OSPF

Antonia Affinito, Annalisa Navarro, Stefania Zinno

October 2022

1 Introduction

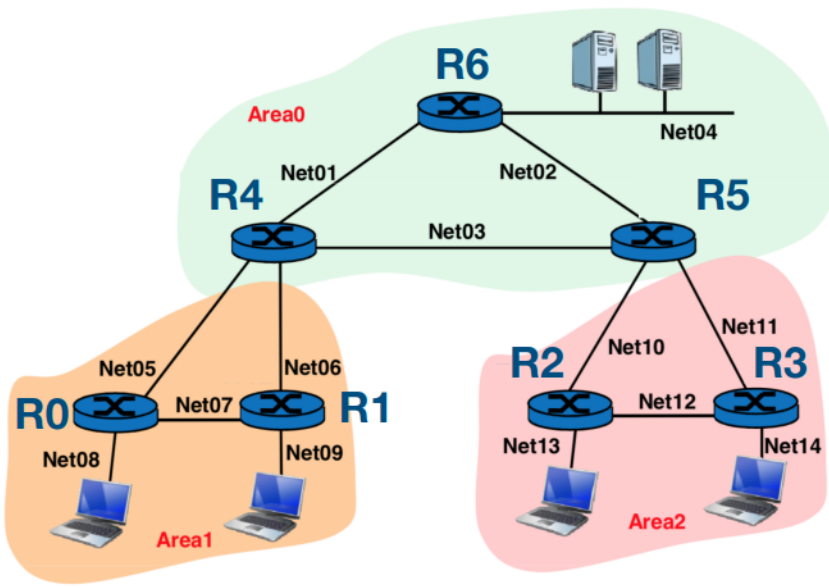


Figure 1: OSPF topology

We want to design and configure the network in figure 1 using OSPF protocol.

We have 128 addresses available 192.168.24.0/25 and the topology is made of 7 routers and 5 end systems, requiring 14 subnets.

We perform subnetting with variable length mask with:

- netmask /30 for 9 point to point links between routers,
- netmask /28 for 5 links from routers to endpoints.

2 Subnetting

End Point	Indirizzo/subnet
S01	192.168.24.50/28
C11	192.168.24.66/28
C12	192.168.24.82/28
C21	192.168.24.98/28
C22	192.168.24.114/28

Network	Indirizzo/subnet
Net 01	192.168.24.0/30
Net 02	192.168.24.4/30
Net 03	192.168.24.8/30
	192.168.24.12/30
Net 05	192.168.24.16/30
Net 06	192.168.24.20/30
Net 07	192.168.24.24/30
	192.168.24.28/30
Net 10	192.168.24.32/30
Net 11	192.168.24.36/30
Net 12	192.168.24.40/30
Net 04	192.168.24.48/28
Net 08	192.168.24.64/28
Net 09	192.168.24.80/28
Net 13	192.168.24.96/28
Net 14	192.168.24.112/28

3 Starting OSPF daemon

On each router you need to enable OSPF daemon

- Start the device
- Open auxiliary shell
- Open the daemons configuration file in *rw* mode :

```
# vi /etc/frr/daemons
```

- Change $ospfd = no$ in $ospfd = yes$ (find the row, press 'i' to update it, then press esc)

```
ospfd=yes
ospf6d=no
ripd=no
ripngd=no
isisd=no
pimd=no
ldpd=no
nhrpd=no
eigrpd=no
babeld=no
sharpd=no
```

- Save and close (press :wq and then enter)
- Reboot the device

```
# reboot
```

3.1 Make Router configuration persistent

- Right click on router
- Configure
- Advanced
- Paste *etc/frr* in the second text area

4 Configure Network in GNS-3

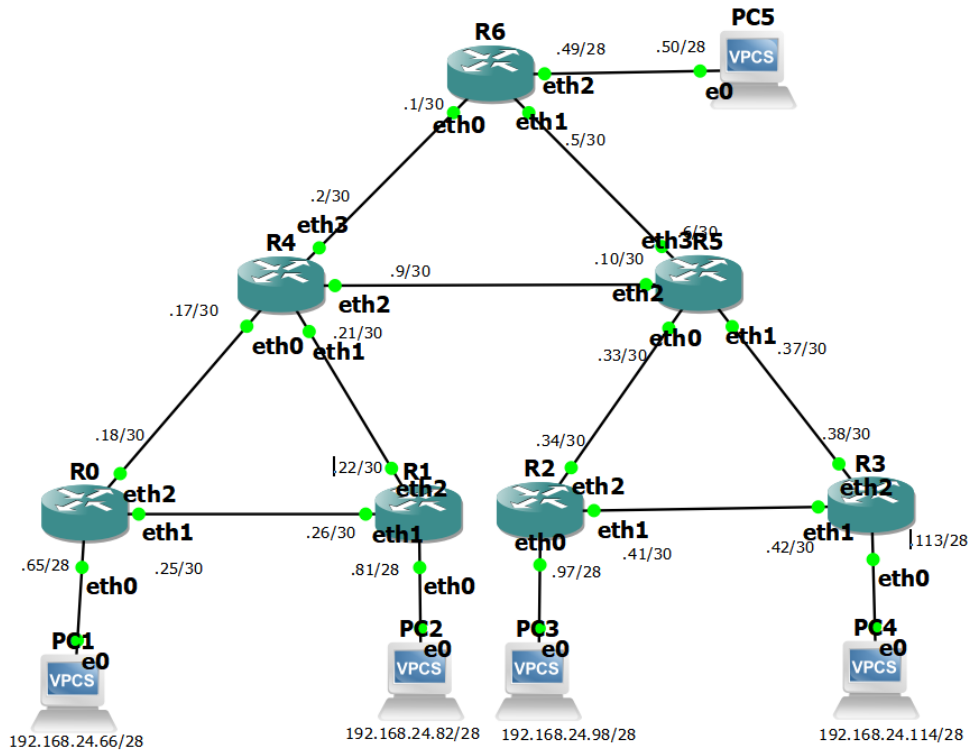


Figure 2: Network simulated in GNS-3

4.1 Routers configuration

To open a Cisco-like command line and enter configuration mode type:

```
# vtysh
# config
```

For R0 we show how to configure it line by line, for the following ones we just show the running configuration, that can be copied and pasted once entered the configuration mode.

- R0

```
R0 (config) # interface eth0
```

```
R0 (config-if) # ip address 192.168.24.65/28
R0 (config-if) # exit

R0 (config) # interface eth1
R0 (config-if) # ip address 192.168.24.25/30
R0 (config-if) # exit


R0 (config) # interface eth2
R0 (config-if) # ip address 192.168.24.18/30
R0 (config-if) # exit

R0 (config) # router ospf
R0 (config-router) # network 192.168.24.24/30 area 1
R0 (config-router) # network 192.168.24.64/28 area 1
R0 (config-router) # network 192.168.24.16/28 area 1
```

- R1

```
!
frr version 8.1_git
frr defaults traditional
hostname R1
no ipv6 forwarding
!
interface eth0
 ip address 192.168.24.81/28
exit
!
interface eth1
 ip address 192.168.24.26/30
exit
!
interface eth2
 ip address 192.168.24.22/30
exit
!
router ospf
 network 192.168.24.20/30 area 1
 network 192.168.24.24/30 area 1
 network 192.168.24.80/28 area 1
exit
!
end
```

- R2

```
!
frr version 8.1_git
frr defaults traditional
hostname R2
no ipv6 forwarding
!
interface eth0
 ip address 192.168.24.97/28
exit
!
interface eth1
 ip address 192.168.24.41/30
exit
!
interface eth2
 ip address 192.168.24.34/30
exit
!
router ospf
 network 192.168.24.40/30 area 2
 network 192.168.24.96/28 area 2
 network 192.168.24.32/30 area 2
exit
!
end
```

- R3

```
!
frr version 8.1_git
frr defaults traditional
hostname R3
no ipv6 forwarding
!
interface eth0
 ip address 192.168.24.113/28
exit
!
interface eth1
 ip address 192.168.24.42/30
exit
!
interface eth2
 ip address 192.168.24.38/30
exit
```

```
!
router ospf
 network 192.168.24.40/30 area 2
 network 192.168.24.112/28 area 2
 network 192.168.24.36/30 area 2
exit
!
end
```

- R4

```
!
frr version 8.1_git
frr defaults traditional
hostname R4
no ipv6 forwarding
!
interface eth0
 ip address 192.168.24.17/28
exit
!
interface eth1
 ip address 192.168.24.21/30
exit
!
interface eth2
 ip address 192.168.24.9/30
exit
!
interface eth3
 ip address 192.168.24.2/30
exit
!
router ospf
 network 192.168.24.16/30 area 1
 network 192.168.24.0/30 area 0
 network 192.168.24.8/30 area 0
 network 192.168.24.20/30 area 1

exit
!
```

- R5

```
!
frr version 8.1_git
frr defaults traditional
```

```
hostname R5
no ipv6 forwarding
!
interface eth0
 ip address 192.168.24.33/30
exit
!
interface eth1
 ip address 192.168.24.37/30
exit
!
interface eth2
 ip address 192.168.24.10/30
exit
!
interface eth3
 ip address 192.168.24.6/30
exit
!
router ospf
 network 192.168.24.32/30 area 2
 network 192.168.24.36/30 area 2
 network 192.168.24.8/30 area 0
 network 192.168.24.4/30 area 0

exit
!
end
```

- R6

```
!
frr version 8.1_git
frr defaults traditional
hostname R6
no ipv6 forwarding
!
interface eth0
 ip address 192.168.24.1/30
exit
!
interface eth1
 ip address 192.168.24.5/30
exit
!
interface eth2
```

```
 ip address 192.168.24.49/28
exit
!
router ospf
 network 192.168.24.0/30 area 0
 network 192.168.24.4/30 area 0
 network 192.168.24.48/28 area 0

exit
!
end
```

Other useful commands:

```
copy running-config startup-config
write
show run
show ip route
```

Once routers have been configured, you may need to restart the lab.

4.2 Endpoint configuration

Open shell, type:

- on PC1:

```
# ip 192.168.24.66/28 192.168.24.65
# save
```

- on PC2:

```
#ip 192.168.24.82/28 192.168.24.81
# save
```

- on PC3:

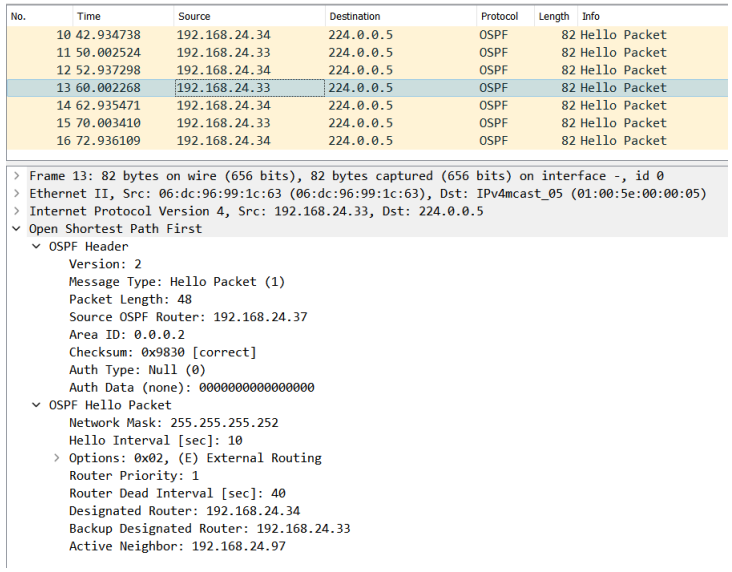
```
#ip 192.168.24.98/28 192.168.24.97
# save
```

- on PC4:

```
#ip 192.168.24.114/28 192.168.24.113
# save
```

- on PC5:

```
#ip 192.168.24.50/28 192.168.24.49
# save
```



No.	Time	Source	Destination	Protocol	Length	Info
10	42.934738	192.168.24.34	224.0.0.5	OSPF	82	Hello Packet
11	50.002524	192.168.24.33	224.0.0.5	OSPF	82	Hello Packet
12	52.937298	192.168.24.34	224.0.0.5	OSPF	82	Hello Packet
13	60.002268	192.168.24.33	224.0.0.5	OSPF	82	Hello Packet
14	62.935471	192.168.24.34	224.0.0.5	OSPF	82	Hello Packet
15	70.003410	192.168.24.33	224.0.0.5	OSPF	82	Hello Packet
16	72.936109	192.168.24.34	224.0.0.5	OSPF	82	Hello Packet

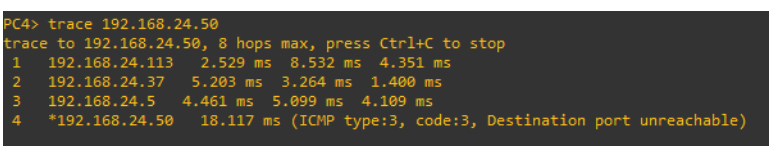
```
> Frame 13: 82 bytes on wire (656 bits), 82 bytes captured (656 bits) on interface -, id 0
> Ethernet II, Src: 06:dc:96:99:1c:63 (06:dc:96:99:1c:63), Dst: IPv4mcast_05 (01:00:5e:00:00:05)
> Internet Protocol Version 4, Src: 192.168.24.33, Dst: 224.0.0.5
v Open Shortest Path First
  v OSPF Header
      Version: 2
      Message Type: Hello Packet (1)
      Packet Length: 48
      Source OSPF Router: 192.168.24.37
      Area ID: 0.0.0.2
      Checksum: 0x9830 [correct]
      Auth Type: Null (0)
      Auth Data (none): 0000000000000000
  v OSPF Hello Packet
      Network Mask: 255.255.255.252
      Hello Interval [sec]: 10
    > Options: 0x02, (E) External Routing
      Router Priority: 1
      Router Dead Interval [sec]: 40
      Designated Router: 192.168.24.34
      Backup Designated Router: 192.168.24.33
      Active Neighbor: 192.168.24.97
```

Figure 3: Hello packets exchanged between R2 and R5

5 What happens in case of link failure?

We start capture on R2 - R5 link. We only see Hello Packets as in figure 3.

We want to know the path chosen by the routing protocol from PC4 to PC5. (How many path do we have?) In order to discover it we execute *traceroute*.



```
PC4> trace 192.168.24.50
trace to 192.168.24.50, 8 hops max, press Ctrl+C to stop
 1   192.168.24.113   2.529 ms  8.532 ms  4.351 ms
 2   192.168.24.37   5.203 ms  3.264 ms  1.400 ms
 3   192.168.24.5   4.461 ms  5.099 ms  4.109 ms
 4   *192.168.24.50   18.117 ms (ICMP type:3, code:3, Destination port unreachable)
```

Figure 4: Traceroute from PC4 to PC5

We find out that path is:

- PC4 − > R3 − > R5 − > PC5. (Fig. 7)

(Why in your opinion? How may we change this?)

Now we simulate a link failure (right click on link from R3 and R5 and click ”suspend”). (What now?)

We execute again trace command (Fig. 5)

We find out that now the path has changed to:

- PC4 − > R3 − > R2 − > R5 − > R6 − > PC5 (Fig. 8)

How is path changed?

```
PC4> trace 192.168.24.50
trace to 192.168.24.50, 8 hops max, press Ctrl+C to stop
 1   192.168.24.113   1.131 ms  1.106 ms  1.114 ms
 2   192.168.24.41   17.652 ms  3.528 ms  5.051 ms
 3   192.168.24.33   5.317 ms  5.654 ms  2.119 ms
 4   192.168.24.5   9.416 ms  1.886 ms  2.024 ms
 5   *192.168.24.50   13.566 ms (ICMP type:3, code:3, Destination port unreachable)
```

Figure 5: Traceroute from PC4 to PC5

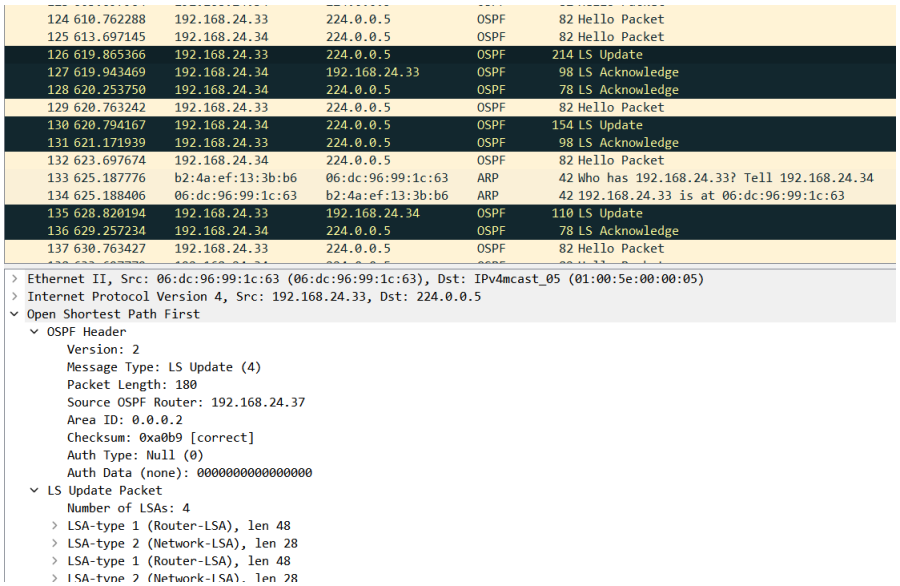


Figure 6: Update packets in case of link failure

According to OSPF protocol, whenever a change in routing information occurs, the router will generate a link-state advertisement.

This advertisement will contain the collection of all link-states on that router.

Upon receiving this information, the neighbour routers will rerun the SPF algorithm for the protocol to converge.

As soon as R5 and R6 detect link failure, they send LS Update packets, as in figure 6.

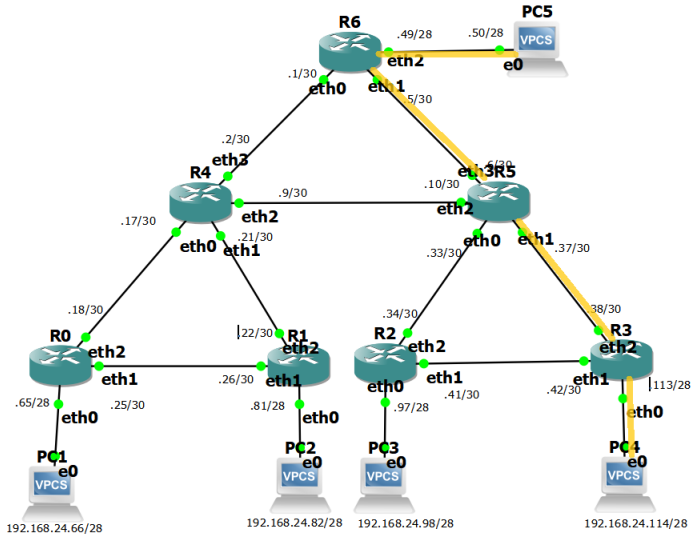


Figure 7: Path computed thanks to OSPF protocol

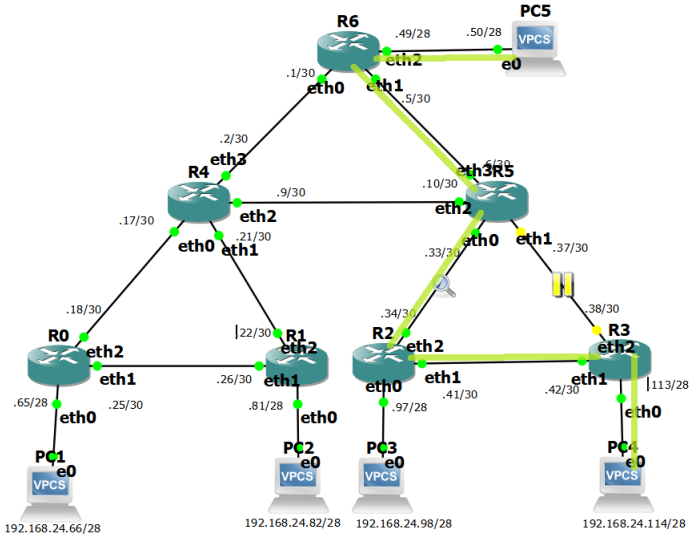


Figure 8: New path computed thanks to OSPF protocol in case of link failure