
PING 224.0.0.1 (224.0.0.1) 56(84) bytes of data.
64 bytes from 172.16.1.3: icmp_seq=1 ttl=64 time=0.102 ms
64 bytes from 172.16.1.3: icmp_seq=2 ttl=64 time=0.062 ms
64 bytes from 172.16.1.3: icmp_seq=3 ttl=64 time=0.064 ms

--- 224.0.0.1 ping statistics ---
3 packets transmitted, 3 received, 0% packet loss, time 2008ms
rtt min/avg/max/mdev = 0.062/0.076/0.102/0.018 ms
```



Is the ping working? Who is answering the ping?
Sí, porque te estás haciendo un ping a ti mismo. (loopback)

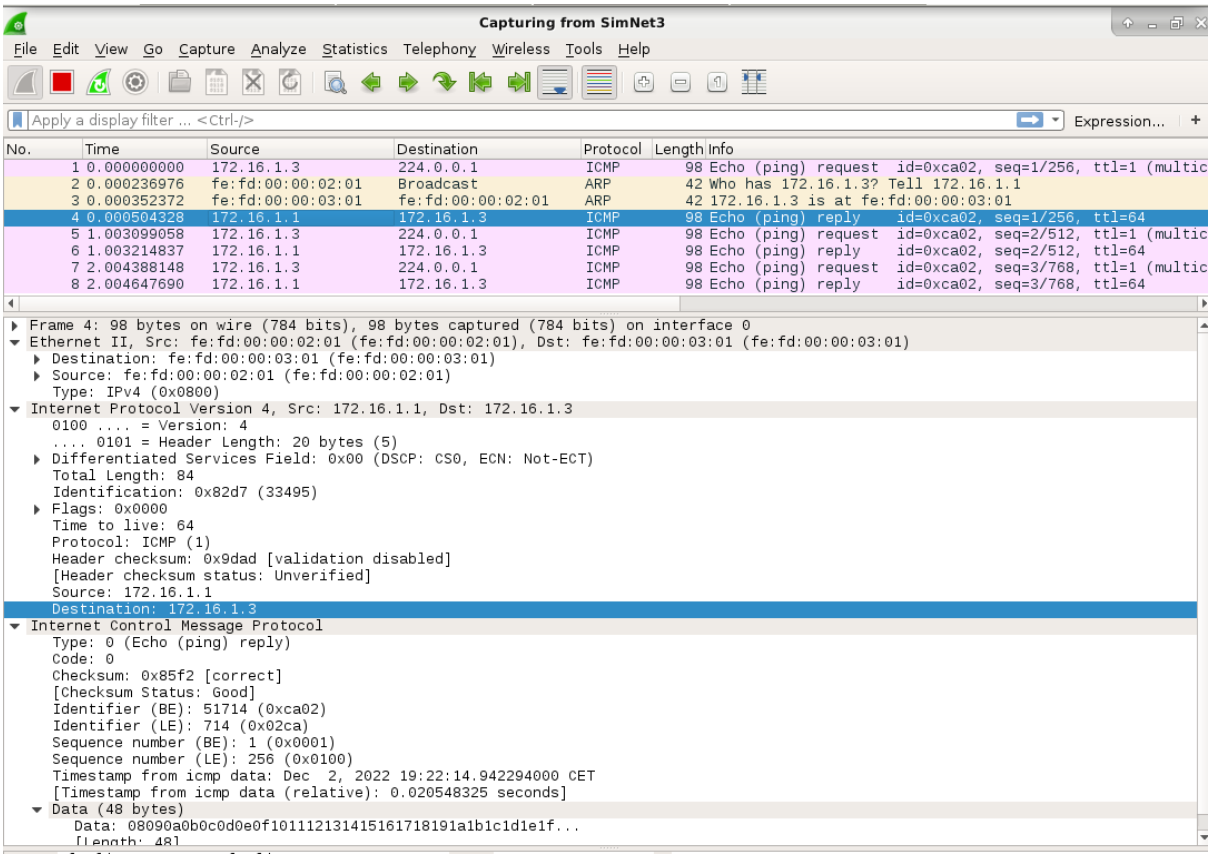
Can you see any reply message in SimNet3?
No

•Now dissable the same flag in R2, and ping from server:
//from R2
echo 0 > /proc/sys/net/ipv4/icmp_echo_ignore_broadcasts

//from server
ping -c3 224.0.0.1

```
server:~# ping -c3 224.0.0.1
PING 224.0.0.1 (224.0.0.1) 56(84) bytes of data.
64 bytes from 172.16.1.3: icmp_seq=1 ttl=64 time=0.052 ms
64 bytes from 172.16.1.1: icmp_seq=1 ttl=64 time=0.663 ms (DUP!)
64 bytes from 172.16.1.3: icmp_seq=2 ttl=64 time=0.064 ms
64 bytes from 172.16.1.1: icmp_seq=2 ttl=64 time=0.354 ms (DUP!)
64 bytes from 172.16.1.3: icmp_seq=3 ttl=64 time=0.075 ms

--- 224.0.0.1 ping statistics ---
3 packets transmitted, 3 received, +2 duplicates, 0% packet loss, time 2004ms
rtt min/avg/max/mdev = 0.052/0.241/0.663/0.239 ms
```



1. Who is now answering to the ping?
fe:fd:00:00:02:01, ip.src == 172.16.1.1, (eth1 de R2).

2. Can you see any reply message in SimNet3? 3. Are the answer packets sent in a multicast way?
Hay 3 respuestas, una por cada echo request. Estos echo request están enviados de forma unicast al origen.

0.6 Multicast transmission in a subnet

0.6.1 Multicast configuration

//from server
cat /proc/net/igmp #fichero que contiene los grupos en la cual el host se ha unido.
netstat -gn

```
server:~# cat /proc/net/igmp
Idx     Device    : Count Querier       Group    Users Timer    Reporter
1       lo        :     1      V3
                              010000E0     1 0:00000000              0
5       eth1      :     1      V3
                              010000E0     1 0:00000000              0
```

Esta configuracion, nos dice que las interfaces lo y eth1 estan unidos en 0100000E0 (1.0.0.224 en hexadecimal).

```
server:~# cat /proc/net/ip_mr_vif
Interface      BytesIn  PktsIn  BytesOut PktsOut Flags Local    Remote
server:~# cat /proc/net/ip_mr_cache
Group    Origin   Iif     Pkts    Bytes    Wrong Oifs
```

```
server:~# netstat -gn
IPv6/IPv4 Group Memberships
Interface       RefCnt Group
--------------- ------ ---------------------
lo              1      224.0.0.1
eth1            1      224.0.0.1
lo              1      ff02::1
tunl0           1      ff02::1
gre0            1      ff02::1
sit0            1      ff02::1
eth1            1      ff02::1:ff00:301
eth1            1      ff02::1
```

/proc/net/ip_mr_vif : este fichero nos muestra las interfaces involucradas en la operacion multicast en el router multicast . Al principio esta vacio porque la informacion solo se ve cuando hay intercambio de tramas multicast.

/proc/net/ip_mr_cache: este fichero muestra el contenido de la cache de multicast Forwarding. Para ello usamos el comando siguiente:
ip mroute show

0.6.2 Transport protocol

TCP no soporta multicast, porque multicast no es un mecanismo orientado a conexión. Multicast se usa básicamente para audio, video streaming entre otros. Por eso las **IP multicast utilizan UDP** como protocolo de la capa de transporte.

So, which is the transport protocol to send information when using multicast?
UDP no es un protocolo fiable, hay perdidas … pero no supone un problema porque no hay control de error. En cambio TCP es problemático para multicast porque está orientado a conexión y si que tiene el control de errores y es un protocolo fiable.

0.6.3 udp-sender

udp-sender ofrece varios opciones para enviar vía broadcast o multicast, tanto unidireccional como bidireccional.
multicast group to send data: `232.43.211.234`
multicast group to control and add reliability: `225.1.2.3`

• Open another console of server, that will be used to see the status of this host meanwhile you are sending the video. Go to the HOST machine and execute:
//from terminal
simctl ipmulticast get server 1
//from server 1
cat /proc/net/igmp

```
server:~# cat /proc/net/igmp
Idx     Device    : Count Querier       Group    Users Timer    Reporter
1       lo        :     1      V3
                                010000E0     1 0:00000000              0
5       eth1      :     1      V3
                                010000E0     1 0:00000000              0
```

Esta configuracion, nos dice que las interfaces lo y eth1 estan unidos en 0100000E0 (1.0.0.224 en hexadecimal).

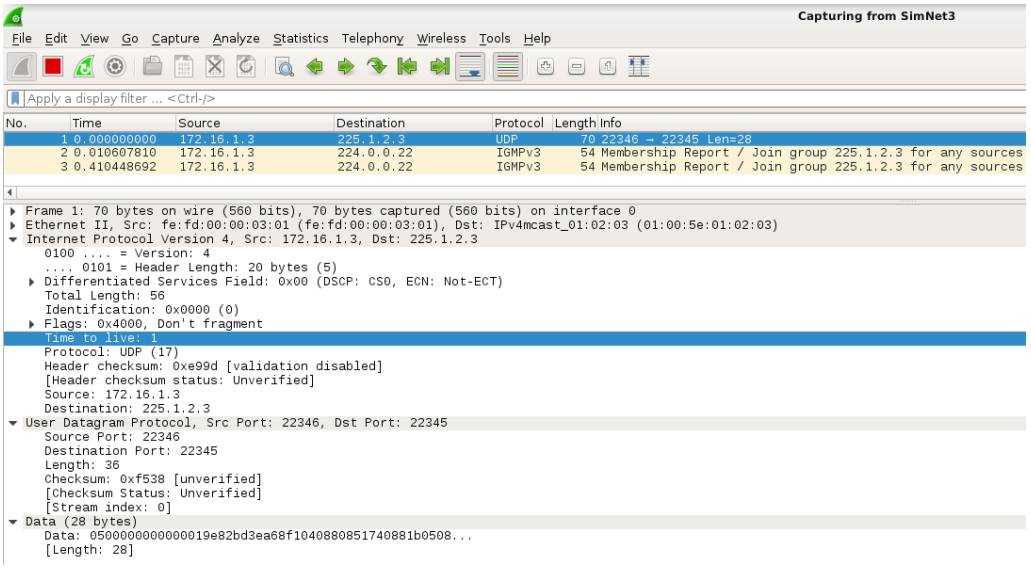
Put a wireshark listening in SimNet3.
• In this case, server will act as video server. So, go to console 0 and execute the following command:
//from server 0
udp-sender --file=./big_664.mpg --min-clients 1 --portbase 22345 --nopointopoint --interface eth1 --ttl 1 --mcast-addr 232.43.211.234 --mcast-all-addr 225.1.2.3
(hay q dar 2 veces al enter)

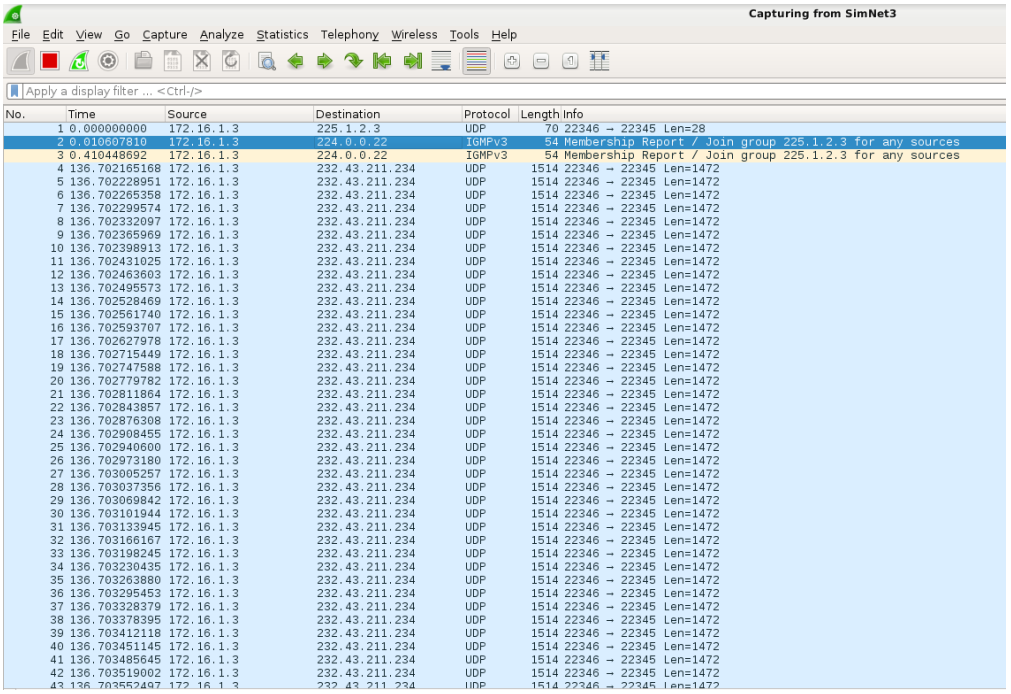
- **file:** Lee la informacion a transmitir des del file./ la ruta relativa del fichero.
- **min-clients:** se inicia automáticamente tan pronto como se haya conectado un número mínimo de clientes.
- **portbase**: puerto para UDP multicast. Default:9000.(tiene que ser igual en sender y revicer)
- **nopointopoint**: está permitido más de un receptor, aunque haya solo 1 receptor, la recepción punto a punto (unicast) no está permitido.

- **mcast-all-addr**: utiliza una dirección de multidifusión no estándar para la conexión de control (que utilizan el remitente y los receptores para "encontrarse" entre sí). Esta **no** es la dirección que se utiliza para transferir los datos.

- **mcast-addr**: utiliza la dirección dada para la multidifusión de datos. Si no se especifica, el programa derivará automáticamente una dirección de multidifusión de su propia IP (manteniendo los últimos 27 bits de la IP y luego agregando 232)

The previous command prepares server to transmit via multicast the locally stored video file big_664.mpg. Have a look to the manual of this command (man udp-sender) and explain each of the options used.





In SimNet3:
1. How many packets can you see? Which type of packets?
Hay como 130 paquetes UDP

2. In the UDP packet, which is the destination address? and the TTL?
La dirección destino es con TTL=1.ip.src == 172.16.1.3, ip.dst == 225.1.2.3

3. Which are the port numbers?
udp.srcport == 22346, udp.dstport == 22345

4. Can you see any IGMP packet? Which type of packet? Which is the IP destination address of this IGMP messages?
Si, 2(por redundancia) de tipo Membership Report/ join group(0x22). ip.dst == 224.0.0.22

Now have a look to the console 1 of server, and again see the contents of the file
//from serve 1
/proc/net/igmp.

```
server:~# cat /proc/net/igmp
Idx     Device    : Count Querier       Group    Users Timer    Reporter
1       lo        :     1      V3
                             010000E0     1 0:00000000                0
5       eth1      :     2      V3
                             030201E1     1 0:00000000                0
                             010000E0     1 0:00000000                0
```

1. Can you see any difference?
Respecto al ejercicio anterior, vemos que eth1 tiene ahora otra entrada para otro grupo.

2. What is the hex and the dot-decimal notation of the newly added multicast group?
030201E1, 0:00000000

• Go to console 0, and close the server by typing Control+C.

```
    138 12621.510866… 172.16.1.3          224.0.0.22          IGMPv3     54 Membership Report / Leave group 225.1.2.3
    139 12629.340613… 172.16.1.3          224.0.0.22          IGMPv3     54 Membership Report / Leave group 225.1.2.3
```

1. Can you see in SimNet3 any new IGMP message? Which type?
Si, IGMP de tipo, Membership Report/Leave group.

2. After closing, can you see again any change in the /proc/net/igmp file? As you can see, when closing udp-sender the sender leaves the control group by sending two IGMP Leave Messages. No answer will be sent to these messages as there is no multicast router.

```
server:~# cat /proc/net/igmp
Idx     Device    : Count Querier       Group    Users Timer    Reporter
1       lo        :     1      V3
                             010000E0     1 0:00000000                0
5       eth1      :     1      V3
                             010000E0     1 0:00000000                0
server:~#
```

Ahora el entry que se añadió antes al iniciar la trasnferencia ya no esta.

0.6.4 upd-receiver

Let us start testing udp-receiver:

• Open another console of R2, that will be used to see the status of this host meanwhile you are launching udp-receiver. Go to the HOST machine and execute:

1. Which interfaces in R2 are joined to group 224.0.0.1?

//from server R2

cat /proc/net/igmp

```
R2:~# cat /proc/net/igmp
Idx     Device    : Count Querier       Group    Users Timer    Reporter
1       lo        :     1      V3
                                010000E0     1 0:00000000                0
5       eth2      :     1      V3
                                010000E0     1 0:00000000                0
6       eth1      :     1      V3
                                010000E0     1 0:00000000                0
```

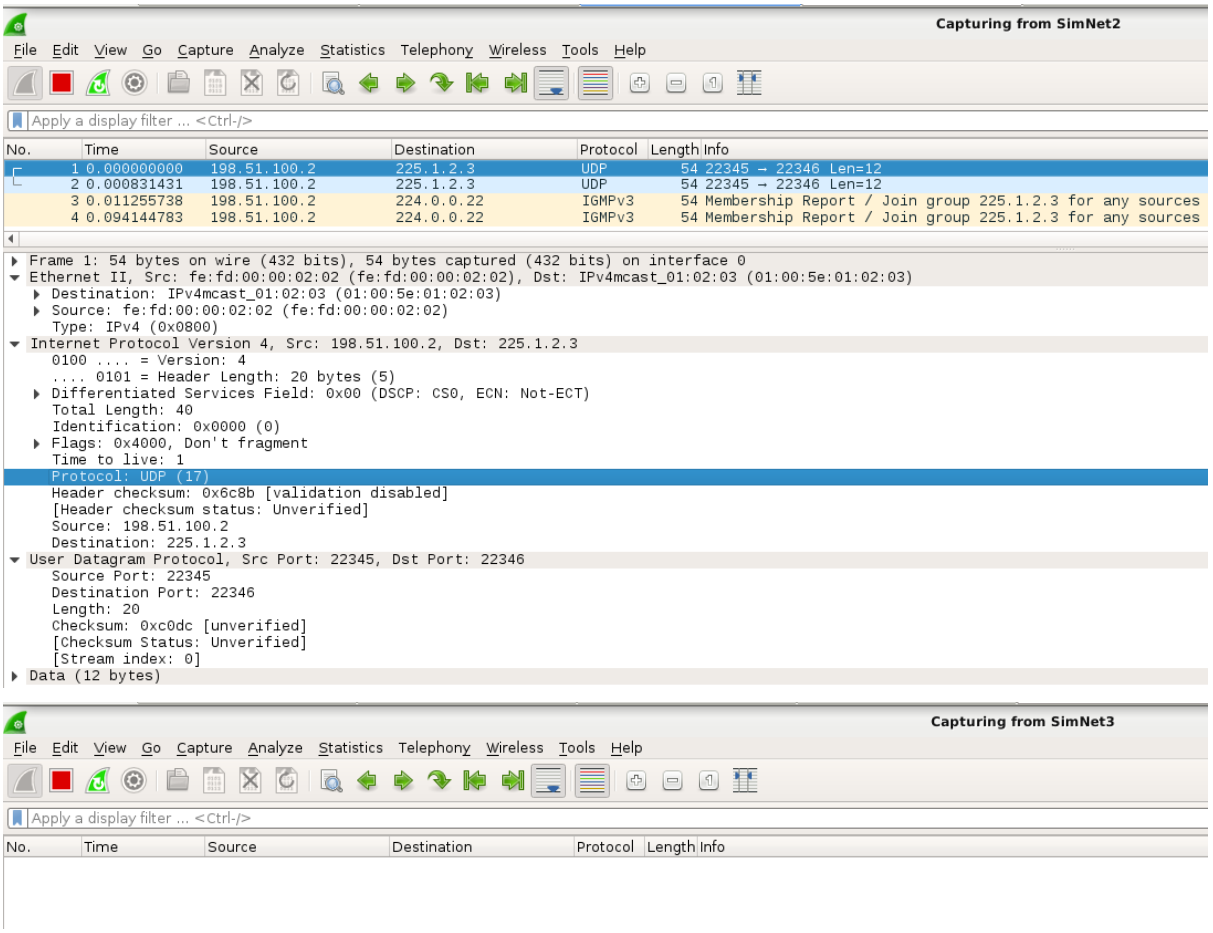
• Now open two wiresharks, one listening in SimNet2 and another one in SimNet3.

• In this case, R2 will act as a host, receiving the video. So, go to console 0 and execute the following command:

//from R2 0

udp-receiver --file=big_664.mpg --mcast-all-addr 225.1.2.3 --ttl 1 --portbase 22345

(el receptor no tiene que especificar por donde lo recibe?)



1. How many packets can you see in SimNet3? and in SimNet2?
SImNet2: 2 paquetes udp i 2 IGMPv3. SimNet3 no vemos nada.

2. Why do you think that these packets are in this network and not in the other?
No vemos nada en la SimNet3 porque R2 no hemos configurado para el multicast??

Later you will change this to make multicast packets to go through SimNet3, but now let us have a look to packets in SimNet2 using wireshark.
1. In the UDP packets, which is the destination address? and the TTL?
ip.src == 198.51.100.2, ip.dst == 225.1.2.3, ip.ttl == 1

2. Which are the port numbers? Are these numbers familiar to you?
udp.src.port == 22345, udp.dst.port == 22346 (son las mismas que el ejercicio anterior)

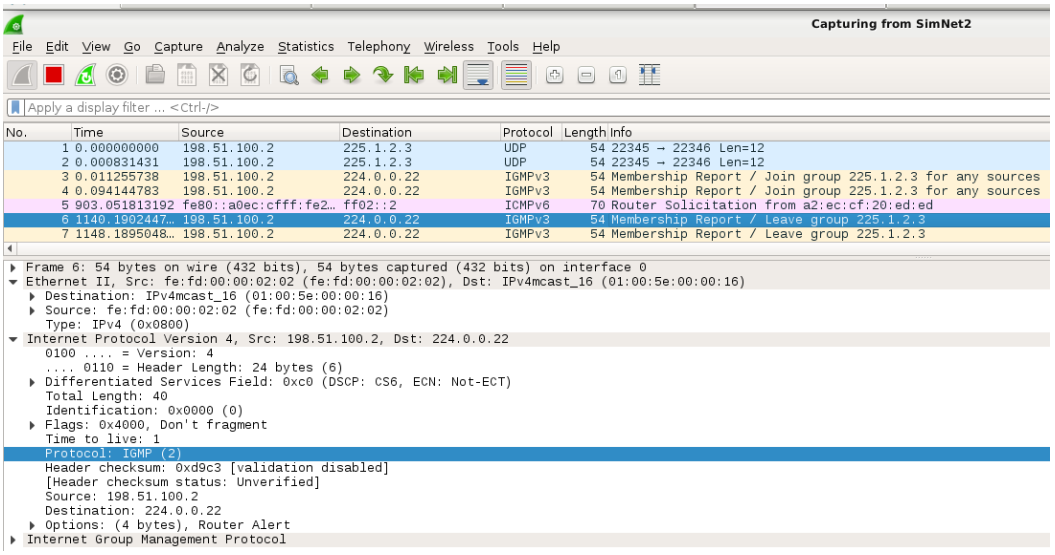
3. Can you see any IGMP packet?
Si vemos 2, de Membership report/ Join group

• Now have a look to the console 1 of R2, and again see the contents of the file **/proc/net/igmp.**

```
R2:~# cat /proc/net/igmp
Idx     Device    : Count Querier       Group    Users Timer    Reporter
1       lo        :     1      V3
                              010000E0     1 0:00000000               0
5       eth2      :     2      V3
                              030201E1     1 0:00000000               0
                              010000E0     1 0:00000000               0
6       eth1      :     1      V3
                              010000E0     1 0:00000000               0
```

1. Can you see any difference?
Vemos que en la interfaz eth2 se ha añadido un nuevo grupo.

• Go to console 0, and close udp-receiver by typing Control+C.



1. Can you see in SimNet2 any new IGMP message? Which type?
2 IGMP Report message de tipo Leave.

2. After closing, can you see again any change in the /proc/net/igmp file?
la Eth2 vuelve a tener solo un grupo. Al terminar la transferencia se elimina el grupo.

0.6.5 Sending the video file in the subnet

• Put a wireshark listening in SimNet3.

Go to console 0 of server and execute again the following command:

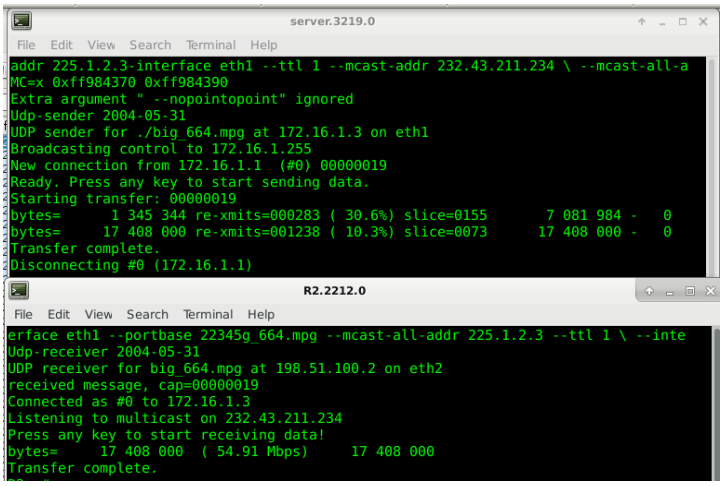
/from server 0

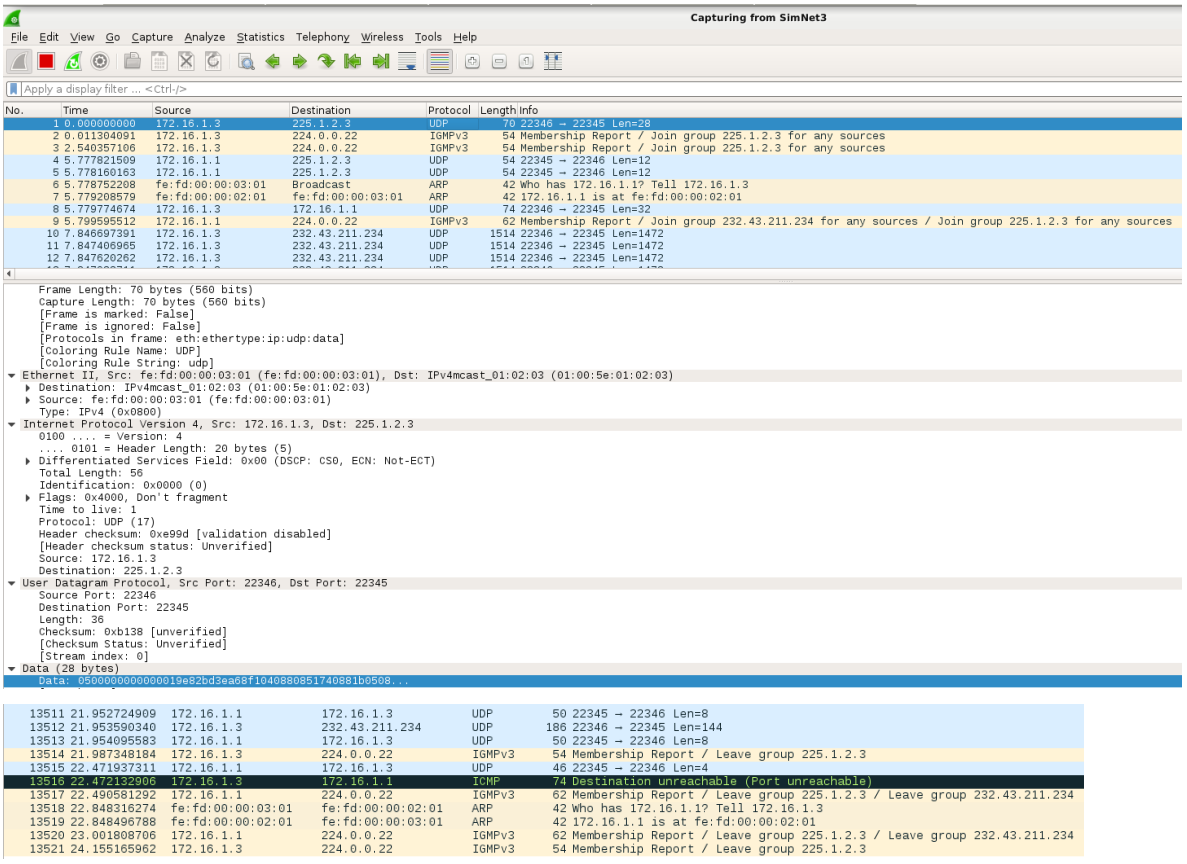
udp-sender --file=./big_664.mpg --min-clients 1 --portbase 22345 --nopointopoint --interface eth1 --ttl 1 --mcast-addr 232.43.211.234 --mcast-all-addr 225.1.2.3

• Go to console 0 of R2 and execute the following command, now forcing the packets to be sent to the proper interface:

//from R2 0

udp-receiver --file=big_664.mpg --mcast-all-addr 225.1.2.3 --ttl 1 --interface eth1 --portbase 22345





1. Was the transmission ok?
Si,
2. How many packets can you see in wireshark?
13521.

• Let us start analyzing the four initial UDP packets of short-length.
1. What do you think is the purpose of these initial packets?
las primeras son para que el emisor y el receptor se identifiquen mutuamente.

2. In the first UDP packet sent by server, which is the IP destination address?
ip.src == 172.16.1.3(server), ip.dst == 255.1.2.3(multicast)

3. Do you recognize anything inside of the DATA field of this packet? Try to convert 232.43.211.234 in hex.
232.43.211.234(dec)=> e8.2b.d3.ea(hex).
data.data==05:00:00:00:00:00:00:19:e8:2b:d3:ea:68:f1:04:08:80:85:17:40:88:1b:05:08:05:b0:4a:ff
El campo de datos contiene la ip.

4. At the time this first packet was sent by the server, was R2 listening at the control multicast address?
No, escucha despues de que se haya establecido la conexion.

5. What do you think is the purpose of the second and third UDP packets (the ones sent by R2)?
Para conectar con el sever.

6. At this time, does R2 know which is the data multicast group that server is going to use to send the video?
No, antes de enviar no sabe solo sabe la ip del multicast de control (225.1.2.3). La ip multicast a la que se envian los datos es (232.43.211.234).
(pero deberia saberlo pq las primeras udp le han enviado la ip)

7. Have a look to the fourth UDP packet. Is it a multicast or unicast packet? What is the purpose of this message? Do you recognize anything in the data field of the packet?
Es un packete unicast enviado des del server a R2 para decirle la ip multicast a la que se enviara los datos.232.43.211.234(dec)=> e8.2b.d3.ea(hex).
(es lo mismo que el 1er paquete, pero ahora destino no es multicast sino R2)

• Regarding the transmission of the video (look at packets that are full of information):
1. Which is the destination IP address of these packets?
232.43.211.234

2. What is the size of most of this data packets?
1514
3. There are some unicast packets from R2 to server. What do you think is the purpose of these feedback packets?
son de feedback (~acks).

0.7 Multicast and routing

In Fig 1 three multicast islands (SimNet0, SimNet3 and SimNet5), multicast routers (R1, R2 and R3), and a router without multicast capacities (RC).
haremos tunnel GRE entre **R1<—>R2**, **R2<—>R3**

0.7.1 Configuring GRE tunnels

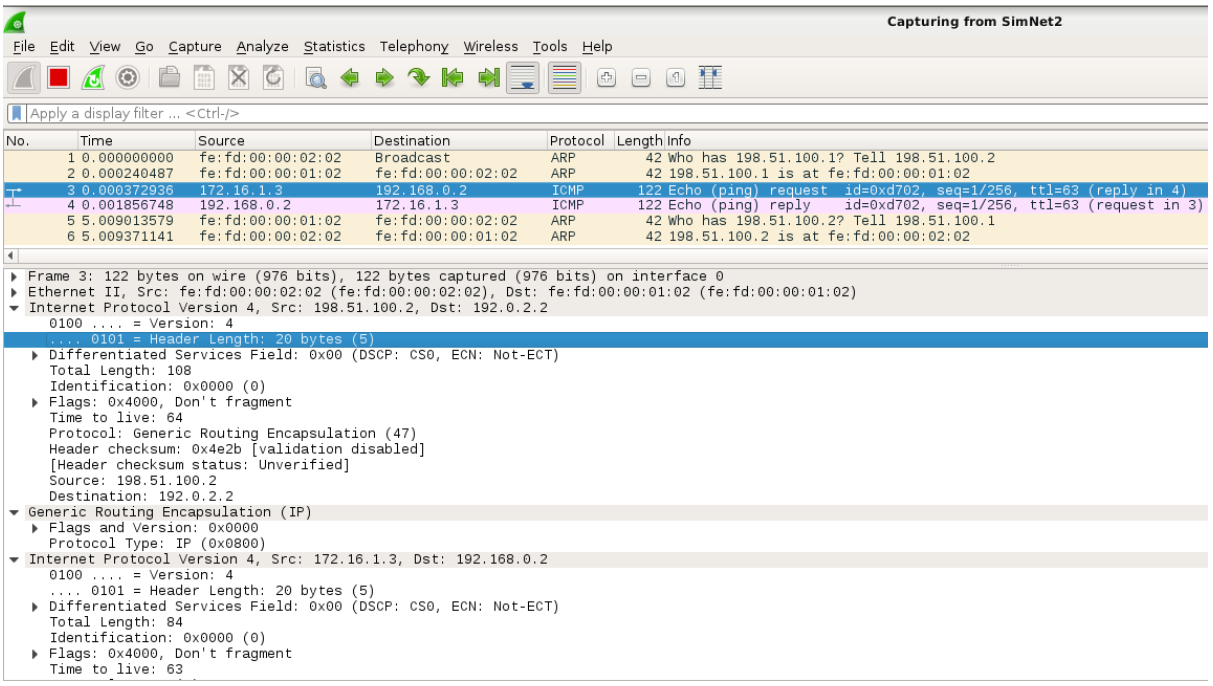
• Configure the tunnel interface by means of the command ip tunnel. Tunnels have to work in gre mode.

• Send a ping from the server to host2.
//from terminal
simctl ipmulticast exec addtun #para crear los 2 tunnels automaticamente

//from server
ping -c1 192.168.0.2

```
server:~# ping -c1 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=62 time=3.11 ms

--- 192.168.0.2 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 3.110/3.110/3.110/0.000 ms
```



1. Is the ping working?
SI

2. Can you see packets in the wireshark? What type of packets? Describe the headers you see.
2 paquetes ICMP, tenemos 3 cabeceras: 1 inner ip, 1 GRE y 1 outer ip.
3. Regarding the IP outer header, which are the source and destination addresses?
ip.src == 198.51.100.2(eth2 R2), ip.dst == 192.0.2.2 (eth2 R1), es del tunnel (R1–R2).

4. Which is the size of the GRE header?
122(total)-20(outer h)-20(inner h)-14(ether h)-8(icmp)-8(timestamp)-48 (data)= 4 bytes.
cuando varia la cabecera??
5. Which is the source and destination addresses in the inner header?
ip.src == 172.16.1.3(server), ip.dst == 192.168.0.2(host2).

• Send also a ping from the server to host4 to verify that tunnel1 works.

```
server:~# ping -c1 192.168.5.4
PING 192.168.5.4 (192.168.5.4) 56(84) bytes of data.
64 bytes from 192.168.5.4: icmp_seq=1 ttl=62 time=3.48 ms

--- 192.168.5.4 ping statistics ---
1 packets transmitted, 1 received, 0% packet loss, time 0ms
rtt min/avg/max/mdev = 3.485/3.485/3.485/0.000 ms
```

0.7.2 Multicast and ICMP

ICMP no es solo para enviar pings, se utiliza tambien para el control de errores. Los mensajes tipicos son:
An ICMP error message (Destination Unreachable, Time Exceeded, Parameter Problem, Source Quench, or Redirect) is never generated in response to a datagram destined to an IP host group.

Pero con el trafico multicast no se utiliza mucho, porque no informa de errores en paquetes multicasts. No se recibe los Host unreachable, fragmentation needes….
Entonces hay que tener cuidado con el TTL, MTU.

0.7.3 Multicast static routing: `smcroute`

Have a look to the file /proc/net/ip_mr_vif in router R2. This file should be empty because the router has not yet taken any action.
• Open four wiresharks, listening from SimNet0 to SimNet3.
• Start the daemon smcroute in router R2.
See again the contents of /proc/net/ip_mr_vif. What changes do you see?
//from R2
cat /proc/net/ip_mr_vif
smcroute -d #empezar el daemon smcroute
cat /proc/net/ip_mr_vif

```
R2:~# cat /proc/net/ip_mr_vif
Interface      BytesIn  PktsIn  BytesOut PktsOut Flags Local    Remote
R2:~# smcroute -d
R2:~# cat /proc/net/ip_mr_vif
Interface      BytesIn  PktsIn  BytesOut PktsOut Flags Local    Remote
 0 eth2              0       0          0       0 00000 026433C6 00000000
 1 eth1              0       0          0       0 00000 010110AC 00000000
 2 tunnel0           0       0          0       0 00000 016EA8C0 00000000
 3 tunnel1           0       0          0       0 00000 026EA8C0 00000000
```

Smcroute= es un simple arbol multicast estatico para connectar SimNet3 y SimNet0.

Execute the following command in R2 to add a new multicast static route:
//from R2
smcroute -a eth1 0.0.0.0 232.43.211.234 tunnel0
#este commando encaminara los datagramas ip atraves de eth1 con cualquier direccion de origen y destino de la direccion del grupo multicast 232.43.211.234, es como dnat y snat (todo pasara por la eth2 del R2).

• Execute the following command to make R2 to join the entry interface eth1 to the multicast group 232.43.211.234:
//from R2
smcroute -j eth1 232.43.211.234 #to join group

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	172.16.1.1	224.0.0.22	IGMPv3	54	Membership Report / Join group 232.43.211.234 for any sources
2	9.816648679	172.16.1.1	224.0.0.22	IGMPv3	54	Membership Report / Join group 232.43.211.234 for any sources

```
R2:~# cat /proc/net/igmp
Idx     Device    : Count Querier       Group    Users Timer    Reporter
1       lo        :     1      V3
                                010000E0     1 0:00000000                0
5       eth2      :     1      V3
                                010000E0     1 0:00000000                0
6       eth1      :     2      V3
                                EAD32BE8     1 0:00000000                0
                                010000E0     1 0:00000000                0
7       tunnel0   :     1      V3
                                010000E0     1 0:00000000                0
8       tunnel1   :     1      V3
                                010000E0     1 0:00000000                0
```

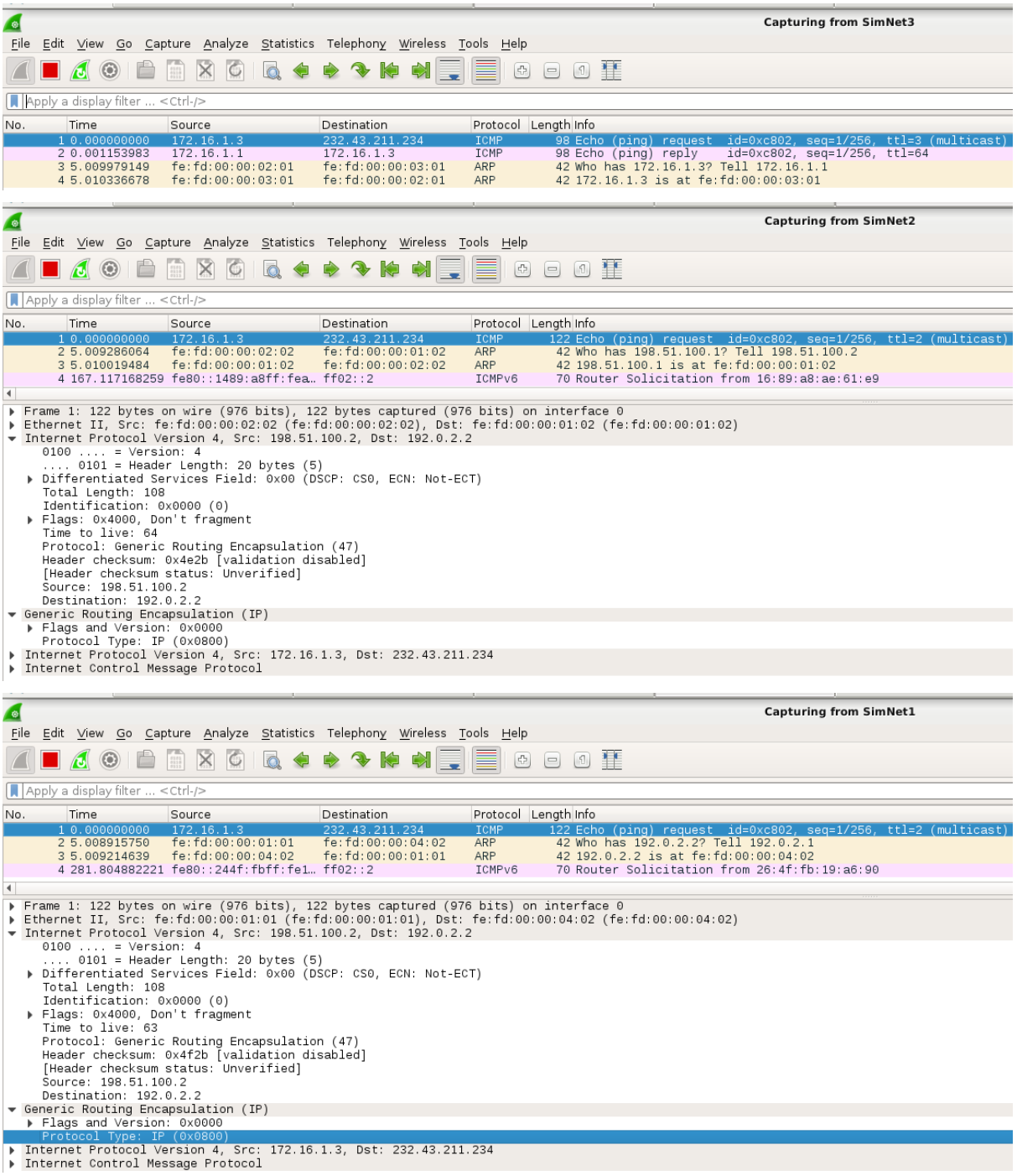
1. View the content of the file /proc/net/igmp. What changes do you see in this file?
Vemos que los tunnels se han configurado correctamente. En eth1 se ha añadido un grupo grup (EAD32BE8 --> 234.211.43.232).

2. Have a look to SimNet3. Can you see any IGMP message in that interface?
Si, 2 de Membership Report de tipo Join group. 1 de cada tunnel.

• Now send a ping from server to the multicast group 232.43.211.234 with a scope of three hops.
//from server
ping -t3 -c1 232.43.211.234

```
server:~# ping -t3 -c1 232.43.211.234
PING 232.43.211.234 (232.43.211.234) 56(84) bytes of data.

--- 232.43.211.234 ping statistics ---
1 packets transmitted, 0 received, 100% packet loss, time 0ms
```



1. Is the ping working? In which SimNets can you see ICMP packets?

Si. Se puede ver el paquete ICMP en SimNet 1,2 y 3.

2. Can you see any encapsulation in the ICMP packet in SimNet1 and SimNet2? What is the size of a GRE header?

Si, es el mismo caso del ejercicio anterior Ltotal=122 y datos 48→ GRE header= 4B.

3. Have a look again to file /proc/net/ip_mr_vif. Do you see any change in the statistics related to tunnel0?

```
R2:~# cat /proc/net/ip_mr_vif
Interface      BytesIn  PktsIn  BytesOut PktsOut Flags Local    Remote
 0 eth2              0       0         0       0 00000 026433C6 00000000
 1 eth1            336       4         0       0 00000 010110AC 00000000
 2 tunnel0           0       0       336       4 00000 016EA8C0 00000000
 3 tunnel1           0       0         0       0 00000 026EA8C0 00000000
```

Podemos ver los cambios en BytesIn y BytesOuts.

4. Execute ip mroute show to see the Multicast Forwarding Cache. What is the meaning of all these parameters?

//from R2

ip mroute show

```
R2:~# ip mroute show
(172.16.1.3, 232.43.211.234)     Iif: eth1       Oifs: tunnel0
```

podemos ver @ip del emisor y destino (mcast), la ruta configurada. Tambien las interface de entrada y salida.

5. Why do you think R1 is not forwarding the packet?

R1 no funciona porque no esta configurado como router multicast.

Using smcroute, configure R1 to route IP datagrams entering through the tunnel with any origin address and destination address the multicast group 232.43.211.234 towards eth1. To do so, just follow the same procedure that you used in R2.

//from R1

echo 0 > /proc/sys/net/ipv4/icmp_echo_ignore_broadcasts

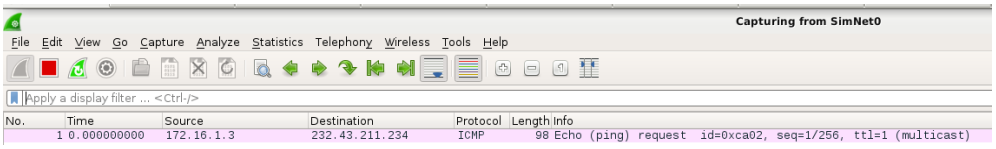
smcroute -d

smcroute -a tunnel0 0.0.0.0 232.43.211.234 eth1

smcroute -j tunnel0 232.43.211.234

/from server

ping -t3 -c1 232.43.211.234



En otras SimNets tenemos ping request y replay.

1. Can you see the packets in SimNet0? Which type of packets?

Si solo 1 echo request.

2. Can you see any ICMP Echo Reply? Why?

No porque nadie está escuchando al tráfico multicast. Pero el tunnel responde al ping. Por eso es exitoso.

3. Which is the TTL value of this packet in SimNet0?

TTL=1.

4. If you send the same ping from server but with TTL=2, would it work?

No, porque se pierde en RC.

0.7.4 Testing tools

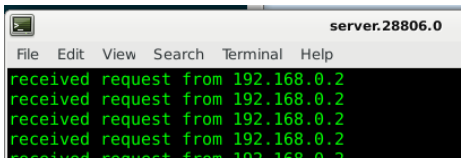
ssmping

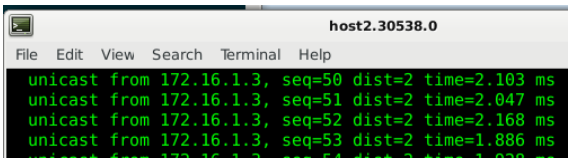
Antes con el smcroute, hemos utilizado el ping, pero el ping no sirve para enviar informacion.
Ahora usaremos ssmping, que permite verificar encaminamiento tanto unicast como multicast. Basicamente ssmping permite verificar si el host puede recibir paquetes SSM(source Specific Multicast) des del otro host enviando paquetes UDP multicast y unicast.(TCP no soporta el trafico multicast)

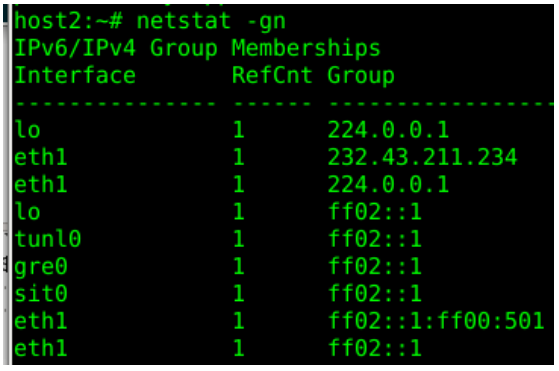
//from server 0
ssmpingd

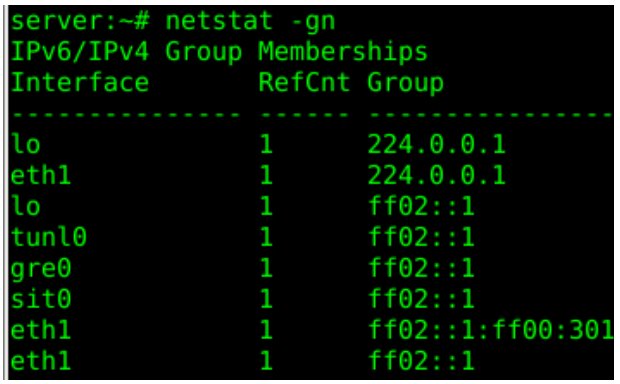
//from host2 0
ssmping 172.16.1.3

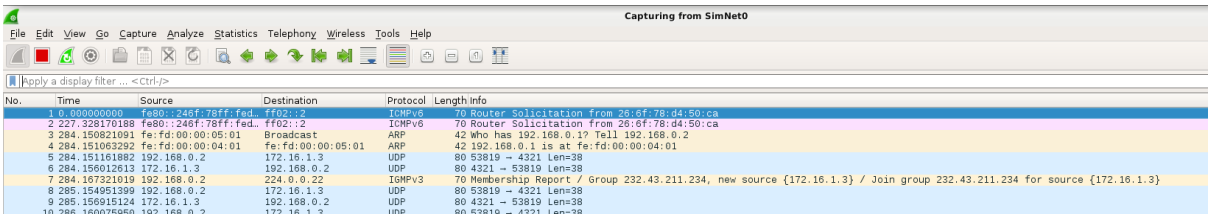
netstat -gn

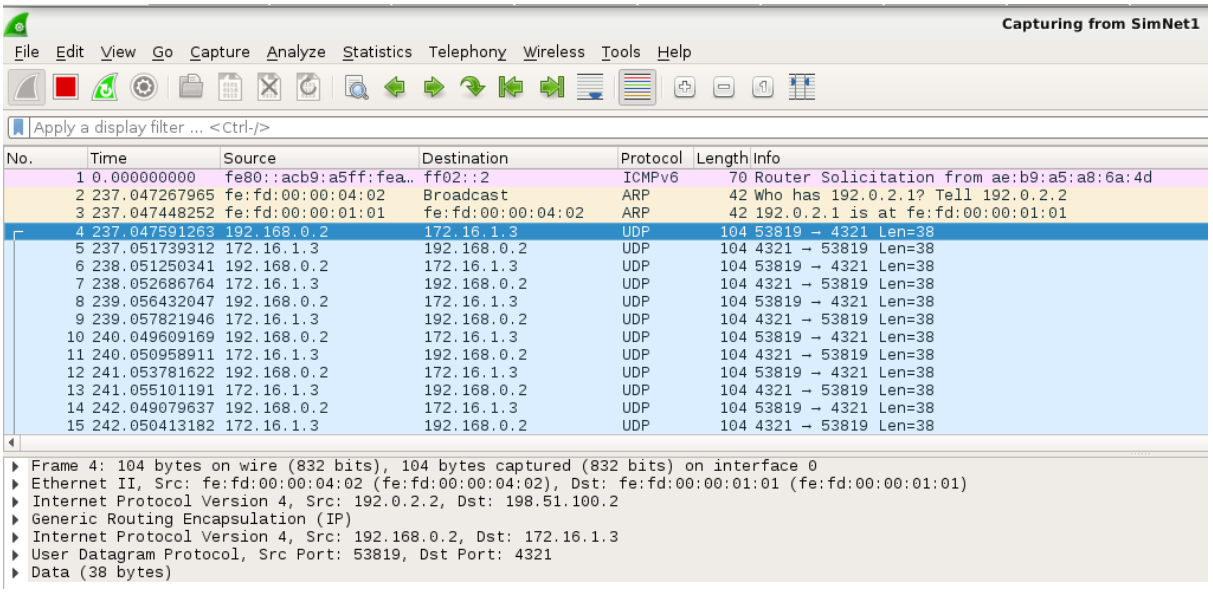


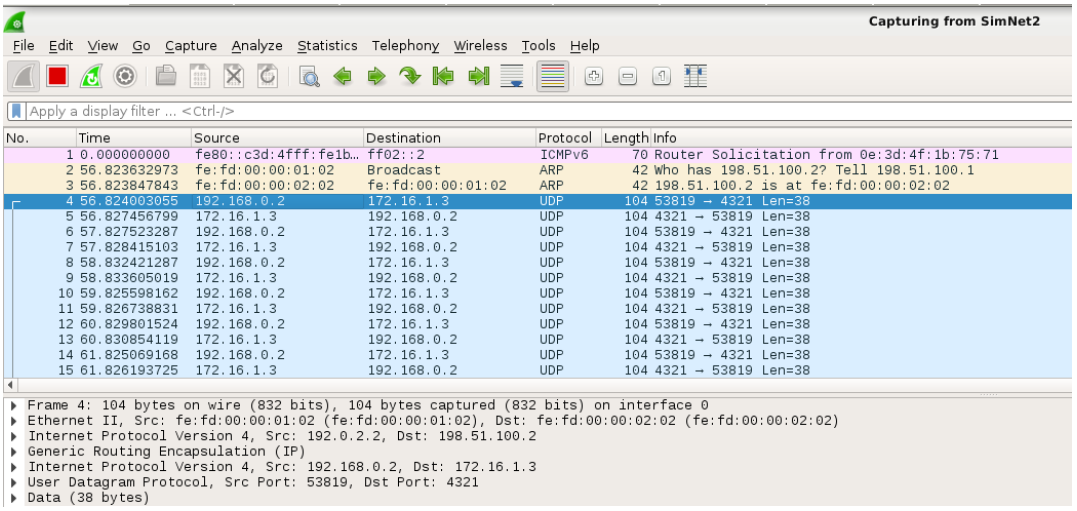


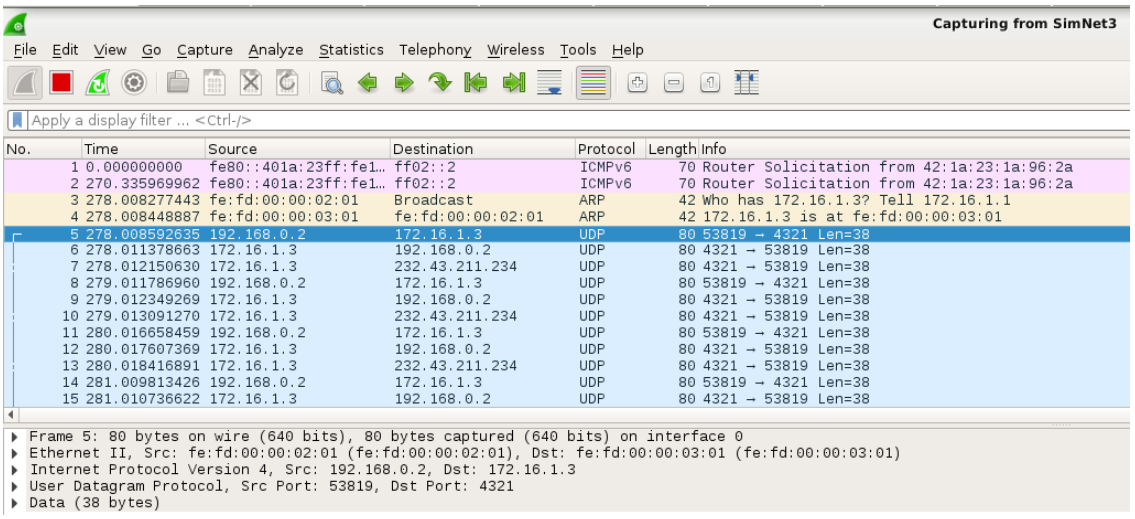












1. What output can you see in host2? and in server?

En host2 vemos los pings enviados y recibidos des del server.

En server recibe ping enviados desde 192.168.0.2 (host2) y envia el ping de vuelta al host2. y a la ip multicast. **(R1 no puede enviar multicast, pq se tiene q ir al server?)**

2. According to this output, do you consider that the multicast routing is working?
Si, porque en este caso ha funcionado.

Notice that ssmping is able to test both unicast and multicast routing. Have a look to the UDP packets. Notice that the behavior is periodical, and groups of three UDP packets are sent every second.

1. What is the destination and origin address of the first packet? Is a unicast or multicast packet?
ip.src == 192.168.0.2, ip.dst == 172.16.1.3, Es unicast.

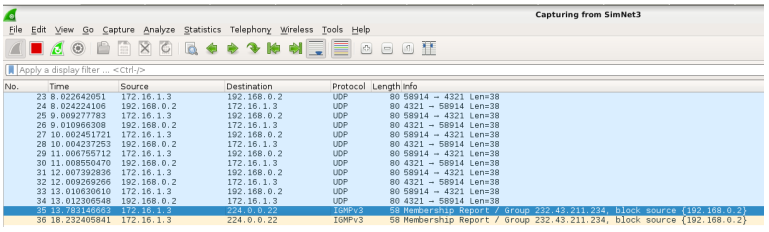
2. And the second one? What is the purpose of these two packets?
ip.src == 172.16.1.3, ip.dst == 192.168.0.2. el propósito es establecer conexion entre ellos.

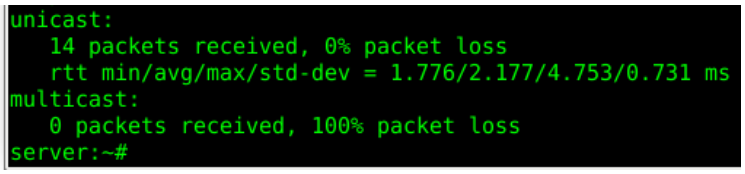
3. Is the third packet different? Who is the origin and destination? Unicast or multicast? So, what is this packet testing? Unidirectional or bidirectional?
ip.src == 192.168.0.2, ip.dst == 172.16.1.3. Pero este es multicast porque se envia después de que se uniera al grupo multicast. Este paquete es unidireccional de host2 al server.

Regarding IGMP packets:
1. In SimNet0, can you see any IGMP Message? What kind of message? Which is the multicast group involved? (for easiness, put igmp in the Filter option available in the top-left corner of wireshark).

Si, vemos 2 mensajes IGMP de Membership Report de tipo Join group. El grupo multicast es 232.43.211.234.

2. Is this information coherent with what you see using netstat -gn?
SI.
3. Is there any other IGMP message in the rest of networks?
NO.





Si intentamos cambiar los roles del server y del host2 . vemos que el host2 no es capaz de enviar el tráfico multicast al server porque no esta configurado el encaminamiento estático. Solo le llega el tráfico único.

mcsender and emcast (TO DO AT HOME)

It is also possible to verify the correct use of multicast static routing using the applications mcsender and emcast. Have a look to the manual of both applications to see how they work.
• Put wiresharks listening in all the involved networks.
• In server (acting as issuer) execute mcsender to send packets to the multicast group 232.43.211.234 using the UDP port 12345 with a scope of three hops.
//from server
mcsender -t3 232.43.211.234:1234
(envía paquetes al grupo 232.43.211.234, utilizando el puerto 1234 con 3 saltos.)

• In host2 (acting as receiver) execute emcast to join group 232.43.211.234 using UDP port 12345.
//from host2
emcast -t3 232.43.211.234:1234

1. What output can you see in host2? and in server?
En el host2 se ve: this is the test message from mclab/mcsender.7
En el server : nada

2. According to this output, do you consider that the multicast routing is working?
Si
3. What is the destination and origin address of the packets? Are they unicast or multicast?
ip.src == 172.16.1.3, ip.dst == 232.43.211.234.

4. Can you see any IGMP Message? Where? What kind of message? Which is the multicast group involved?
Si, en SimNet0 vemos 4 de IGMPs, 2 de Join group y 2 de Leave group. El grupo multicast es 232.43.211.234.

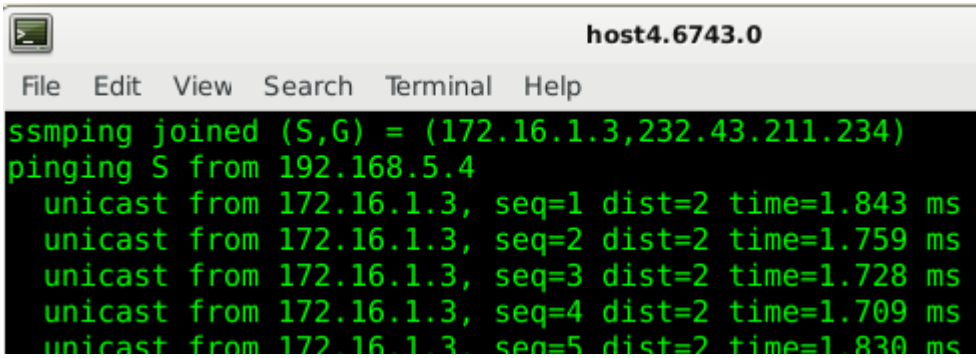
0.7.5 Trees with multiple branches

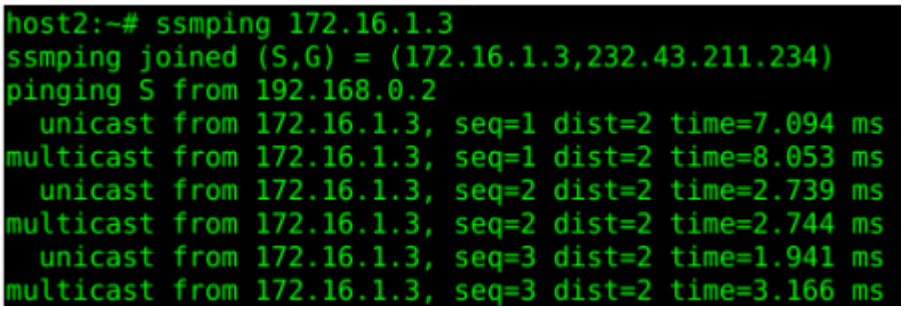
• Put wiresharks listening in all the involved networks.
//from R2
smcroute -k # kill prevoius daemon
smcroute -d # start new daemon
smcroute -a eth1 0.0.0.0 232.43.211.234 tunnel0 tunnel1
#adding list of interfaces used as output
smcroute -j eth1 232.43.211.234
#join the entry interface eht1 to multicast grup 232.43.211.434.

/from server
ssmpingd

//from host2
ssmping 172.16.1.3

//from host4
ssmping 172.16.1.3





1. Is ssmping working? What output message can you see in host2? host4? And in server?
El trafico multicast funciona entre host2 y server. Pero no entre host4 y server.

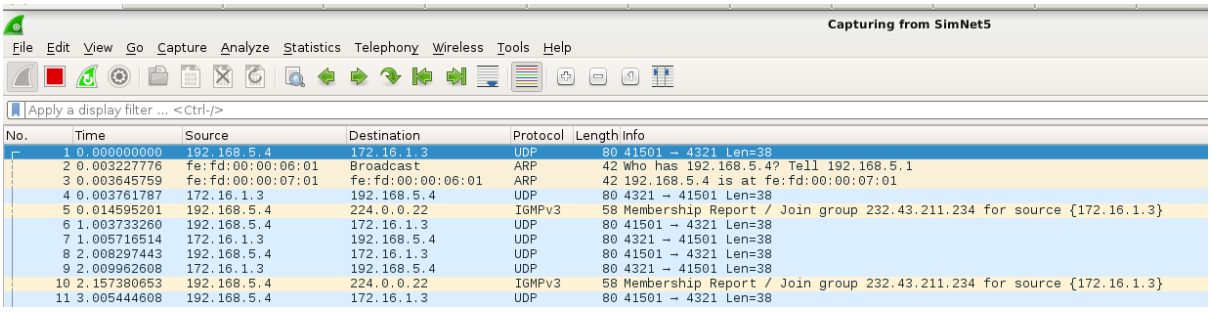
2. What will deduce from this output messages? What do you consider is missing?
El host4 no recibe tramas multicast debido que la R3 no está configurado para trafico multicast. (lo de echo o ignore….)

3. Have a look to SimNet4, what type of messages can you see? unicast or multicast? And in SimNet5?
En SimNet4 hay trafico multicast pero en SimNet5 no, porque R3 bloquea trafico multicast.

• Make the necessary changes to make the multicast routing work so you can send a multicast flow from SimNet0 to both SimNet3 and SimNet5.
//from R3
echo 0 > /proc/sys/net/ipv4/icmp_echo_ignore_broadcasts
smcroute -d
smcroute -a tunnel1 0.0.0.0 232.43.211.234 eth1
smroute -j tunnel1 232.43.211.234

//from server
ssmpingd
//from host4
ssmping 172.16.1.3

//from server
mcsender -t3 232.43.211.234:12345
//fromhsot4
emcast 232.43.211.234:12345



0.7.6 Sending the video

• Configure the multicast routers for the control group 225.1.2.3, exactly in the same way you did previously with the data group 232.43.211.234.
//from R2
smcroute -a eth1 0.0.0.0 225.1.2.3 tunnel0 tunnel1
smcroute -j eth1 225.1.2.3

//from R1
smcroute -a tunnel0 0.0.0.0 225.1.2.3 eth1
smcroute -j tunnel0 225.1.2.3

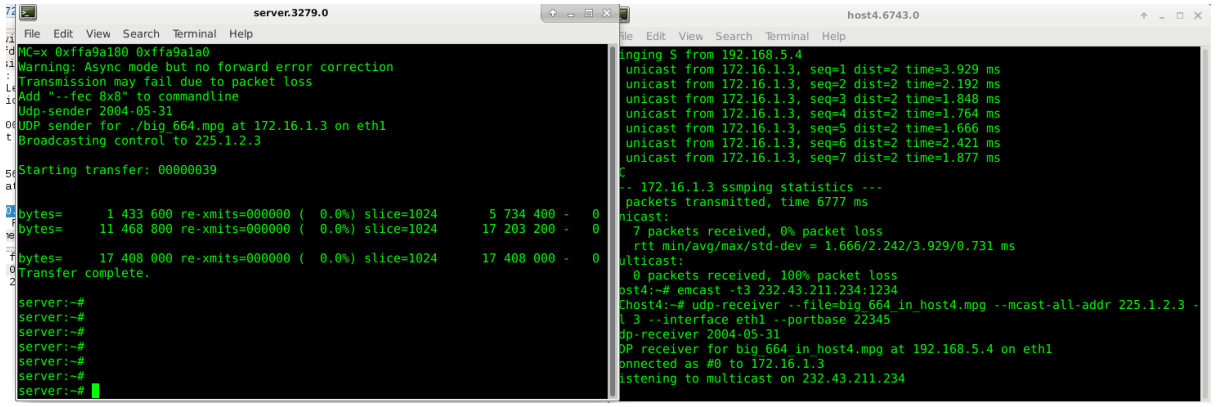
//from R3
smcroute -a tunnel1 0.0.0.0 225.1.2.3 eth1
smcroute -j tunnel1 225.1.2.3

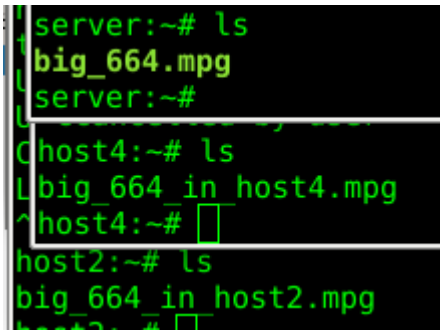
• Test that this control group 225.1.2.3 is properly transmitted by the multicast tree from SimNet0 to both SimNet3 and SimNet5.

• Start udp-receiver in both host2 and host4:
//from host2
udp-receiver --file=big_664_in_host2.mpg --mcast-all-addr 225.1.2.3 --ttl 3 --interface eth1 --portbase 22345

//from host4
udp-receiver --file=big_664_in_host4.mpg --mcast-all-addr 225.1.2.3 --ttl 3 --interface eth1 --portbase 22345

• Start upd-sender to transmit the video big_664.mpg from server. Remember that your multicast routing tree is unidirectional, and hence you will not receive any feedback from the receivers (for that reason we use the options autostart and max-bitrate. Notice also that you need to put the proper ttl and blocksize values to properly traverse the tunnels. Execute:
//from server
udp-sender --file=./big_664.mpg --portbase 22345 --nopointopoint --interface eth1 --ttl 3 --mcast-addr 232.43.211.234 --mcast-all-addr 225.1.2.3 --nokbd --async --max-bitrate 900K --autostart 1 --blocksize 1400





En todas las SimNets salen mensajes udps, luego IGMP Membership/join group y luego udps de datos. (como en los anteriores).

0.7.7 Bidirectional tree (TO DO AT HOME)

0.7.8 Live streaming (TO DO AT HOME)

0.7.9 The end of the overlay (TO DO AT HOME)

teoria

Direccionamiento Multicast (RFC5771)

Mapping entre IP de grupo y dirección MAC:

Todas las MACs multicast existen en el rango 01-00-5E-00-00-00 y 01-00-5E-7F-FF-FF

1. Tomar los últimos 3 octetos de la dirección IP (24 bits)
2. Cambiar el primer bit de la izquierda a 0 si es que es 1, y si es 0 se deja en 0.
3. Se convierten los 3 bytes a hexadecimal y se agregan al prefijo 01:00:5E

Ejemplo 1:
1. 224.64.16.1 = 1110 0000.0100 0000.0001 0000.0000 0001
2. 4 0 1 0 0 1
3. MAC FINAL = **01:00:5E:40:10:01**

Ejemplo 2:
1. 224.192.16.1 = 1110 0000.1100 0000.0001 0000.0000 0001
2. 4 0 1 0 0 1
3. MAC FINAL = **01:00:5E:40:10:01**

Internet Group Management Protocol (IGMP)

IGMPv1: Cuando un host quiere unirse a un grupo Mcast, envía un mensaje IGMP Report Message al router indicando que quiere recibir tráfico de ese grupo. El router envía mensajes IGMP Query cada 60 segs para determinar el host aún quiere estar en el grupo. Los mensajes se envían a 224.0.0.1 (todos los hosts)

IGMPv2: Los routers envían mensajes a grupos específicos y los hosts pueden enviar mensajes "Leave" cuando quieran abandonar un grupo, lo cual permite optimizar recursos de la red.

IGMPv3: Si existe más de un origen Multicast para el mismo grupo, los routers pueden decidir cual de los orígenes escojen mediante el envío de mensajes "Source" (SSM o Source Specific Multicast).

IGMPv1=el host envia una query cada 60s para determinar si el router aun quiere formar parte del grupo. Si abandona el grupo el router, el host no sabe hasta q envia la query.ttl=1

IGMPv2= Se introdujo el mensaje Leave, cuando el router no quiere formar parte del grupo, envia un leave y yata.ttl=1

IGMPv3= funciona como la IGMPv2 pero ahora permite definir multiples origenes. 2 servidores enviando al mismo ip multicast, el host puede decidir en que server conectarte.ttl=1

L2 Multicast Addressing

Mapping L3 to L2

- For IP multicast, there is a well-known MAC OUI that is used exclusively
  - `01-00-5E`
- Of the remaining 24 bits, the most significant bit is fixed to `0`
  - This leaves 23 bits to map the L3 IP
- LO 23 bits of the IP are simply copied to LO 23 bits of the MAC
  - Since 28 bits of the IP are being mapped onto 23 bits of the MAC, there is ambiguity
  - As 5 bits are left unmapped, 32 (2^5) IPs map to the same MAC
  - Eg. `230.1.2.3`, `230.129.2.3` and `239.1.2.3` all map to:
    - `0100-5E01-0203`
- A savings of about $15,500 in 1989 dollars