



## **Universidad rey Juan Carlos**

**Escuela Técnica Superior de Ingeniería de Telecomunicación**

**Sistemas telemáticos**

**Practica 2**

**OSPF**

Iván Moreno Martín

2º GIT

## **1.1 Activación de R1**

A continuación vamos a configurar r1 de la siguiente manera, para ello vamos a activar el protocolo OSPF en /etc/quagga/daemons y seguidamente modificamos el fichero de r1 /etc/quagga/ospfd.conf de la siguiente manera:

```
mc - ~
/etc/quagga/ospfd.conf [-M--] 0 L:[ 1+11 12/ 13] *(209 / 210b)= . 10 0x0A
! #-*- ospf -*-

hostname ospfd
password zebra

router ospf
    router-id 17.0.0.1.
    passive-interface eth0
    network 15.0.0.0/20 area 0.0.0.0
    network 11.0.0.0/20 area 0.0.0.0
    network 17.0.0.0/20 area 0.0.0.0

1 Help 2 Save 3 Mark 4 Replace 5 Copy 6 Move 7 Search 8 Delete 9 PullIn 10 Quit
```

### **1.1.1.**

a)

En este caso como hemos configurado pc1 como interfaz pasiva no nos llegarán mensajes de HELLO. Por tanto nos centramos en las capturas de r2 y r5. Como vemos en R2 los mensajes HELLO se mandan cada 10 segundos y además coincide con el campo HELLO Interval

| No. | Time       | Source   | Destination | Protocol | Length | Info   |
|-----|------------|----------|-------------|----------|--------|--|
| 1   | 0.000000   | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 2   | 0.026315   | 11.0.0.1 | 224.0.0.22  | IGMPv3   | 54     | Membership Report / Join group 224.0.0.5 for any sources |
| 3   | 0.0296325  | 11.0.0.1 | 224.0.0.22  | IGMPv3   | 54     | Membership Report / Join group 224.0.0.5 for any sources |
| 4   | 10.003535  | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 5   | 20.009017  | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 6   | 30.012050  | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 7   | 40.017165  | 11.0.0.1 | 224.0.0.22  | IGMPv3   | 54     | Membership Report / Join group 224.0.0.6 for any sources |
| 8   | 40.018687  | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 9   | 44.715228  | 11.0.0.1 | 224.0.0.22  | IGMPv3   | 54     | Membership Report / Join group 224.0.0.6 for any sources |
| 10  | 50.024986  | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 11  | 60.031083  | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 12  | 70.033902  | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 13  | 80.040302  | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 14  | 90.050935  | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 15  | 100.055740 | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 16  | 110.062068 | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 17  | 120.068027 | 11.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |

> Frame 1: 78 bytes on wire (624 bits), 78 bytes captured (624 bits)  
> Ethernet II, Src: 2e:c9:61:78:80:79 (2e:c9:61:78:80:79), Dst: IPv4mcast\_05 (01:00:5e:00:00:05)  
> Internet Protocol Version 4, Src: 11.0.0.1, Dst: 224.0.0.5  
Open Shortest Path First  
  > OSPF Header  
    > OSPF Hello Packet  
      Network Mask: 255.255.255.0  
      Hello Interval [sec]: 10  
      > Options: 0x02 ((E) External Routing)  
      Router Priority: 1

Como vemos también en r5 los mensajes HELLO se repiten cada 10 segundos y también coincide con su HELLO interval.

r5.cap

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

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

| No. | Time       | Source   | Destination | Protocol | Length | Info   |
|-----|------------|----------|-------------|----------|--------|--|
| 1   | 0.000000   | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 2   | 0.025650   | 15.0.0.1 | 224.0.0.22  | IGMPv3   | 54     | Membership Report / Join group 224.0.0.5 for any sources |
| 3   | 1.1348975  | 15.0.0.1 | 224.0.0.22  | IGMPv3   | 54     | Membership Report / Join group 224.0.0.5 for any sources |
| 4   | 10.003744  | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 5   | 20.009206  | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 6   | 30.012198  | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 7   | 40.017029  | 15.0.0.1 | 224.0.0.22  | IGMPv3   | 54     | Membership Report / Join group 224.0.0.6 for any sources |
| 8   | 40.018888  | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 9   | 47.907790  | 15.0.0.1 | 224.0.0.22  | IGMPv3   | 54     | Membership Report / Join group 224.0.0.6 for any sources |
| 10  | 50.025158  | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 11  | 60.031293  | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 12  | 70.034441  | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 13  | 80.040445  | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 14  | 90.051112  | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 15  | 100.055932 | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 16  | 110.062244 | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |
| 17  | 120.067463 | 15.0.0.1 | 224.0.0.5   | OSPF     | 78     | Hello Packet   |

> Frame 4: 78 bytes on wire (624 bits), 78 bytes captured (624 bits)  
> Ethernet II, Src: b6:27:df:75:14:ae (b6:27:df:75:14:ae), Dst: IPv4mcast\_05 (01:00:5e:00:00:05)  
> Internet Protocol Version 4, Src: 15.0.0.1, Dst: 224.0.0.5  
Open Shortest Path First  
OSPF Header  
OSPF Hello Packet  
Network Mask: 255.255.255.0  
Hello Interval [sec]: 10  
Options: 0x02 ((E) External Routing)  
Router Priority: 1

b)

Como hemos mencionado anteriormente la configuración realizada en r1 es la siguiente:

router-id 17.0.0.1

passive-interface eth0

network 15.0.0.0/20 area 0.0.0.0

network 11.0.0.0/20 area 0.0.0.0

network 17.0.0.0/20 area 0.0.0.0

Comprobamos en las capturas de r2 y r5 y observamos que efectivamente el campo AreaID es el 0.0.0.0

|               |            |                                |            |               |                                |            |            |                                |
|---------------|------------|--------------------------------|------------|---------------|--------------------------------|------------|------------|--------------------------------|
| 20.190.107950 | 11.0.0.1   | 224.0.0.5                      | OSPF       | 20.190.106736 | 15.0.0.1                       | 224.0.0.5  | OSPF       | 78 Hello                       |
| ▼ OSPF Header | Version: 2 | Message Type: Hello Packet (1) | Captura R2 | Version: 2    | Message Type: Hello Packet (1) | Captura R5 | Version: 2 | Message Type: Hello Packet (1) |

c)

En las capturas realizadas en r2 y en r5 hemos comprobado que en el campo requerido obtenemos:

**OSPF HEADER → Source OSPF Router : 17.0.0.1**

Que coincide con la configuración realizada en el fichero ospfd.conf de r1 (route-id 17.0.0.1)

d)

Observamos en las capturas que en los mensajes anteriores a 40 segundos no existe cambio en el DR ni en el DBR. El cambio se produce a partir de los 40 segundos. En el caso de R2 pasados estos segundos su DR se ha modificado de 0.0.0.0 a 11.0.0.1 y en el caso de r5 de 0.0.0.0 a 15.0.0.1, en ambos casos no se modifica su DBR que sigue siendo 0.0.0.0. Esto se debe a tres razones:

1. Cada router elige como DR al router que envíe mayor número en el campo Prio de los mensajes HELLO
2. En caso de empate en ese campo, cada router elige como DR el que tenga mayor identificador (Source OSPF Router)
3. Una vez elegido el DR se coloca la IP en el campo correspondiente de los mensajes HELLO

### **1.1.2**

En nuestro caso no se observan en la captura porque para poder ver estos mensajes debería haber pasado al menos 1800 segundos para que los routers se intercambiasen información sobre sus bases de datos, nuestra captura solo tiene una duración de 120 segundos. Por otro lado solo hemos configurado OSPF en r1 por lo que no llegan los mensajes DB Description porque no ha descubierto ningún router vecino que le mandase mensajes HELLO.

### **1.1.3**

Consultamos las rutas aprendidas por el router r1 con el comando route y comprobamos que:

17.0.0.0

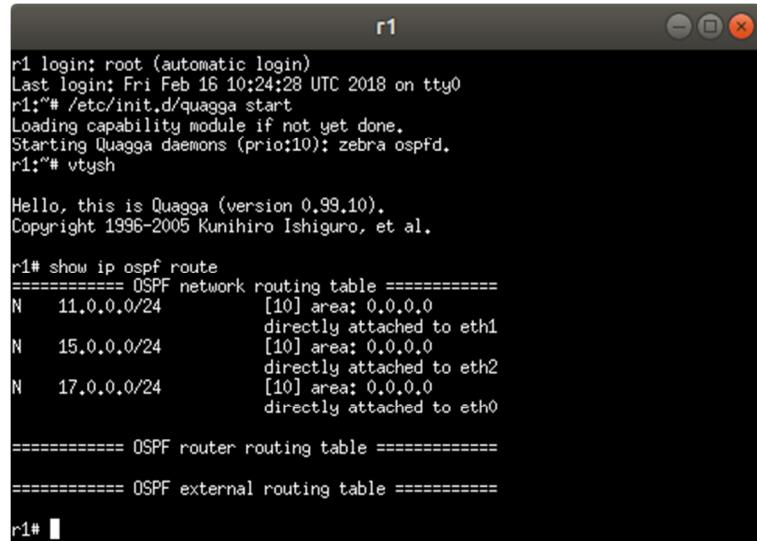
15.0.0.0

11.0.0.0

Por lo que llegamos a la conclusión de que r1 solo conoce sus propias direcciones y no aprende otras.

#### 1.1.4

Al introducir el comando **show ip ospf route** vemos:



A terminal window titled 'r1' showing the output of the 'show ip ospf route' command. The output includes the OSPF network routing table, OSPF router routing table, and OSPF external routing table. The network table lists routes for 11.0.0.0/24, 15.0.0.0/24, and 17.0.0.0/24 with area 0.0.0.0 and direct attachment to interfaces eth1, eth2, and eth0 respectively.

```
r1 login: root (automatic login)
Last login: Fri Feb 16 10:24:28 UTC 2018 on tty0
r1:# /etc/init.d/quagga start
Loading capability module if not yet done.
Starting Quagga daemons (priorities: zebra ospfd).
r1:# vtysh

Hello, this is Quagga (version 0.99.10).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

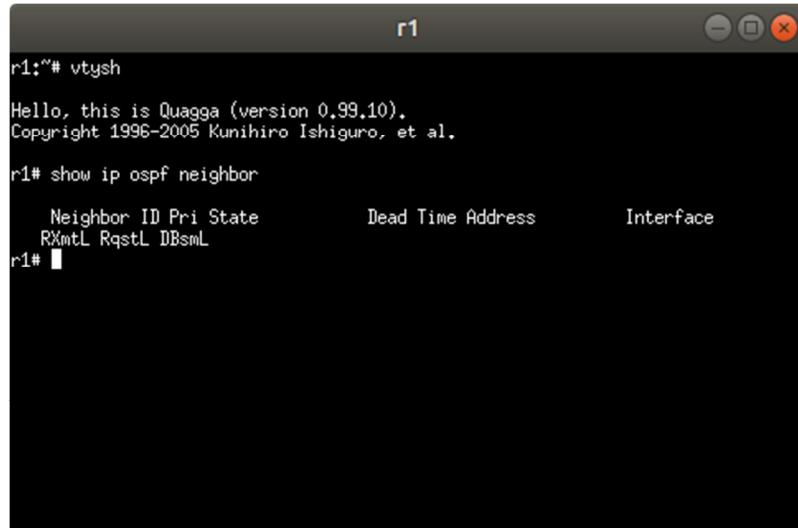
r1# show ip ospf route
=====
OSPF network routing table =====
N 11.0.0.0/24      [10] area: 0.0.0.0
                           directly attached to eth1
N 15.0.0.0/24      [10] area: 0.0.0.0
                           directly attached to eth2
N 17.0.0.0/24      [10] area: 0.0.0.0
                           directly attached to eth0

=====
OSPF router routing table =====
===== OSPF external routing table =====

r1#
```

#### 1.1.5

Comprobamos dentro de VTY con el comando **show ip ospf neighbor** y no deberíamos obtener vecinos ya que solo tenemos activado OSPF en un router:



A terminal window titled 'r1' showing the output of the 'show ip ospf neighbor' command. The output shows a header for the neighbor table with columns: Neighbor ID, Pri, State, Dead Time, Address, and Interface. Below the header, there is a single row entry: 'r1#'. This indicates that there are no neighbors present on the router.

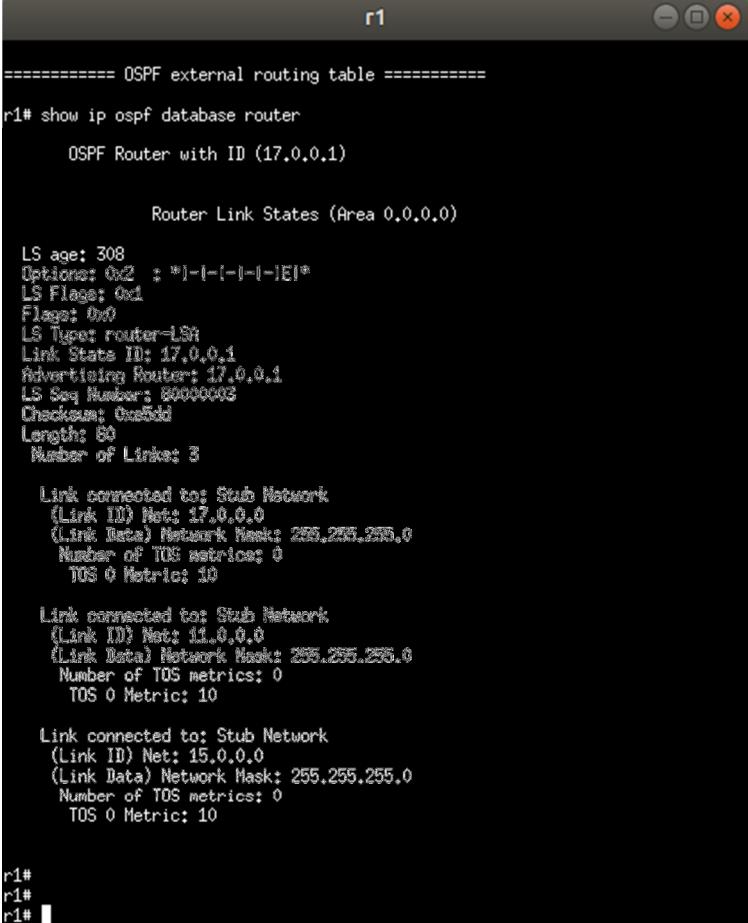
```
r1:# vtysh

Hello, this is Quagga (version 0.99.10).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

r1# show ip ospf neighbor

   Neighbor ID Pri State          Dead Time Address      Interface
   RXmtL RqstL DBsmL
r1#
```

### 1.1.6



A terminal window titled 'r1' displaying the output of the command 'show ip ospf database router'. The output shows the Router Link States for Area 0.0.0.0. It details three stub network connections with Link ID 17.0.0.1, Network Mask 255.255.255.0, and TOS 0 Metric 10. The LS age is 308 and the LS Seq Number is 80000003.

```
===== OSPF external routing table =====
r1# show ip ospf database router
      OSPF Router with ID (17.0.0.1)

      Router Link States (Area 0.0.0.0)

      LS age: 308
      Options: 0x2  : *|-(-|-)-|E|*
      LS Flags: 0x1
      Flags: 0x0
      LS Type: router-LSR
      Link State ID: 17.0.0.1
      Advertising Router: 17.0.0.1
      LS Seq Number: 80000003
      Checksum: 0x55d1
      Length: 80
      Number of Links: 3

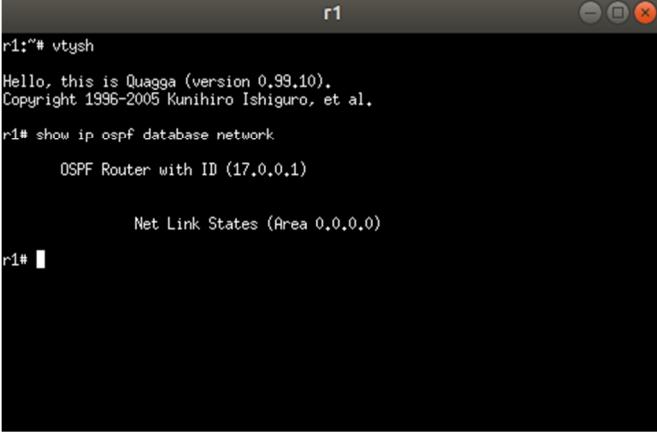
      Link connected to: Stub Network
      (Link ID) Net: 17.0.0.0
      (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
      TOS 0 Metric: 10

      Link connected to: Stub Network
      (Link ID) Net: 11.0.0.0
      (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
      TOS 0 Metric: 10

      Link connected to: Stub Network
      (Link ID) Net: 15.0.0.0
      (Link Data) Network Mask: 255.255.255.0
      Number of TOS metrics: 0
      TOS 0 Metric: 10

r1#
r1#
r1#
```

### 1.1.7



A terminal window titled 'r1' displaying the output of the command 'show ip ospf database network'. The output shows the Net Link States for Area 0.0.0.0. It lists one network entry with a Network Mask of 255.255.255.0 and a TOS 0 Metric of 10.

```
r1:"# vtysh
Hello, this is Quagga (version 0.99.10).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

r1# show ip ospf database network
      OSPF Router with ID (17.0.0.1)

      Net Link States (Area 0.0.0.0)

r1#
```

La única network que nos aparece es la que está definida en r1 con una única área.

## **1.2 Activación de R2**

### **1.2.1**

a)

En un primer momento vemos que a r1 le llega un paquete HELLO de parte de r2, el paso siguiente que realiza r1 es enviar una solicitud de ARP preguntando por r2. Tras la respuesta a esta solicitud ambos routers OSPF se intercambian las bases de datos para conocer LSA almacenados en sus bases de datos.

Los propósitos que podemos encontrar son los siguientes, el primero es conocer routers vecinos pertenecientes a la misma área, otro de los propósitos que se buscan con el intercambio de mensajes HELLO es establecer el DR (Designated Router).

El intercambio de bases de datos sirve para que cada uno de los routers se manden mensajes LSA que tienen en sus bases de datos y para más adelante completar sus tablas con los LSA's que les faltan a cada uno de ellos.

La IP destino que aparece en la captura de r1 es la de 224.0.0.5 para los mensajes de HELLO, luego para el intercambio de bases de datos aparece la IP 11.0.0.2

b)

Como podemos ver en la captura en el paquete LS Request en la sección de Link State Request, Advertising router (que se corresponde con el router que genera el anuncio ) vemos que la primera solicitud ha sido generada por el router r1 solicitando el LSA de 12.0.0.2 a través de la dirección 11.0.0.2, y a continuación r2 hace la misma solicitud a r1 a través de la IP 11.0.0.1

c)

El contenido del mensaje es un Router LSA de r2, que se corresponde con el LS Request enviado por éste. El mensaje incluye a la red 11.0.0.0/24 como de tipo stub. Esta información cambiará en breve, ya que la red 11.0.0.0/24 pasará de tipo stub a tipo transit.

d)

Lo que contiene el mensaje es un Router\_LSA del router r2, que se corresponde con el LS Request enviado por r1. El mensaje incluye a la red que hemos comentado en el apartado anterior (11.0.0.0/24) como stub. Esto cambiará rápidamente a transit.

Podemos observar que el campo LS Age tiene un valor muy bajo, por lo que el Router-LSA se ha generado hace poco.

e)

Estos mensajes no responden a ningún LS Request anterior. Estos son el nuevo Router-LSA del router r1 que ahora muestra la red 11.0.0.0/24 como de tipo transit, y el Network-LSA de la red 11.0.0.0/24 que crea r1 por ser el DR de esa subred. Incluye los identificadores de los routers conectados a esa subred.

Como ocurría anteriormente el campo LS Age tiene un valor muy bajo por lo que llegamos a la conclusión de que esos LSA están recientemente creados.

f)

Ese mensaje no responde a ningún LS Request anterior. Se trata del nuevo Router-LSA de r2, que ahora muestra a la red 11.0.0.0/24 como de tipo transit, y esto nos indica ahora que el DR es r1.

Nuevamente el LS Age tiene un valor muy bajo y por los mismos motivos de antes, es decir, el Router-LSA esta recientemente creado.

g)

No envía ningún mensaje Network-LSA porque r2 no es el DR de la subred. Sólo el DR genera estos mensajes.

h)

Los LS-Acknowledge contienen uno o varios LSA ACK. Estos LSA se identifican por los siguientes campos:

LSA Type, Link State ID, Advertising Router, LS Sequence Number.

i)

El DR no ha cambiado y se elige como DBR a r2, indicándose en el campo BDR de los mensajes HELLO la IP de éste router.

### 1.2.2

a)

No se ha configurado r5 con ospf por lo que únicamente recibe los mensajes de HELLO de r1 que es con quien está conectado. Los mensajes LS Update se generan entre routers con OSPF activado en una misma área.

b)

Como se ha descrito en el apartado anterior no tenemos configurado r5 con ospf, además no existe conexión directa entre r2 y r5. Si observamos la captura sólo le llegan mensajes de HELLO de r1.

### 1.2.3

a)

Partimos de que r3 no está configurado como router con ospf, los únicos mensajes que le llegan son de HELLO. Por otro lado, no le llegan los mensajes LS Update porque no ha contestado a los mensajes HELLO, con lo cual r2 no lo considera como vecino

b)

Ocurre lo mismo que en el apartado anterior, r1 no reconoce como vecino a r3 (por no estar configurado con ospf) ya que este no contestara a los mensajes HELLO mandados por r1. De hecho, sólo recibe mensajes HELLO de r2 por estar directamente conectados.

### 1.2.4

Podemos ver a través del comando route que ambos aprenden rutas nuevas

The screenshot shows two terminal windows side-by-side. The left window is titled 'r1' and the right window is titled 'r2'. Both windows display the output of the 'route' command.

**r1:**

```
r1:"# route
Kernel IP routing table
a Destination     Gateway         Genmask        Flags Metric Ref Use Iface
o 17.0.0.0        *               255.255.255.0   U     0      0    0 eth0
J 11.0.0.0        *               255.255.255.0   U     0      0    0 eth1
S 12.0.0.0        11.0.0.2       255.255.255.0   UG    20     0    0 eth1
S 15.0.0.0        *               255.255.255.0   U     0      0    0 eth2
pr1:"# [REDACTED]
```

**r2:**

```
r2:"# route
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref Use Iface
17.0.0.0        11.0.0.1       255.255.255.0   UG    20     0    0 eth0
255.255.255.0  *               0             U     0      0    0 eth0
11.0.0.0        *               255.255.255.0   U     0      0    0 eth1
12.0.0.0        *               255.255.255.0   U     0      0    0 eth1
255.255.255.0  11.0.0.1       0             UG    20     0    0 eth0
r2:"# [REDACTED]
```

### 1.2.5

The screenshot shows two terminal windows side-by-side. The left window is titled 'r1' and the right window is titled 'r2'. Both windows display the output of the 'vtysh' command.

**r1:**

```
r1:"# vtysh
Hello, this is Quagga (version 0.99.10).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

r1# show ip ospf route
===== OSPF network routing table =====
N 11.0.0.0/24      [10] area: 0.0.0.0
                           directly attached to eth1
N 12.0.0.0/24      [20] area: 0.0.0.0
                           via 11.0.0.2, eth1
N 15.0.0.0/24      [10] area: 0.0.0.0
                           directly attached to eth2
N 17.0.0.0/24      [10] area: 0.0.0.0
                           directly attached to eth0

===== OSPF router routing table =====
===== OSPF external routing table =====

r1# [REDACTED]
```

**r2:**

```
r2:"# vtysh
Hello, this is Quagga (version 0.99.10).
Copyright 1996-2005 Kunihiro Ishiguro, et al.

r2# show ip ospf route
===== OSPF network routing table =====
N 11.0.0.0/24      [10] area: 0.0.0.0
                           directly attached to eth0
N 12.0.0.0/24      [10] area: 0.0.0.0
                           directly attached to eth1
N 15.0.0.0/24      [20] area: 0.0.0.0
                           via 11.0.0.1, eth0
N 17.0.0.0/24      [20] area: 0.0.0.0
                           via 11.0.0.1, eth0

===== OSPF router routing table =====
===== OSPF external routing table =====

r2# [REDACTED]
```

En el caso de r1, vemos que para sus propias interfaces tiene la métrica por defecto en este caso 10, sin embargo, vemos que para la 12.0.0.0/24 la métrica es 20. Como podemos en r2 tenemos dos direcciones con métrica 20 que pertenecen a r1 que son la 17.0.0.0/24 y la 15.0.0.0/24

## 1.2.6

```

r1# show ip ospf route
Copyright 1996-2005 Kunihiro Ishiguro, et al.

=====
OSPF network routing table
=====
N 11.0.0/24      [10] area: 0.0.0
    directly attached to eth1
N 12.0.0/24      [20] area: 0.0.0
    via 11.0.0.2, eth1
N 15.0.0/24      [10] area: 0.0.0
    directly attached to eth2
N 17.0.0/24      [10] area: 0.0.0
    directly attached to eth0

=====
OSPF router routing table
=====

=====
OSPF external routing table
=====

r1# show ip ospf neighbor
Copyright 1996-2005 Kunihiro Ishiguro, et al.

Neighbor ID Pri State      Dead Time Address      Interface
RmtL RqstL DBsmL
12.0.0.2          1 Full/Backup   32,313s 11.0.0.2   eth1:11.0.0.1
12.0.0.2          0             0                 0
r1# []

r2# show ip ospf route
Copyright 1996-2005 Kunihiro Ishiguro, et al.

=====
OSPF network routing table
=====
N 11.0.0/24      [10] area: 0.0.0
    directly attached to eth0
N 12.0.0/24      [20] area: 0.0.0
    directly attached to eth1
N 15.0.0/24      [20] area: 0.0.0
    via 11.0.0.1, eth0
N 17.0.0/24      [20] area: 0.0.0
    via 11.0.0.1, eth0

=====
OSPF router routing table
=====

=====
OSPF external routing table
=====

r2# show ip ospf neighbor
Copyright 1996-2005 Kunihiro Ishiguro, et al.

Neighbor ID Pri State      Dead Time Address      Interface
RmtL RqstL DBsmL
17.0.0.1          1 Full/DR     31,102s 11.0.0.1   eth0:11.0.0.2
17.0.0.1          0             0                 0
r2# []

```

## 1.2.7

```

r1# show ip ospf database network
Copyright 1996-2005 Kunihiro Ishiguro, et al.

(OSPF Router with ID (17.0.0.1))

Net Link States (Area 0.0.0.0)

LS age: 30
Options: 0x2 : *I-I-I-I-IE*
LS Flags: 0x1
LS Type: network-LSA
Link State ID: 11.0.0.1 (address of Designated Router)
Advertising Router: 17.0.0.1
LS Seq Number: 80000002
Checksum: 988c2
Length: 32
Network Mask: /24
Attached Router: 17.0.0.1
Attached Router: 12.0.0.2

r1# []

r2# show ip ospf database network
Copyright 1996-2005 Kunihiro Ishiguro, et al.

(OSPF Router with ID (12.0.0.2))

Net Link States (Area 0.0.0.0)

LS age: 39
Options: 0x2 : *I-I-I-I-IE*
LS Flags: 0x8
LS Type: network-LSA
Link State ID: 11.0.0.1 (address of Designated Router)
Advertising Router: 17.0.0.1
LS Seq Number: 80000002
Checksum: 0x8bb2
Length: 32
Network Mask: /24
Attached Router: 17.0.0.1
Attached Router: 12.0.0.2

r2# []

```

## 1.2.8/1.2.9

The screenshot shows two terminal windows, r1 and r2, running vtysh. Both routers are using Quagga version 0.99.10. Router r1 has an OSPF Router ID of 17.0.0.1 and router r2 has an OSPF Router ID of 12.0.0.2. Both routers are in Area 0.0.0.0.

**r1# show ip ospf database**

| OSPF Router with ID (17.0.0.1)    |            |     |            |        |            |  |
|-----------------------------------|------------|-----|------------|--------|------------|--|
| Router Link States (Area 0.0.0.0) |            |     |            |        |            |  |
| Link ID                           | Adv Router | Age | Seq#       | CkSum  | Link count |  |
| 12.0.0.2                          | 12.0.0.2   | 860 | 0x80000004 | 0xaf3c | 2          |  |
| 17.0.0.1                          | 17.0.0.1   | 899 | 0x80000006 | 0xf2c1 | 3          |  |

**Net Link States (Area 0.0.0.0)**

| Link ID  | Adv Router | Age | Seq#       | CkSum  | Link count |  |
|----------|------------|-----|------------|--------|------------|--|
| 11.0.0.1 | 17.0.0.1   | 899 | 0x80000002 | 0x68b2 |            |  |

**r2# show ip ospf database**

| OSPF Router with ID (12.0.0.2)    |            |     |            |        |            |  |
|-----------------------------------|------------|-----|------------|--------|------------|--|
| Router Link States (Area 0.0.0.0) |            |     |            |        |            |  |
| Link ID                           | Adv Router | Age | Seq#       | CkSum  | Link count |  |
| 12.0.0.2                          | 12.0.0.2   | 871 | 0x80000004 | 0xaf3c | 2          |  |
| 17.0.0.1                          | 17.0.0.1   | 912 | 0x80000006 | 0xf2c1 | 3          |  |

**Net Link States (Area 0.0.0.0)**

| Link ID  | Adv Router | Age | Seq#       | CkSum  | Link count |  |
|----------|------------|-----|------------|--------|------------|--|
| 11.0.0.1 | 17.0.0.1   | 912 | 0x80000002 | 0x68b2 |            |  |

## 1.3 Activación de R3 y R4

### 1.3.1

En la red 12.0.0.0/24 el DR no debería cambiar, es decir sigue siendo r2. Al arrancar r3 y r4 a la vez se elegirá el DBR (el que tenga mayor identificador).

### 1.3.2/1.3.3

Los mensajes LS Update que reenvía r3 por el método de flood, al ser recibidos por r4 tendrán en el campo Advertising Router el ID del router r4.

### 1.3.4

Los mensajes que deberían de aparecer son mensajes HELLO cada 10 segundos. También deberían aparecer mensajes de Router-LSA, Network-LSA y LS Acknowledge.

### 1.3.5

The screenshot shows four terminal windows, r1, r2, r3, and r4, running vtysh. Router r1 has an OSPF Router ID of 17.0.0.1, r2 has 12.0.0.2, r3 has 11.0.0.1, and r4 has 13.0.0.1. All routers are in Area 0.0.0.0.

**r1# show ip route**

| OSPF network routing table |             |      |               |  |  |  |
|----------------------------|-------------|------|---------------|--|--|--|
| N                          | 11.0.0.0/24 | [10] | area: 0.0.0.0 |  |  |  |
| N                          | 12.0.0.0/24 | [20] | area: 0.0.0.0 |  |  |  |
| N                          | 13.0.0.0/24 | [30] | area: 0.0.0.0 |  |  |  |
| N                          | 14.0.0.0/24 | [40] | area: 0.0.0.0 |  |  |  |
| N                          | 15.0.0.0/24 | [30] | area: 0.0.0.0 |  |  |  |
| N                          | 16.0.0.0/24 | [20] | area: 0.0.0.0 |  |  |  |
| N                          | 17.0.0.0/24 | [30] | area: 0.0.0.0 |  |  |  |

**r2# show ip route**

| OSPF network routing table |             |      |               |  |  |  |
|----------------------------|-------------|------|---------------|--|--|--|
| N                          | 11.0.0.0/24 | [10] | area: 0.0.0.0 |  |  |  |
| N                          | 12.0.0.0/24 | [20] | area: 0.0.0.0 |  |  |  |
| N                          | 13.0.0.0/24 | [30] | area: 0.0.0.0 |  |  |  |
| N                          | 14.0.0.0/24 | [40] | area: 0.0.0.0 |  |  |  |
| N                          | 15.0.0.0/24 | [40] | area: 0.0.0.0 |  |  |  |
| N                          | 16.0.0.0/24 | [10] | area: 0.0.0.0 |  |  |  |
| N                          | 17.0.0.0/24 | [40] | area: 0.0.0.0 |  |  |  |

**r3# show ip route**

| OSPF network routing table |             |      |               |  |  |  |
|----------------------------|-------------|------|---------------|--|--|--|
| N                          | 11.0.0.0/24 | [10] | area: 0.0.0.0 |  |  |  |
| N                          | 12.0.0.0/24 | [20] | area: 0.0.0.0 |  |  |  |
| N                          | 13.0.0.0/24 | [30] | area: 0.0.0.0 |  |  |  |
| N                          | 14.0.0.0/24 | [40] | area: 0.0.0.0 |  |  |  |
| N                          | 15.0.0.0/24 | [30] | area: 0.0.0.0 |  |  |  |
| N                          | 16.0.0.0/24 | [20] | area: 0.0.0.0 |  |  |  |
| N                          | 17.0.0.0/24 | [30] | area: 0.0.0.0 |  |  |  |

**r4# show ip route**

| OSPF network routing table |             |      |               |  |  |  |
|----------------------------|-------------|------|---------------|--|--|--|
| N                          | 11.0.0.0/24 | [10] | area: 0.0.0.0 |  |  |  |
| N                          | 12.0.0.0/24 | [20] | area: 0.0.0.0 |  |  |  |
| N                          | 13.0.0.0/24 | [30] | area: 0.0.0.0 |  |  |  |
| N                          | 14.0.0.0/24 | [40] | area: 0.0.0.0 |  |  |  |
| N                          | 15.0.0.0/24 | [40] | area: 0.0.0.0 |  |  |  |
| N                          | 16.0.0.0/24 | [10] | area: 0.0.0.0 |  |  |  |
| N                          | 17.0.0.0/24 | [40] | area: 0.0.0.0 |  |  |  |

### 1.3.6

### 1.3.7

```
r1# show ip ospf database router
OSPF Router with ID (17.0.0.1)

Router Link States (Area 0,0,0)
LS age: 984
Options: 0x2 : *|I-|-I|-I|-E*
LS Flags: 0x6
Flags: 0x0
LS Type: router-LSA
Link State ID: 12.0.0.2
Advertising Router: 12.0.0.2
LS Seq Number: 80000006
Checksum: 0x664
Length: 48
Number of Links: 2

Link connected to; a Transit Network
  (Link ID) Designated Router address: 11.0.0.1
  (Link Data) Router Interface address: 11.0.0.2
  Number of TOS metrics: 0
  TOS 0 Metric: 10

Link connected to; a Transit Network
  (Link ID) Designated Router address: 12.0.0.2
  (Link Data) Router Interface address: 12.0.0.2
  Number of TOS metrics: 0
  TOS 0 Metric: 10

LS age: 984
Options: 0x2 : *|I-|-I|-I|-E*
LS Flags: 0x6
Flags: 0x0
LS Type: router-LSA
Link State ID: 15.0.0.4
Advertising Router: 15.0.0.4
LS Seq Number: 80000005
Checksum: 0x664
Length: 80
Number of Links: 3

Link connected to; a Transit Network
  (Link ID) Designated Router address: 13.0.0.4
  (Link Data) Router Interface address: 13.0.0.4
  Number of TOS metrics: 0
  TOS 0 Metric: 10

Link connected to; a Stub Network
  (Link ID) Net: 14.0.0.0
  (Link Data) Network Mask: 255,255,255,0
  Number of TOS metrics: 0
  TOS 0 Metric: 10

Link connected to; a Stub Network
  (Link ID) Net: 15.0.0.0
  (Link Data) Network Mask: 255,255,255,0
  Number of TOS metrics: 0
  TOS 0 Metric: 10

Link connected to; a Transit Network
  (Link ID) Designated Router address: 13.0.0.5
  (Link Data) Router Interface address: 13.0.0.5
  Number of TOS metrics: 0
  TOS 0 Metric: 10

LS age: 1260
Options: 0x2 : *|I-|-I|-I|-E*
LS Flags: 0x1
Flags: 0x0
LS Type: router-LSA
Link State ID: 17.0.0.1
Advertising Router: 17.0.0.1
LS Seq Number: 80000006
Checksum: 0x2c1
Length: 60
Number of Links: 3

Link connected to; a Stub Network
  (Link ID) Net: 17.0.0.0
  (Link Data) Network Mask: 255,255,255,0
  Number of TOS metrics: 0
  TOS 0 Metric: 10

Link connected to; a Transit Network
  (Link ID) Designated Router address: 11.0.0.1
  (Link Data) Router Interface address: 11.0.0.1
  Number of TOS metrics: 0
  TOS 0 Metric: 10

Link connected to; a Stub Network
  (Link ID) Net: 15.0.0.0
  (Link Data) Network Mask: 255,255,255,0
  Number of TOS metrics: 0
  TOS 0 Metric: 10
```

|  |   |
|--|---|
| OSPF Router with ID (13.0.0.3)   |   |
| Router Link States (Area 0.0.0.0)  |   |
| LS age: 775<br>Options: 0x2 : "1-1-1-1-1-E!"<br>LS Flags: 0x0<br>Flags: 0x0<br>LS Type: router-LSA<br>Link State ID: 12.0.0.2<br>Advertising Router: 12.0.0.2<br>LS Seq Number: 80000007<br>Checksum: 0x0400<br>Length: 48<br>Number of Links: 2 | Number of TOS metrics: 0<br>TOS 0 Metric: 10<br><br>Link connected to: a Transit Network<br>[Link ID] Designated Router address: 11.0.0.1<br>[Link Data] Router Interface address: 11.0.0.2<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10<br><br>Link connected to a Transit Network<br>[Link ID] Designated Router address: 12.0.0.2<br>[Link Data] Router Interface address: 12.0.0.2<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10<br><br>Link connected to a Transit Network<br>[Link ID] Designated Router address: 13.0.0.2<br>[Link Data] Router Interface address: 13.0.0.3<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10<br><br>Link connected to: a Transit Network<br>[Link ID] Designated Router address: 12.0.0.2<br>[Link Data] Router Interface address: 12.0.0.3<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10<br><br>Link connected to: a Transit Network<br>[Link ID] Designated Router address: 13.0.0.3<br>[Link Data] Router Interface address: 13.0.0.3<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10 |
| -Metric:   |   |

```

r1 OSPF Router with ID (17.0.0.1)
Net Link States (Area 0.0.0.0)

LS age: 202
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x1
LS Type: network-LSA
Link State ID: 11.0.0.1 (address of Designated Router)
Advertising Router: 17.0.0.1
LS Seq Number: 80000004
Checksum: 0x64b4
Length: 32
Network Mask: /24
Attached Router: 17.0.0.1
Attached Router: 12.0.0.2

LS age: 1721
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 12.0.0.2 (address of Designated Router)
Advertising Router: 12.0.0.2
LS Seq Number: 80000003
Checksum: 0x78a7
Length: 32
Network Mask: /24
Attached Router: 12.0.0.2
Attached Router: 13.0.0.3

LS age: 1692
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 15.0.0.4 (address of Designated Router)
Advertising Router: 15.0.0.4
LS Seq Number: 80000003
Checksum: 0x65a9
Length: 32
Network Mask: /24
Attached Router: 15.0.0.3
Attached Router: 16.0.0.4

r2 OSPF Router with ID (12.0.0.2)
Net Link States (Area 0.0.0.0)

LS age: 211
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 11.0.0.1 (address of Designated Router)
Advertising Router: 17.0.0.1
LS Seq Number: 80000004
Checksum: 0x64b4
Length: 32
Network Mask: /24
Attached Router: 17.0.0.1
Attached Router: 12.0.0.2

LS age: 1728
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 12.0.0.2 (address of Designated Router)
Advertising Router: 12.0.0.2
LS Seq Number: 80000003
Checksum: 0x78a7
Length: 32
Network Mask: /24
Attached Router: 12.0.0.2
Attached Router: 13.0.0.3

LS age: 1589
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 15.0.0.4 (address of Designated Router)
Advertising Router: 15.0.0.4
LS Seq Number: 80000003
Checksum: 0x65a9
Length: 32
Network Mask: /24
Attached Router: 13.0.0.3
Attached Router: 16.0.0.4

r3 OSPF Router with ID (15.0.0.3)
Net Link States (Area 0.0.0.0)

LS age: 411
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 11.0.0.1 (address of Designated Router)
Advertising Router: 17.0.0.1
LS Seq Number: 80000004
Checksum: 0x64b4
Length: 32
Network Mask: /24
Attached Router: 17.0.0.1
Attached Router: 12.0.0.2

LS age: 1628
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 12.0.0.2 (address of Designated Router)
Advertising Router: 12.0.0.2
LS Seq Number: 80000003
Checksum: 0x78a7
Length: 32
Network Mask: /24
Attached Router: 12.0.0.2
Attached Router: 13.0.0.3

LS age: 1586
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 15.0.0.4 (address of Designated Router)
Advertising Router: 15.0.0.4
LS Seq Number: 80000003
Checksum: 0x65a9
Length: 32
Network Mask: /24
Attached Router: 13.0.0.3
Attached Router: 16.0.0.4

r4 OSPF Router with ID (16.0.0.4)
Net Link States (Area 0.0.0.0)

LS age: 402
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 11.0.0.1 (address of Designated Router)
Advertising Router: 17.0.0.1
LS Seq Number: 80000004
Checksum: 0x64b4
Length: 32
Network Mask: /24
Attached Router: 17.0.0.1
Attached Router: 12.0.0.2

LS age: 1619
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x6
LS Type: network-LSA
Link State ID: 12.0.0.2 (address of Designated Router)
Advertising Router: 12.0.0.2
LS Seq Number: 80000003
Checksum: 0x78a7
Length: 32
Network Mask: /24
Attached Router: 12.0.0.2
Attached Router: 13.0.0.3

LS age: 1576
Options: 0x2 : *|-|-|-|-|E|*
LS Flags: 0x3
LS Type: network-LSA
Link State ID: 13.0.0.4 (address of Designated Router)
Advertising Router: 15.0.0.4
LS Seq Number: 80000003
Checksum: 0x65a9
Length: 32
Network Mask: /24
Attached Router: 13.0.0.3
Attached Router: 16.0.0.4

```

### 1.3.8

```

r1 OSPF Router with ID (17.0.0.1)
Router Link States (Area 0.0.0.0)

Link ID      ADV Router      Age  Seq#      CkSum  Link count
12.0.0.2     12.0.0.2       92   0x80000006 0x6ed4 2
13.0.0.3     13.0.0.3       39   0x80000006 0x7a53 2
16.0.0.4     16.0.0.4       38   0x80000006 0xe2c5 3
17.0.0.1     17.0.0.1       418  0x80000007 0xf0c2 3

Net Link States (Area 0.0.0.0)

Link ID      ADV Router      Age  Seq#      CkSum
11.0.0.1     17.0.0.1       418  0x80000003 0x6bb3
12.0.0.2     12.0.0.2       83   0x80000003 0x78a7
13.0.0.4     16.0.0.4       43   0x80000005 0x65a9

r2 OSPF Router with ID (12.0.0.2)
Router Link States (Area 0.0.0.0)

Link ID      ADV Router      Age  Seq#      CkSum  Link count
12.0.0.2     12.0.0.2       95   0x80000006 0x6ed4 2
13.0.0.3     13.0.0.3       51   0x80000006 0x7a53 2
16.0.0.4     16.0.0.4       50   0x80000005 0xe2c5 3
17.0.0.1     17.0.0.1       432  0x80000007 0xf0c2 3

Net Link States (Area 0.0.0.0)

Link ID      ADV Router      Age  Seq#      CkSum
11.0.0.1     17.0.0.1       432  0x80000003 0x6bb3
12.0.0.2     12.0.0.2       95   0x80000003 0x78a7
13.0.0.4     16.0.0.4       55   0x80000005 0x65a9

r3 Hello, this is Quagga (version 0.99.10).
Copyright 1996-2005 Kunihiro Ishiguro, et al.
r3# show ip ospf database
OSPF Router with ID (15.0.0.3)
Router Link States (Area 0.0.0.0)

Link ID      ADV Router      Age  Seq#      CkSum  Link count
12.0.0.2     12.0.0.2       112  0x80000006 0x6ed4 2
13.0.0.3     13.0.0.3       55   0x80000005 0x7a53 2
16.0.0.4     16.0.0.4       55   0x80000006 0xe2c5 3
17.0.0.1     17.0.0.1       449  0x80000007 0xf0c2 3

Net Link States (Area 0.0.0.0)

Link ID      ADV Router      Age  Seq#      CkSum
11.0.0.1     17.0.0.1       449  0x80000003 0x6bb3
12.0.0.2     12.0.0.2       112  0x80000003 0x78a7
13.0.0.4     16.0.0.4       70   0x80000005 0x65a9

r4 OSPF Router with ID (15.0.0.4)
Router Link States (Area 0.0.0.0)

Link ID      ADV Router      Age  Seq#      CkSum  Link count
12.0.0.2     12.0.0.2       122  0x80000006 0x6ed4 2
13.0.0.3     13.0.0.3       77   0x80000005 0x7a53 2
16.0.0.4     16.0.0.4       74   0x80000006 0xe2c5 3
17.0.0.1     17.0.0.1       430  0x80000007 0xf0c2 3

Net Link States (Area 0.0.0.0)

Link ID      ADV Router      Age  Seq#      CkSum
11.0.0.1     17.0.0.1       450  0x80000003 0x6bb3
12.0.0.2     12.0.0.2       123  0x80000003 0x78a7
13.0.0.4     16.0.0.4       79   0x80000005 0x65a9

```

## **1.4 Activacion R5**

### **1.4.1**

Realizando esta operación nos sale aproximadamente una espera de 0,5 milisegundos desde que se vuelve a arrancar quagga.

### **1.4.2**

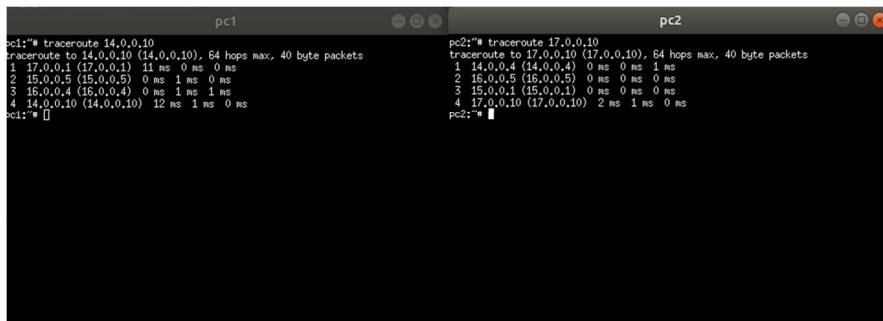
A través del comando route podemos observar que la métrica es de 40, esto se debe a que en r1 inserta por defecto 10 si además tenemos en cuenta los saltos que da, es decir,  $r1 \rightarrow r2 \rightarrow r3 \rightarrow r4$ , cada uno de ellos inserta una métrica 10 y por esta razón tenemos un resulta de métrica 40.

### **1.4.3**

Comprobamos que únicamente tenemos que configurar ospf en r5 para que la ruta a seguir sea esa, además en esta red vemos que el DR será r5 por tener la IP más grande.

La configuración de r5 es la siguiente:

```
route ospf
router-id 16.0.0.5
network 15.0.0.0/24 area 0.0.0.0
network 16.0.0.0/24 area 0.0.0.0
```



The screenshot shows two terminal windows, pc1 and pc2, running on a Linux system. Both windows display the output of the traceroute command to a destination at 17.0.0.10.

**pc1:**

```
pc1:~# traceroute 17.0.0.10
traceroute to 17.0.0.10 (14.0.0.10), 64 hops max, 40 byte packets
1 17.0.0.1 (17.0.0.1) 11 ms 0 ms 0 ms
2 15.0.0.5 (15.0.0.5) 0 ms 1 ms 0 ms
3 16.0.0.4 (16.0.0.4) 0 ms 1 ms 1 ms
4 14.0.0.10 (14.0.0.10) 12 ms 1 ms 0 ms
pc1:~#
```

**pc2:**

```
pc2:~# traceroute 17.0.0.10
traceroute to 17.0.0.10 (17.0.0.10), 64 hops max, 40 byte packets
1 14.0.0.4 (14.0.0.4) 0 ms 0 ms 1 ms
2 16.0.0.5 (16.0.0.5) 0 ms 0 ms 0 ms
3 15.0.0.1 (15.0.0.1) 0 ms 0 ms 0 ms
4 17.0.0.10 (17.0.0.10) 2 ms 1 ms 0 ms
pc2:~#
```

Comprobamos cómo ha mejorado la métrica para la red 14.0.0.0/24 desde el router r1.

```
r1:~# route
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref    Use Iface
16.0.0.0        15.0.0.5      255.255.255.0 UG    20      0        0 eth2
17.0.0.0        *              255.255.255.0 U       0      0        0 eth0
11.0.0.0        *              255.255.255.0 U       0      0        0 eth1
12.0.0.0        11.0.0.2      255.255.255.0 UG    20      0        0 eth1
13.0.0.0        11.0.0.2      255.255.255.0 UG    30      0        0 eth1
14.0.0.0        15.0.0.5      255.255.255.0 UG    30      0        0 eth2
15.0.0.0        *              255.255.255.0 U       0      0        0 eth2
r1:~#
```

Como podemos observar en la captura de pantalla anterior hemos mejorado la métrica, concretamente nos hemos ahorrado un salto, decir ahora el ping solo pasa a través de 3 routers en vez de 4.

#### 1.4.4

Como se ha indicado anteriormente, los mensajes pasan de la siguiente manera:

Pc1 → r1 → r5 → r4 → Pc2  
Pc2 → r4 → r5 → r1 → Pc1

#### 1.4.5/1.4.6

Usando el interfaz VTY podemos ver como en el caso de r4 pierde la dirección de r5 porque ha sido desconectado OSPF en él. La entrada que no reinicia la cuenta desde los 40 s es la 16.0.0.0/24 que es aquella que pertenece a r5.

El Dead Time nos indica la cuenta atrás desde el último HELLO recibido del vecino, en nuestro caso con la desconexión de OSPF en r5, éste no enviará mensajes HELLO a r4, con lo cual no se renueva el Dead Time.

| r3                        |                   | r4                        |                   |
|---------------------------|-------------------|---------------------------|-------------------|
| r3# show ip ospf neighbor |                   | r4# show ip ospf neighbor |                   |
| Neighbor ID               | Pri State         | Neighbor ID               | Pri State         |
| Rxmt RqstL DBsmL          | Dead Time Address | Rxmt RqstL DBsmL          | Dead Time Address |
| 12.0.0.2                  | 0 0               | 12.0.0.2                  | 0 0               |
| 16.0.0.4                  | 0 0               | 16.0.0.4                  | 0 0               |
| r3# show ip ospf neighbor |                   | r4# show ip ospf neighbor |                   |
| Neighbor ID               | Pri State         | Neighbor ID               | Pri State         |
| Rxmt RqstL DBsmL          | Dead Time Address | Rxmt RqstL DBsmL          | Dead Time Address |
| 12.0.0.2                  | 0 0               | 12.0.0.2                  | 0 0               |
| 16.0.0.4                  | 0 0               | 16.0.0.4                  | 0 0               |
| r3# show ip ospf neighbor |                   | r4# show ip ospf neighbor |                   |
| Neighbor ID               | Pri State         | Neighbor ID               | Pri State         |
| Rxmt RqstL DBsmL          | Dead Time Address | Rxmt RqstL DBsmL          | Dead Time Address |
| 12.0.0.2                  | 0 0               | 12.0.0.2                  | 0 0               |
| 16.0.0.4                  | 0 0               | 16.0.0.4                  | 0 0               |

### 1.4.8

Ahora que r5 tiene desactivado OSPF y ya no es el DR, los paquetes pasaran por su anterior ruta, es decir, a través de los routers que sí tienen activado ospf, en este caso r1, r2, r3 y r4. Lo comprobamos a través de traceroute.

The image shows two terminal windows side-by-side. The left window is titled 'pc1' and the right is 'pc2'. Both show the command 'traceroute 14.0.0.10' followed by the traceroute output. The output shows the path from pc1 to pc2 through routers r1, r2, r3, and r4.

```
pc1:"# traceroute 14.0.0.10
traceroute to 14.0.0.10 (14.0.0.10), 64 hops max, 40 byte packets
1 17.0.0.1 (17.0.0.1) 0 ms 0 ms 0 ms
2 11.0.0.2 (11.0.0.2) 0 ms 0 ms 0 ms
3 12.0.0.3 (12.0.0.3) 0 ms 0 ms 0 ms
4 13.0.0.4 (13.0.0.4) 0 ms 0 ms 0 ms
5 14.0.0.10 (14.0.0.10) 0 ms 0 ms 0 ms
pc1:"# []

pc2:"# traceroute 17.0.0.10
traceroute to 17.0.0.10 (17.0.0.10), 64 hops max, 40 byte packets
1 14.0.0.4 (14.0.0.4) 0 ms 0 ms 0 ms
2 13.0.0.3 (13.0.0.3) 0 ms 0 ms 0 ms
3 12.0.0.2 (12.0.0.2) 0 ms 0 ms 0 ms
4 11.0.0.1 (11.0.0.1) 0 ms 0 ms 0 ms
5 17.0.0.10 (17.0.0.10) 0 ms 0 ms 0 ms
pc2:"# ]
```

### 1.4.9

The image shows a single terminal window titled 'pc1'. It displays a detailed traceroute output from pc1 to pc2. The output shows multiple ICMP sequence numbers (seq=3 to seq=25) being sent at different times, with some packets timing out due to TTL exceeding. The final output shows the path from pc1 to pc2 through routers r1, r2, r3, and r4.

```
64 bytes from 14.0.0.10: icmp_seq=3 ttl=60 time=1.18 ms
64 bytes from 14.0.0.10: icmp_seq=4 ttl=60 time=1.19 ms
64 bytes from 14.0.0.10: icmp_seq=5 ttl=60 time=1.18 ms
64 bytes from 14.0.0.10: icmp_seq=6 ttl=60 time=1.29 ms
64 bytes from 14.0.0.10: icmp_seq=7 ttl=60 time=1.06 ms
64 bytes from 14.0.0.10: icmp_seq=8 ttl=60 time=0.498 ms
64 bytes from 14.0.0.10: icmp_seq=9 ttl=60 time=2.18 ms
64 bytes from 14.0.0.10: icmp_seq=10 ttl=60 time=1.01 ms
From 15.0.0.5 icmp_seq=11 Time to live exceeded
From 15.0.0.5 icmp_seq=12 Time to live exceeded
From 15.0.0.5 icmp_seq=13 Time to live exceeded
From 15.0.0.5 icmp_seq=14 Time to live exceeded
From 15.0.0.5 icmp_seq=15 Time to live exceeded
From 15.0.0.5 icmp_seq=16 Time to live exceeded
From 15.0.0.5 icmp_seq=17 Time to live exceeded
From 15.0.0.5 icmp_seq=18 Time to live exceeded
From 15.0.0.5 icmp_seq=19 Time to live exceeded
From 15.0.0.5 icmp_seq=20 Time to live exceeded
64 bytes from 14.0.0.10: icmp_seq=21 ttl=61 time=0.913 ms
64 bytes from 14.0.0.10: icmp_seq=22 ttl=61 time=0.973 ms
64 bytes from 14.0.0.10: icmp_seq=23 ttl=61 time=0.771 ms
64 bytes from 14.0.0.10: icmp_seq=24 ttl=61 time=0.768 ms
64 bytes from 14.0.0.10: icmp_seq=25 ttl=61 time=2.63 ms
[]
```

Como hemos pasado de la secuencia icmp\_sec=10 a la secuencia icmp\_sec=21 y como decíamos antes estos paquetes aparecen 1 vez cada segundo, entonces  $21 - 10 = 11$  s. También vemos que algunos paquetes se pierden ya que se agota su TTL, más en concreto perdemos 10 paquetes por este motivo.

La nueva ruta que siguen ahora los paquetes lo vemos a través de traceroute, y en este caso:

The image shows two terminal windows side-by-side. The left window is titled 'pc1' and the right is 'pc2'. Both show the command 'traceroute 14.0.0.10' followed by the traceroute output. The output shows the path from pc1 to pc2 through routers r1, r2, r3, and r4.

```
pc1:"# traceroute 14.0.0.10
traceroute to 14.0.0.10 (14.0.0.10), 64 hops max, 40 byte packets
1 17.0.0.1 (17.0.0.1) 0 ms 0 ms 0 ms
2 15.0.0.5 (15.0.0.5) 0 ms 0 ms 0 ms
3 16.0.0.4 (16.0.0.4) 0 ms 0 ms 0 ms
4 14.0.0.10 (14.0.0.10) 9 ms 1 ms 0 ms
pc1:"# []

pc2:"# traceroute 17.0.0.10
traceroute to 17.0.0.10 (17.0.0.10), 64 hops max, 40 byte packets
1 14.0.0.4 (14.0.0.4) 1 ms 0 ms 0 ms
2 16.0.0.5 (16.0.0.5) 0 ms 0 ms 0 ms
3 15.0.0.1 (15.0.0.1) 0 ms 0 ms 0 ms
4 17.0.0.10 (17.0.0.10) 0 ms 0 ms 0 ms
pc2:"# ]
```

## 2. Varias Áreas

### 2.1

The image shows four terminal windows labeled r1, r4, r6, and r9. Each window displays a login message, the command to start Quagga daemons, and the configuration of Quagga modules. Following this, each window shows the kernel IP routing table.

**r1:**

```
Netkit phase 2 initialization terminated
r1 login: root (automatic login)
Last login: Tue Feb 23 01:21:15 UTC 2016 on ttys1
r1:# /etc/init.d/quagga start
Loading capability module if not yet done.
Starting Quagga daemons (priorities: zebra ospfd).
r1:# route
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref    Use Iface
16.0.0.0        15.0.0.5   255.255.255.0 UG         20      0      0 eth2
17.0.0.0        *          255.255.255.0 UG         0      0      0 eth0
18.0.0.0        15.0.0.5   255.255.255.0 UG         40      0      0 eth2
11.0.0.0        *          255.255.255.0 UG         0      0      0 eth1
19.0.0.0        15.0.0.5   255.255.255.0 UG         40      0      0 eth2
12.0.0.0        11.0.0.2   255.255.255.0 UG         20      0      0 eth1
20.0.0.0        15.0.0.5   255.255.255.0 UG         50      0      0 eth2
13.0.0.0        11.0.0.2   255.255.255.0 UG         30      0      0 eth1
21.0.0.0        15.0.0.5   255.255.255.0 UG         50      0      0 eth2
14.0.0.0        15.0.0.5   255.255.255.0 UG         30      0      0 eth2
22.0.0.0        15.0.0.5   255.255.255.0 UG         30      0      0 eth2
15.0.0.0        *          255.255.255.0 UG         0      0      0 eth2
r1:#
```

**r4:**

```
Netkit phase 2 initialization terminated
r4 login: root (automatic login)
Last login: Tue Feb 23 01:22:45 UTC 2016 on ttys1
r4:# /etc/init.d/quagga start
Loading capability module if not yet done.
Starting Quagga daemons (priorities: zebra ospfd).
r4:# route
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref    Use Iface
16.0.0.0        *          255.255.255.0 UG         0      0      0 eth2
17.0.0.0        16.0.0.5   255.255.255.0 UG         30      0      0 eth2
18.0.0.0        22.0.0.6   255.255.255.0 UG         20      0      0 eth3
11.0.0.0        13.0.0.3   255.255.255.0 UG         30      0      0 eth0
19.0.0.0        22.0.0.6   255.255.255.0 UG         20      0      0 eth3
12.0.0.0        13.0.0.3   255.255.255.0 UG         20      0      0 eth0
20.0.0.0        22.0.0.6   255.255.255.0 UG         30      0      0 eth3
13.0.0.0        *          255.255.255.0 UG         0      0      0 eth0
21.0.0.0        22.0.0.6   255.255.255.0 UG         30      0      0 eth3
14.0.0.0        *          255.255.255.0 UG         0      0      0 eth1
22.0.0.0        *          255.255.255.0 UG         0      0      0 eth3
15.0.0.0        16.0.0.5   255.255.255.0 UG         20      0      0 eth2
r4:#
```

**r6:**

```
r6 login: root (automatic login)
r6:# /etc/init.d/quagga start
Loading capability module if not yet done.
Starting Quagga daemons (priorities: zebra ospfd).
r6:# route
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref    Use Iface
16.0.0.0        22.0.0.4   255.255.255.0 UG         20      0      0 eth0
17.0.0.0        22.0.0.4   255.255.255.0 UG         40      0      0 eth0
18.0.0.0        *          255.255.255.0 UG         0      0      0 eth1
11.0.0.0        22.0.0.4   255.255.255.0 UG         40      0      0 eth0
19.0.0.0        *          255.255.255.0 UG         0      0      0 eth2
12.0.0.0        22.0.0.4   255.255.255.0 UG         30      0      0 eth0
20.0.0.0        18.0.0.7   255.255.255.0 UG         20      0      0 eth1
13.0.0.0        22.0.0.4   255.255.255.0 UG         20      0      0 eth0
21.0.0.0        19.0.0.8   255.255.255.0 UG         20      0      0 eth2
14.0.0.0        22.0.0.4   255.255.255.0 UG         20      0      0 eth0
22.0.0.0        *          255.255.255.0 UG         0      0      0 eth0
15.0.0.0        22.0.0.4   255.255.255.0 UG         30      0      0 eth0
r6:#
```

**r9:**

```
r9 login: root (automatic login)
Last login: Tue Feb 23 01:24:51 UTC 2016 on ttys1
r9:# /etc/init.d/quagga start
Loading capability module if not yet done.
Starting Quagga daemons (priorities: zebra ospfd).
r9:# route
Kernel IP routing table
Destination     Gateway      Genmask      Flags Metric Ref    Use Iface
16.0.0.0        20.0.0.7   255.255.255.0 UG         40      0      0 eth0
17.0.0.0        20.0.0.7   255.255.255.0 UG         60      0      0 eth0
18.0.0.0        20.0.0.7   255.255.255.0 UG         20      0      0 eth0
11.0.0.0        20.0.0.7   255.255.255.0 UG         60      0      0 eth0
19.0.0.0        21.0.0.8   255.255.255.0 UG         20      0      0 eth1
12.0.0.0        20.0.0.7   255.255.255.0 UG         50      0      0 eth0
20.0.0.0        *          255.255.255.0 UG         0      0      0 eth0
13.0.0.0        20.0.0.7   255.255.255.0 UG         40      0      0 eth0
21.0.0.0        *          255.255.255.0 UG         0      0      0 eth1
14.0.0.0        20.0.0.7   255.255.255.0 UG         40      0      0 eth0
22.0.0.0        20.0.0.7   255.255.255.0 UG         30      0      0 eth0
15.0.0.0        20.0.0.7   255.255.255.0 UG         50      0      0 eth0
r9:#
```

### 2.2

En la base de datos de router aparecen todos los routers cada uno con sus interfaces transit con el DR correspondiente y stub.

En la base de datos de network aparecen todos los router DR de cada subred con los routers ospf unidos en esa subred.

### 2.3

En este caso comprobamos a través del interfaz VTY que tanto r5 como r1 no tienen ningún mensaje LSU Sumary-LSA ya es ambas máquinas pertenecen a la misma área, además hemos de tener en cuenta que aún no hemos activado OSPF en r4 ni en r6 con lo cual tampoco tenemos comunicación con otras áreas de la red.

### 2.4

a) Son de tipo LSA Summary

b) El router que está anunciando estos LSA's es el router frontera r4

c) El Summary LSA que envía r4 procedente del área 0 es de métrica 10 ya que es vecino área 1. El Summary LSA que envía r4 proveniente del área tiene métrica 20 porque tiene un área intermedia y hay 2 routers de distancia .

d) Ahora la métrica para la red [22.0.0.0/25](#) es 20 (se le suma 10 porque ahora está r4 ), y la métrica para las redes del área 2 ahora tienen métrica 30 en lugar de métrica 20 por la misma razón.

## 2.5

- a) Serán de tipo Summary LSA. Los que se envían para informar de todas esas subredes que pertenecen al área 1 tendrán métrica 20 porque no está en el área 0 (en ese caso tendrían métrica 10).
- b) Cuando r7 las añada a su tabla de encaminamiento, los añadirá con métrica la que le mandara r6 + 10 que son propios de r6. Si comprobamos la tabla de encaminamiento ospf de r7 vemos que le ha sumado 10 a todas las métricas anteriores.

## 2.6

r3 la aprende de r4. No aparece en ningún mensaje.

r6 la aprende de r4. En un mensaje DB Description, donde hay un Router LSA con la id de r4  
r7 la aprende de r6. No aparece en ningún mensaje

## 2.7

r3 la aprende de r4. La aprende de un Router LSA que le envía r4 por estar en la misma área.

r6 la aprende de r4. En un mensaje DB Description que anuncia r4, donde hay un Router LSA con la id de, en el que además hay un Summary LSA en el que le informa de todas las redes del área 1.

r7 la aprende de r6. La aprende de un Summary LSA, en el que r6 le informa de todas las subredes del área 1 con sus métricas.

2.8

```
r1# show ip ospf database summary
OSPF Router with ID (17.0.0.1)

Summary Link States (Area 0.0.0.1)

r1# exit
r1:# route
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref  Use Iface
16.0.0.0        15.0.0.5      255.255.255.0 UG  20    0      0 eth2
17.0.0.0        *              255.255.255.0 U   0    0      0 eth0
18.0.0.0        15.0.0.5      255.255.255.0 UG  40    0      0 eth2
11.0.0.0        *              255.255.255.0 U   0    0      0 eth1
19.0.0.0        15.0.0.5      255.255.255.0 UG  40    0      0 eth2
12.0.0.0        11.0.0.2      255.255.255.0 UG  20    0      0 eth1
20.0.0.0        15.0.0.5      255.255.255.0 UG  50    0      0 eth2
13.0.0.0        11.0.0.2      255.255.255.0 UG  30    0      0 eth1
21.0.0.0        15.0.0.5      255.255.255.0 UG  50    0      0 eth2
14.0.0.0        15.0.0.5      255.255.255.0 UG  30    0      0 eth2
22.0.0.0        15.0.0.5      255.255.255.0 UG  30    0      0 eth2
15.0.0.0        *              255.255.255.0 U   0    0      0 eth2
r1:# []

r4:# /etc/init.d/quagga start
Loading capability module if not yet done.
Starting Quagga daemons (priorities: zebra ospfd).
r4:# fg % "tcpdump"
tcpdump -i eth3 -s0 -w /hosthome/r4.cap
72 packets captured
72 packets received by filter
0 packets dropped by kernel
r4:# route
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref  Use Iface
16.0.0.0        *              255.255.255.0 U   0    0      0 eth2
17.0.0.0        15.0.0.5      255.255.255.0 UG  30    0      0 eth0
18.0.0.0        22.0.0.6      255.255.255.0 UG  20    0      0 eth2
11.0.0.0        13.0.0.3      255.255.255.0 UG  30    0      0 eth1
19.0.0.0        22.0.0.6      255.255.255.0 UG  20    0      0 eth2
12.0.0.0        13.0.0.3      255.255.255.0 UG  30    0      0 eth0
20.0.0.0        22.0.0.6      255.255.255.0 UG  30    0      0 eth2
13.0.0.0        *              255.255.255.0 U   0    0      0 eth1
21.0.0.0        22.0.0.6      255.255.255.0 UG  30    0      0 eth2
14.0.0.0        *              255.255.255.0 U   0    0      0 eth1
22.0.0.0        *              255.255.255.0 U   0    0      0 eth2
15.0.0.0        16.0.0.5      255.255.255.0 UG  20    0      0 eth2
r4:# []

r6# last login: Tue Feb 23 16:06:05 UTC 2016 on ttym1
r6:# /etc/init.d/quagga start
Loading capability module if not yet done.
Starting Quagga daemons (priorities: zebra ospfd).
r6:# route
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref  Use Iface
16.0.0.0        22.0.0.4      255.255.255.0 UG  20    0      0 eth0
17.0.0.0        22.0.0.4      255.255.255.0 UG  40    0      0 eth0
18.0.0.0        *              255.255.255.0 U   0    0      0 eth1
11.0.0.0        22.0.0.4      255.255.255.0 UG  40    0      0 eth0
19.0.0.0        *              255.255.255.0 U   0    0      0 eth2
12.0.0.0        22.0.0.4      255.255.255.0 UG  30    0      0 eth0
20.0.0.0        18.0.0.7      255.255.255.0 UG  20    0      0 eth1
13.0.0.0        22.0.0.4      255.255.255.0 UG  20    0      0 eth0
21.0.0.0        19.0.0.8      255.255.255.0 UG  20    0      0 eth2
14.0.0.0        22.0.0.4      255.255.255.0 UG  20    0      0 eth0
22.0.0.0        *              255.255.255.0 U   0    0      0 eth0
15.0.0.0        22.0.0.4      255.255.255.0 UG  30    0      0 eth0
r6:# []

r9# last login: Tue Feb 23 15:29:53 UTC 2016 on ttym0
r9:# /etc/init.d/quagga start
Loading capability module if not yet done.
Starting Quagga daemons (priorities: zebra ospfd).
r9:# route
Kernel IP routing table
Destination     Gateway         Genmask        Flags Metric Ref  Use Iface
16.0.0.0        18.0.0.0      255.255.255.0 UG  40    0      0 eth0
17.0.0.0        18.0.0.0      255.255.255.0 UG  60    0      0 eth0
18.0.0.0        20.0.0.7      255.255.255.0 UG  20    0      0 eth0
11.0.0.0        20.0.0.7      255.255.255.0 UG  60    0      0 eth0
19.0.0.0        21.0.0.8      255.255.255.0 UG  20    0      0 eth1
12.0.0.0        20.0.0.7      255.255.255.0 UG  50    0      0 eth0
20.0.0.0        *              255.255.255.0 U   0    0      0 eth1
13.0.0.0        20.0.0.7      255.255.255.0 UG  40    0      0 eth0
21.0.0.0        *              255.255.255.0 U   0    0      0 eth1
14.0.0.0        14.0.0.0      255.255.255.0 UG  40    0      0 eth0
22.0.0.0        20.0.0.7      255.255.255.0 UG  30    0      0 eth0
15.0.0.0        20.0.0.7      255.255.255.0 UG  50    0      0 eth0
r9:# []

```

2.9

|   |   |   |
|---|---|---|
| OSPF Router with ID (21.0.0.9)  | Number of TOS metrics: 0<br>TOS 0 Metric: 10  | Length: 48<br>Number of Links: 2  |
| Router Link States (Area 0.0.0.2)   | Link connected to: a Transit Network<br>(Link ID) Designated Router address: 21.0.0.9<br>(Link Data) Router Interface address: 21.0.0.8<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10   | Link connected to: a Transit Network<br>(Link ID) Designated Router address: 18.0.0.8<br>(Link Data) Router Interface address: 18.0.0.6<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10 |
| LS age: 598<br>Options: 0x2 : *I-I-I-I-1-EI*<br>LS Flags: 0x6<br>Link ID: 21.0.0.9<br>LS Type: router-LSA<br>Link State ID: 20.0.0.7<br>Advertising Router: 20.0.0.7<br>LS Seq Number: 80000008<br>Checksum: 0xb019<br>Length: 48<br>Number of Links: 2 | LS age: 162<br>Options: 0x2 : *I-I-I-I-1-EI*<br>LS Flags: 0x6<br>Link ID: 21.0.0.9<br>LS Type: router-LSA<br>Link State ID: 21.0.0.9<br>Advertising Router: 21.0.0.9<br>LS Seq Number: 80000007<br>Checksum: 0xe6d0<br>Length: 48<br>Number of Links: 2 | Link connected to: a Transit Network<br>(Link ID) Designated Router address: 19.0.0.8<br>(Link Data) Router Interface address: 19.0.0.6<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10 |
| Link connected to: a Transit Network<br>(Link ID) Designated Router address: 18.0.0.7<br>(Link Data) Router Interface address: 18.0.0.7<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10   | Link connected to: a Transit Network<br>(Link ID) Designated Router address: 20.0.0.9<br>(Link Data) Router Interface address: 20.0.0.9<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10   | Link connected to: a Transit Network<br>(Link ID) Designated Router address: 21.0.0.9<br>(Link Data) Router Interface address: 21.0.0.9<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10 |
| Link connected to: a Transit Network<br>(Link ID) Designated Router address: 20.0.0.9<br>(Link Data) Router Interface address: 20.0.0.9<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10   | Link connected to: a Transit Network<br>(Link ID) Designated Router address: 21.0.0.9<br>(Link Data) Router Interface address: 21.0.0.9<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10   | Link connected to: a Transit Network<br>(Link ID) Designated Router address: 19.0.0.8<br>(Link Data) Router Interface address: 19.0.0.8<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10 |
| LS age: 600<br>Options: 0x2 : *I-I-I-I-1-EI*<br>LS Flags: 0x6<br>Link ID: 21.0.0.9<br>LS Type: router-LSA<br>Link State ID: 21.0.0.8<br>Advertising Router: 21.0.0.8<br>LS Seq Number: 80000008<br>Checksum: 0xb0c5<br>Length: 48<br>Number of Links: 2 | LS age: 594<br>Options: 0x2 : *I-I-I-I-1-EI*<br>LS Flags: 0x6<br>Link ID: 21.0.0.8<br>LS Type: router-LSA<br>Link State ID: 22.0.0.6<br>Advertising Router: 22.0.0.6<br>LS Seq Number: 80000004<br>Checksum: 0xf698<br>Length: 48                       | Link connected to: a Transit Network<br>(Link ID) Designated Router address: 19.0.0.8<br>(Link Data) Router Interface address: 19.0.0.8<br>Number of TOS metrics: 0<br>TOS 0 Metric: 10 |

Usando el comando en los routers (r1, r4,r6,r9) a través de la interfaz VTY, show ip ospf database network vemos que tanto r4 como r6 funcionan como si fueran router frontera entre las áreas. En r1 aparecen mensajes network LSA de 5 de vecinos en la misma área (contando también sus interfaces). En r4 por el contrario aparecen dos áreas conectadas al área 0.0.0.0 y al área 0.0.0.1, en el área 0 sólo está conectado a r6 que es el único que pertenece a ésta, y en el área 1 aparecen todos.

**Este documento, sus imágenes y capturas se encuentran también en:**

**<https://github.com/imorenoma/practica2-st>**