Trábajo práctico IPv6

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1. Wireshark

1.c.

```
3:03% ifconfig
lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 20  bytes 1000 (1000.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 20  bytes 1000 (1000.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

wlp3s0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.0.201  netmask 255.255.255.0  broadcast 192.168.0.255
        inet6 fe80::e29d:31ff:fe14:38d4  prefixlen 64  scopeid 0x20<link>
        ether e0:9d:31:14:38:d4  txqueuelen 1000  (Ethernet)
        RX packets 2207130  bytes 1694172621 (1.5 GiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 529558  bytes 70553061 (67.2 MiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

Primero se ve la interfaz loopback (lo) con direcciones 127.0.0.1 y ::1 para IPv4 e IPv6.

Después se ve otra interfaz wlp3s0, que tiene dirección IPv6 fe80::e29d:31ff:fe14:38d4 con el prefijo fe80 que indica una dirección link local, o sea que es válida sólo para el enlace local. Su dirección MAC es e0:9d:31:14:38:d4.

1.d.

```
7:28% ping ::1
PING ::1(::1) 56 data bytes
64 bytes from ::1: icmp_seq=1 ttl=64 time=0.036 ms
64 bytes from ::1: icmp_seq=2 ttl=64 time=0.047 ms
64 bytes from ::1: icmp_seq=3 ttl=64 time=0.054 ms
64 bytes from ::1: icmp_seq=4 ttl=64 time=0.101 ms
64 bytes from ::1: icmp_seq=5 ttl=64 time=0.070 ms
^C
--- ::1 ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4048ms
rtt min/avg/max/mdev = 0.036/0.061/0.101/0.022 ms
```

1.e.

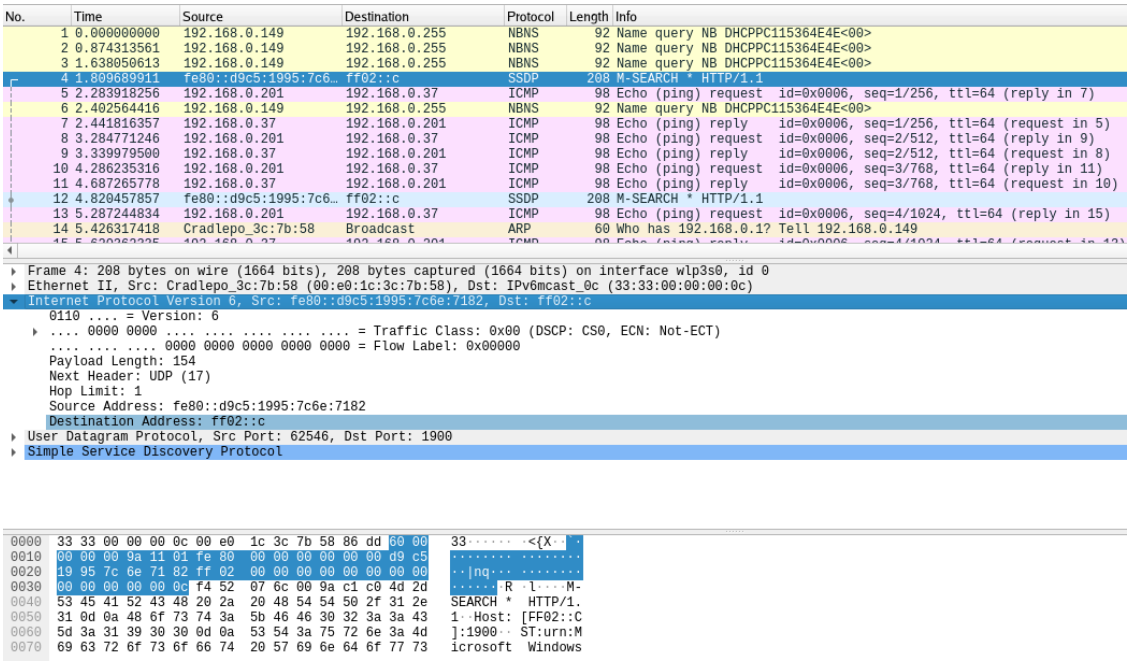
No pude hacer este ejercicio con IPv6, así que usé direcciones IPv4 para ver los paquetes capturados.

```
7:34% ping 192.168.0.37
PING 192.168.0.37 (192.168.0.37) 56(84) bytes of data.
64 bytes from 192.168.0.37: icmp_seq=1 ttl=64 time=158 ms
64 bytes from 192.168.0.37: icmp_seq=2 ttl=64 time=55.3 ms
64 bytes from 192.168.0.37: icmp_seq=3 ttl=64 time=401 ms
64 bytes from 192.168.0.37: icmp_seq=4 ttl=64 time=333 ms
64 bytes from 192.168.0.37: icmp_seq=5 ttl=64 time=225 ms
64 bytes from 192.168.0.37: icmp_seq=6 ttl=64 time=476 ms
64 bytes from 192.168.0.37: icmp_seq=7 ttl=64 time=496 ms
^C
--- 192.168.0.37 ping statistics ---
7 packets transmitted, 7 received, 0% packet loss, time 6007ms
rtt min/avg/max/mdev = 55.275/306.430/496.208/154.066 ms
```

	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	192.168.0.149	192.168.0.255	NBNS	92	Name query NB DHCPPC115364E4E<00>
2	0.874313561	192.168.0.149	192.168.0.255	NBNS	92	Name query NB DHCPPC115364E4E<00>
3	1.638050613	192.168.0.149	192.168.0.255	NBNS	92	Name query NB DHCPPC115364E4E<00>
4	1.809689911	fe80::d9c5:1995:7c6…	ff02::c	SSDP	208	M-SEARCH * HTTP/1.1
5	2.283918256	192.168.0.201	192.168.0.37	ICMP	98	Echo (ping) request id=0x0006, seq=1/256, ttl=64 (reply in 7)
6	2.402564416	192.168.0.149	192.168.0.255	NBNS	92	Name query NB DHCPPC115364E4E<00>
7	2.441816357	192.168.0.37	192.168.0.201	ICMP	98	Echo (ping) reply id=0x0006, seq=1/256, ttl=64 (request in 5)
8	3.284771246	192.168.0.201	192.168.0.37	ICMP	98	Echo (ping) request id=0x0006, seq=2/512, ttl=64 (reply in 9)
9	3.339979500	192.168.0.37	192.168.0.201	ICMP	98	Echo (ping) reply id=0x0006, seq=2/512, ttl=64 (request in 8)
10	4.286235316	192.168.0.201	192.168.0.37	ICMP	98	Echo (ping) request id=0x0006, seq=3/768, ttl=64 (reply in 11)
11	4.687265778	192.168.0.37	192.168.0.201	ICMP	98	Echo (ping) reply id=0x0006, seq=3/768, ttl=64 (request in 10)
12	4.820457857	fe80::d9c5:1995:7c6…	ff02::c	SSDP	208	M-SEARCH * HTTP/1.1
13	5.287244834	192.168.0.201	192.168.0.37	ICMP	98	Echo (ping) request id=0x0006, seq=4/1024, ttl=64 (reply in 15)
14	5.426317418	Cradlepo_3c:7b:58	Broadcast	ARP	60	Who has 192.168.0.1? Tell 192.168.0.149
15	5.620362335	192.168.0.37	192.168.0.201	ICMP	98	Echo (ping) reply id=0x0006, seq=4/1024, ttl=64 (request in 13)
16	6.288348261	192.168.0.201	192.168.0.37	ICMP	98	Echo (ping) request id=0x0006, seq=5/1280, ttl=64 (reply in 17)
17	6.513617136	192.168.0.37	192.168.0.201	ICMP	98	Echo (ping) reply id=0x0006, seq=5/1280, ttl=64 (request in 16)
18	7.289678508	192.168.0.201	192.168.0.37	ICMP	98	Echo (ping) request id=0x0006, seq=6/1536, ttl=64 (reply in 21)
19	7.374531450	IntelCor_14:38:d4	be:a0:0d:fd:8b:f7	ARP	42	Who has 192.168.0.37? Tell 192.168.0.201
20	7.741623732	be:a0:0d:fd:8b:f7	IntelCor_14:38:d4	ARP	62	192.168.0.37 is at be:a0:0d:fd:8b:f7
21	7.765619963	192.168.0.37	192.168.0.201	ICMP	98	Echo (ping) reply id=0x0006, seq=6/1536, ttl=64 (request in 18)

Se pueden ver los paquetes ICMP en rojo de los ping request y reply entre 192.168.0.37 y 192.168.0.201. La información adicional que se muestra es el id del mensaje ping, el número de secuencia y el time to live (ttl).

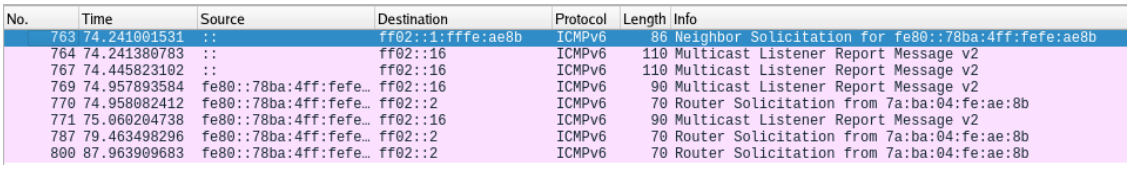
1.f.



Se puede ver que la cabecera del paquete tiene los campos:

- versión: 0110 (6)
- trafic class: 0x00
- flow label: 0x00000
- payload length: 154
- next header: 17 (UDP)
- hop limit: 1
- source address
- destination address

1.g.



No.	Time	Source	Destination	Protocol	Length	Info
763	74.241001531	::	ff02::1:fffe:ae8b	ICMPv6	86	Neighbor Solicitation for fe80::78ba:4ff:fefe:ae8b
764	74.241380783	::	ff02::16	ICMPv6	110	Multicast Listener Report Message v2
767	74.445823102	::	ff02::16	ICMPv6	110	Multicast Listener Report Message v2
769	74.957893584	fe80::78ba:4ff:fefe…	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
770	74.958082412	fe80::78ba:4ff:fefe…	ff02::2	ICMPv6	70	Router Solicitation from 7a:ba:04:fe:ae:8b
771	75.060204738	fe80::78ba:4ff:fefe…	ff02::16	ICMPv6	90	Multicast Listener Report Message v2
787	79.463498296	fe80::78ba:4ff:fefe…	ff02::2	ICMPv6	70	Router Solicitation from 7a:ba:04:fe:ae:8b
800	87.963909683	fe80::78ba:4ff:fefe…	ff02::2	ICMPv6	70	Router Solicitation from 7a:ba:04:fe:ae:8b

Cuando se conectó un nodo nuevo pude capturar los siguientes paquetes ICMPv6:

- **Neighbor Solicitation:** tipo 135. Se usa para determinar direcciones MAC de los vecinos.

```
▸ Frame 763: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface wlp3s0, id 0
▸ Ethernet II, Src: 7a:ba:04:fe:ae:8b (7a:ba:04:fe:ae:8b), Dst: IPv6mcast_ff:fe:ae:8b (33:33:ff:fe:ae:8b)
▸ Internet Protocol Version 6, Src: ::, Dst: ff02::1:fffe:ae8b
▾ Internet Control Message Protocol v6
    Type: Neighbor Solicitation (135)
    Code: 0
    Checksum: 0xc192 [correct]
    [Checksum Status: Good]
    Reserved: 00000000
    Target Address: fe80::78ba:4ff:fefe:ae8b
  ▸ ICMPv6 Option (Nonce)
```

- **Multicast Listener Report Message:** tipo 143. Es para descubrir nodos que deseen recibir paquetes multicast.

```
▸ Frame 764: 110 bytes on wire (880 bits), 110 bytes captured (880 bits) on interface wlp3s0, id 0
▸ Ethernet II, Src: 7a:ba:04:fe:ae:8b (7a:ba:04:fe:ae:8b), Dst: IPv6mcast_16 (33:33:00:00:00:16)
▸ Internet Protocol Version 6, Src: ::, Dst: ff02::16
▾ Internet Control Message Protocol v6
    Type: Multicast Listener Report Message v2 (143)
    Code: 0
    Checksum: 0x6b80 [correct]
    [Checksum Status: Good]
    Reserved: 0000
    Number of Multicast Address Records: 2
  ▸ Multicast Address Record Changed to include: ff02::1:ffae:52b8
  ▸ Multicast Address Record Changed to exclude: ff02::1:fffe:ae8b
```

- **Router Solicitation:** tipo 133. Cuando un nodo nuevo se conecta pide al router que se anuncie para informar a los nodos.

```
▸ Frame 770: 70 bytes on wire (560 bits), 70 bytes captured (560 bits) on interface wlp3s0, id 0
▸ Ethernet II, Src: 7a:ba:04:fe:ae:8b (7a:ba:04:fe:ae:8b), Dst: IPv6mcast_02 (33:33:00:00:00:02)
▸ Internet Protocol Version 6, Src: fe80::78ba:4ff:fefe:ae8b, Dst: ff02::2
▾ Internet Control Message Protocol v6
    Type: Router Solicitation (133)
    Code: 0
    Checksum: 0x22a6 [correct]
    [Checksum Status: Good]
    Reserved: 00000000
  ▸ ICMPv6 Option (Source link-layer address : 7a:ba:04:fe:ae:8b)
```

2. Packet tracer

Tarea 2.

b.

Las 4 interfaces tienen IPv6 habilitado.

Dispositivo		Dirección IP local	Dirección IP global
Router0	**Fa0/0**	FE80::202:4AFF:FE35:6301	2001:DB8:1:0:202:4AFF:FE35:6301
	Fa0/1	FE80::202:4AFF:FE35:6302	2001:DB8:2:0:202:4AFF:FE35:6302
Router1	**Fa0/0**	FE80::2D0:BCFF:FE88:ED01	2001:DB8:3:0:2D0:BCFF:FE88:ED01
	Fa0/1	FE80::2D0:BCFF:FE88:ED02	2001:DB8:2:0:2D0:BCFF:FE88:ED02

Router0:

```
FastEthernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::202:4AFF:FE35:6301
  No Virtual link-local address(es):
  Global unicast address(es):
    2001:DB8:1:0:202:4AFF:FE35:6301, subnet is 2001:DB8:1::/64 [EUI]
FastEthernet0/1 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::202:4AFF:FE35:6302
  No Virtual link-local address(es):
  Global unicast address(es):
    2001:DB8:2:0:202:4AFF:FE35:6302, subnet is 2001:DB8:2::/64 [EUI]
```

Router1:

```
FastEthernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::2D0:BCFF:FE88:ED01
  No Virtual link-local address(es):
  Global unicast address(es):
    2001:DB8:3:0:2D0:BCFF:FE88:ED01, subnet is 2001:DB8:3::/64 [EUI]
FastEthernet0/1 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::2D0:BCFF:FE88:ED02
  No Virtual link-local address(es):
  Global unicast address(es):
    2001:DB8:2:0:2D0:BCFF:FE88:ED02, subnet is 2001:DB8:2::/64 [EUI]
```

1. Una dirección IPv6 tiene 128 bits.

2. El prefijo es 2001:DB8:1::/64 y el ID de la interface es 202:4AFF:FE35:6301.

3. La MAC es 0002.4A35.6301. El ID de la interface se forma dividiendo la MAC en dos partes de 24 bits, agregando en el medio FFFE e invirtiendo el séptimo bit, por lo que el primer grupo pasa de 0002 a 0202. Éste es el formato EUI-64.

c.

Router0:

```
Router>show ipv6 route
IPv6 Routing Table - 6 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
C   2001:DB8:1::/64 [0/0]
     via ::, FastEthernet0/0
L   2001:DB8:1:0:202:4AFF:FE35:6301/128 [0/0]
     via ::, FastEthernet0/0
C   2001:DB8:2::/64 [0/0]
     via ::, FastEthernet0/1
L   2001:DB8:2:0:202:4AFF:FE35:6302/128 [0/0]
     via ::, FastEthernet0/1
R   2001:DB8:3::/64 [120/2]
     via FE80::2D0:BCFF:FE88:ED02, FastEthernet0/1
L   FF00::/8 [0/0]
     via ::, Null0
```

directamente conectado con PC0
sale por Fa0/0

dirección de Fa0/0

directamente conectado con Router1
sale por Fa0/1

dirección de Fa0/1

no está directamente conectado con PC1
tiene que salir por Fa0/1

Router1:

```
Router>show ipv6 route
IPv6 Routing Table - 6 entries
Codes: C - Connected, L - Local, S - Static, R - RIP, B - BGP
       U - Per-user Static route, M - MIPv6
       I1 - ISIS L1, I2 - ISIS L2, IA - ISIS interarea, IS - ISIS summary
       ND - ND Default, NDp - ND Prefix, DCE - Destination, NDr - Redirect
       O - OSPF intra, OI - OSPF inter, OE1 - OSPF ext 1, OE2 - OSPF ext 2
       ON1 - OSPF NSSA ext 1, ON2 - OSPF NSSA ext 2
       D - EIGRP, EX - EIGRP external
R   2001:DB8:1::/64 [120/2]
     via FE80::202:4AFF:FE35:6302, FastEthernet0/1
C   2001:DB8:2::/64 [0/0]
     via ::, FastEthernet0/1
L   2001:DB8:2:0:2D0:BCFF:FE88:ED02/128 [0/0]
     via ::, FastEthernet0/1
C   2001:DB8:3::/64 [0/0]
     via ::, FastEthernet0/0
L   2001:DB8:3:0:2D0:BCFF:FE88:ED01/128 [0/0]
     via ::, FastEthernet0/0
L   FF00::/8 [0/0]
     via ::, Null0
```

d.

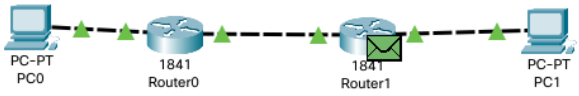
```
Packet Tracer PC Command Line 1.0
C:\>ping 2001:DB8:3:0:20C:CFFF:FE97:7944

Pinging 2001:DB8:3:0:20C:CFFF:FE97:7944 with 32 bytes of data:

Reply from 2001:DB8:3:0:20C:CFFF:FE97:7944: bytes=32 time<1ms TTL=126
Reply from 2001:DB8:3:0:20C:CFFF:FE97:7944: bytes=32 time<1ms TTL=126
Reply from 2001:DB8:3:0:20C:CFFF:FE97:7944: bytes=32 time<1ms TTL=126
Reply from 2001:DB8:3:0:20C:CFFF:FE97:7944: bytes=32 time<1ms TTL=126

Ping statistics for 2001:DB8:3:0:20C:CFFF:FE97:7944:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```

Tarea 3.



Event List

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	PC0	ICMPv6
	0.001	PC0	Router0	ICMPv6
	0.002	Router0	Router1	ICMPv6
	0.003	Router1	PC1	ICMPv6
	0.004	PC1	Router1	ICMPv6
	0.005	Router1	Router0	ICMPv6
	0.006	Router0	PC0	ICMPv6
	12.134	--	Router0	NDP
	12.135	Router0	Router1	NDP
	13.160	--	Router1	NDP

- PC0 crea el paquete ICMPv6 y lo manda a la puerta de enlace predeterminada, que es Router0.
- Router0 recibe el paquete, se fija el destino y mira en la tabla de ruteo para dónde tiene que dirigirlo. La tabla indica que tiene que enviarlo por el enlace a Router1.
- Router1 hace lo mismo, pero en este caso ve que el destino está directamente conectado. Lo envía por el enlace correspondiente.
- PC1 recibe el paquete y prepara la respuesta.
- Se da el proceso inverso.
- Sigue con paquetes NDP de router advertisement.

Tarea 4.

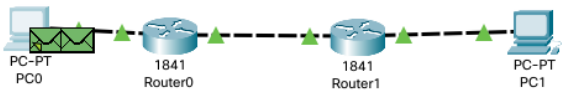
d.

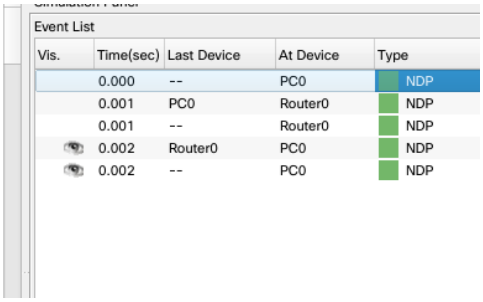
Paquetes ICMPv6 que se envían desde PC0 con tipo 128 *echo request*, y los que devuelve PC1 con tipo 129 de *echo reply*. Las direcciones IP de origen y destino se mantienen, lo que cambia son las direcciones MAC de las tramas que son de los dos routers intermedios.

Tipo	128
Dirección Fuente	2001:db8:1:0:201:96ff:fe1d:8173 (PC0), 0001.961d.8173 (MAC Fa0 PC0)
Dirección Destino	2001:db8:3:0:20c:cfff:fe97:7944 (PC1), 0002.4a35.6301 (MAC Fa0/0 Router0)
Dato	
Tipo	128
Dirección Fuente	2001:db8:1:0:201:96ff:fe1d:8173 (PC0), 0002.4a35.6302 (MAC Fa0/1 Router0)
Dirección Destino	2001:db8:3:0:20c:cfff:fe97:7944 (PC1), 00d0.bc88.ed02 (MAC Fa0/1 Router1)
Dato	
Tipo	128
Dirección Fuente	2001:db8:1:0:201:96ff:fe1d:8173 (PC0), 00d0.bc88.ed01 (MAC Fa0/0 Router1)
Dirección Destino	2001:db8:3:0:20c:cfff:fe97:7944 (PC1), 000c.cf97.7944 (MAC Fa0 PC1)
Dato	
Tipo	129
Dirección Fuente	2001:db8:3:0:20c:cfff:fe97:7944 (PC1), 000c.cf97.7944 (MAC Fa0 PC1)
Dirección Destino	2001:db8:1:0:201:96ff:fe1d:8173 (PC0), 00d0.bc88.ed01 (MAC Fa0/0 Router1)
Dato	
Tipo	129
Dirección Fuente	2001:db8:3:0:20c:cfff:fe97:7944 (PC1), 00d0.bc88.ed02 (MAC Fa0/1 Router1)
Dirección Destino	2001:db8:1:0:201:96ff:fe1d:8173 (PC0), 0002.4a35.6302 (MAC Fa0/1 Router0)
Dato	
Tipo	129
Dirección Fuente	2001:db8:3:0:20c:cfff:fe97:7944 (PC1), 0002.4a35.6301 (MAC Fa0/0 Router0)
Dirección Destino	2001:db8:1:0:201:96ff:fe1d:8173 (PC0), 0001.961d.8173 (MAC Fa0 PC0)
Dato	

e.

Estos son los paquetes que se envían desde que pongo configuración automática de IPv6 en PC0 hasta que aparece *ipv6 request successful*





Tipo	133 (Router Solicitation Message)
Dirección Fuente	fe80::201:96ff:fe1d:8173 (PC0), 0001.961d.8173 (MAC Fa0 PC0)
Dirección Destino	ff02::2 (multicast local all routers)
Dato	
Tipo	134 (Router Advertisement Message)
Dirección Fuente	fe80::202:4aff:fe35:6301 (Fa0/0 Router0), 0002.4a35.6301
Dirección Destino	ff02::1 (multicast local all nodes)
Dato	
Tipo	135 (Neighbor Message)
Dirección Fuente	2001:db8:1:0:201:96ff:fe1d:8173 (PC0), 0001.961d.8173 (MAC Fa0 PC0)
Dirección Destino	ff02::1:ff1d:8173
Dato	