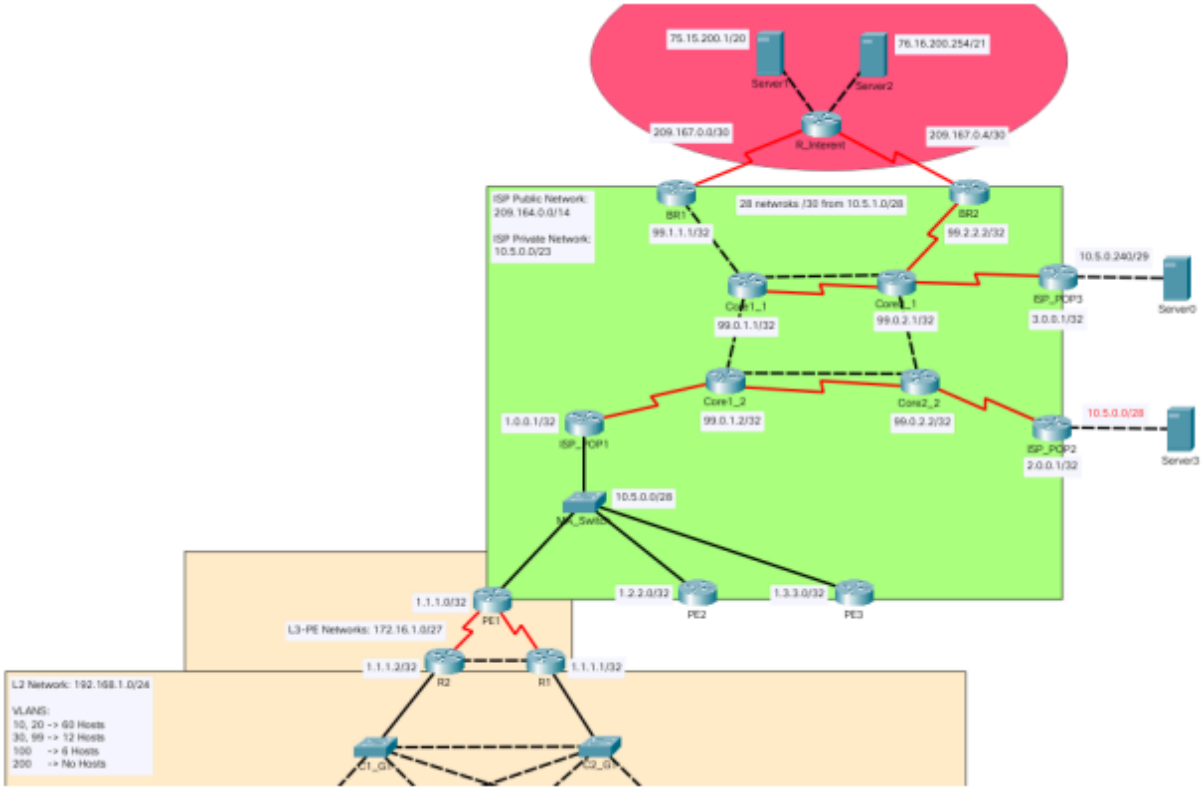
Experience 3 - Static Routing and OSPF



Part 1 - Static Routing

Topology Changes

DEVICE	PORT	CONNECTED TO
R1	gi0/0	gi0/1 - C2_G1
	gi0/1	gi0/1 - R2
R2	gi0/0	gi0/1 - C1_G1
	gi0/1	gi0/1 - R1

Sono state eseguite le seguenti configurazioni iniziali su *R2*:

- hostname
- configurazione SSH

Inter-VLAN Routing

L'interfaccia *gi0/0* di *R1* è già configurata per le VLAN 10,30 per cui sarà sufficiente eliminare le precedenti configurazioni sull'interfaccia gi0/1:

R1(config)**#int** *gi0/1.x*

R1(config-subif)**#no ip address** *192.168.1.x 255.255.255.x*
R1(config-subif)**#no encapsulation dot1Q** *x*
R1(config)**#no int** *gi0/1.x*

Configurazione interfaccia *gi0/0* di *R2*:

R2(config)**#int** *gi0/0*
R2(config-subif)**#int** *gi0/0.20*
R2(config-subif)**#encapsulation dot1Q** *20*
R2(config-subif)**#ip add** *192.168.1.126 255.255.255.192*
R2(config-subif)**#int** *gi0/0.99*
R2(config-subif)**#encapsulation dot1Q** 99
R2(config-subif)**#ip add** *192.168.1.158 255.255.255.240*
R2(config-subif)**#int** *gi0/0.100*
R2(config-subif)**#encapsulation dot1Q** *100*
R2(config-subif)**#ip add** *192.168.1.166 255.255.255.248*

Static Routing

Configurazioni:

R1(config- if)**#ip add** *172.16.1.29 255.255.255.252* ← gi0/1

R2(config-if)**#ip add** *172.16.1.30 255.255.255.252* ← gi0/1
R2(config-if)**#ip add** *1.1.1.2 255.255.255.255* ← *Loopback0*

Rotte statiche su *R1*:

ip route *192.168.1.64 255.255.255.192 gi0/1 172.16.1.30* ← per vlan20
ip route *192.168.1.144 255.255.255.240 gi0/1 172.16.1.30* ← per vlan99
ip route *192.168.1.160 255.255.255.248 gi0/1 172.16.1.30* ← per vlan100

Rotte statiche su *R2*:

ip route *192.168.1.0 255.255.255.192 gi0/1 172.16.1.29* ← per vlan10
ip route *192.168.1.128 255.255.255.240 gi0/1 172.16.1.29* ← per vlan30

*la Fully Specified Static Route non è compatibile con i router utilizzati o con la loro versione software(oppure incompatibilità versione di Packet Tracer); è stato solamente utilizzato il *next-hop*

Aggiunta router *PE1*

DEVICE	PORT	CONNECTED TO
PE1	s0/3/0	s0/3/0 - R2
	s0/3/1	s0/3/0 - R1

PE1(config-if)**#ip add** *172.16.1.25 255.255.255.252* ← s0/3/0
PE1(config-if)**#ip add** *172.16.1.21 255.255.255.252* ← s0/3/1

R1(config- if)**#ip add** *172.16.1.22 255.255.255.252* ← s0/3/0
R2(config- if)**#ip add** *172.16.1.26 255.255.255.252* ← s0/3/0

Dato che potrebbe essere implementato il protocollo OSPF(AD=110), per le floating static route è stata impostata una distanza amministrativa di 111.

Rotte statiche

PE1(config)**#ip route** *192.168.1.0 255.255.255.192 s0/3/1* ← per vlan10
PE1(config)**#ip route** *192.168.1.64 255.255.255.192 s0/3/0* ← per vlan20
PE1(config)**#ip route** *192.168.1.128 255.255.255.240 s0/3/1* ← per vlan30
PE1(config)**#ip route** *192.168.1.144 255.255.255.240 s0/3/0* ← per vlan99
PE1(config)**#ip route** *192.168.1.160 255.255.255.248 s0/3/0* ← per vlan100

Floating Static Route

R1(config)**#ip route** *0.0.0.0 0.0.0.0 172.16.1.21 111* ← per tutte le vlan
R2(config)**#ip route** *192.168.1.0 255.255.255.192 172.16.1.25 111* ← vlan10
R2(config)**#ip route** *192.168.1.128 255.255.255.240 172.16.1.25 111* ← vlan30
*su R2 non è stata utilizzata la default static route al solo fine di test

Risultati delle route table: R1 <- -> R2 (connessi)

```
R2#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.2/32 is directly connected, Loopback0
     172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
C       172.16.1.24/30 is directly connected, Serial0/3/0
L       172.16.1.26/32 is directly connected, Serial0/3/0
C       172.16.1.28/30 is directly connected, GigabitEthernet0/1
L       172.16.1.30/32 is directly connected, GigabitEthernet0/1
     192.168.1.0/24 is variably subnetted, 8 subnets, 4 masks
S       192.168.1.0/26 [1/0] via 172.16.1.29
C       192.168.1.64/26 is directly connected, GigabitEthernet0/0.20
L       192.168.1.126/32 is directly connected, GigabitEthernet0/0.20
S       192.168.1.128/28 [1/0] via 172.16.1.29
C       192.168.1.144/28 is directly connected, GigabitEthernet0/0.99
L       192.168.1.158/32 is directly connected, GigabitEthernet0/0.99
C       192.168.1.160/29 is directly connected, GigabitEthernet0/0.100
L       192.168.1.166/32 is directly connected, GigabitEthernet0/0.100
```

```
R1#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 172.16.1.21 to network 0.0.0.0

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1/32 is directly connected, Loopback0
     172.16.0.0/16 is variably subnetted, 4 subnets, 2 masks
C       172.16.1.20/30 is directly connected, Serial0/3/0
L       172.16.1.22/32 is directly connected, Serial0/3/0
C       172.16.1.28/30 is directly connected, GigabitEthernet0/1
L       172.16.1.29/32 is directly connected, GigabitEthernet0/1
     192.168.1.0/24 is variably subnetted, 7 subnets, 4 masks
C       192.168.1.0/26 is directly connected, GigabitEthernet0/0.10
L       192.168.1.62/32 is directly connected, GigabitEthernet0/0.10
S       192.168.1.64/26 [1/0] via 172.16.1.30
C       192.168.1.128/28 is directly connected, GigabitEthernet0/0.30
L       192.168.1.142/32 is directly connected, GigabitEthernet0/0.30
S       192.168.1.144/28 is directly connected, GigabitEthernet0/1
                         [1/0] via 172.16.1.30
S       192.168.1.160/29 [1/0] via 172.16.1.30
S*   0.0.0.0/0 [111/0] via 172.16.1.21
```

Risultati delle route table: R1 <-x -> R2 (non connessi)

```
R2#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.2/32 is directly connected, Loopback0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.1.24/30 is directly connected, Serial0/3/0
L       172.16.1.26/32 is directly connected, Serial0/3/0
     192.168.1.0/24 is variably subnetted, 8 subnets, 4 masks
S       192.168.1.0/26 [111/0] via 172.16.1.25
C       192.168.1.64/26 is directly connected, GigabitEthernet0/0.20
L       192.168.1.126/32 is directly connected, GigabitEthernet0/0.20
S       192.168.1.128/28 [111/0] via 172.16.1.25
C       192.168.1.144/28 is directly connected, GigabitEthernet0/0.99
L       192.168.1.158/32 is directly connected, GigabitEthernet0/0.99
C       192.168.1.160/29 is directly connected, GigabitEthernet0/0.100
L       192.168.1.166/32 is directly connected, GigabitEthernet0/0.100
```

```
R1#sh ip route
Codes: L - local, C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is 172.16.1.21 to network 0.0.0.0

     1.0.0.0/32 is subnetted, 1 subnets
C       1.1.1.1/32 is directly connected, Loopback0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
C       172.16.1.20/30 is directly connected, Serial0/3/0
L       172.16.1.22/32 is directly connected, Serial0/3/0
     192.168.1.0/24 is variably subnetted, 4 subnets, 3 masks
C       192.168.1.0/26 is directly connected, GigabitEthernet0/0.10
L       192.168.1.62/32 is directly connected, GigabitEthernet0/0.10
C       192.168.1.128/28 is directly connected, GigabitEthernet0/0.30
L       192.168.1.142/32 is directly connected, GigabitEthernet0/0.30
S*   0.0.0.0/0 [111/0] via 172.16.1.21

R1#
```

Confrontando i risultati si evince che sono state utilizzate le Floating Static Route dopo la disconnessione R1-R2.

Configurazioni *Default Route* su R1 ed R2, e *Loopback0* su PE1:

R1(config)**#ip route** *0.0.0.0 0.0.0.0 172.16.1.21*
R2(config)**#ip route** *0.0.0.0 0.0.0.0 172.16.1.25*
PE1(config-if)**#ip add** *1.1.1.0 255.255.255.255*

Part 2 - OSPF

Topology Changes (add the ISP)

DEVICE	PORT	CONNECTED TO
MA_Switch	gi0/1	gi0/2 - ISP_POP1
	gi0/2	gi0/2 - PE1
	fa0/23	gi0/2 - PE2
	fa0/24	gi0/2 - PE3

exp3_topolgyMap_1.1

Static Routing & Addressing

Per soddisfare i requisiti delle 20 reti per i *Point_Of_Presence*, della prima /28 per *ISP_POP1*, della prima /29 per *ISP_POP2* e dell'ultima /29 per *ISP_POP3*, sono state considerate le seguenti suddivisioni e le relative configurazioni:

- 12 reti ***/28***: *10.5.0.0 - 10.5.0.176*
- 8 reti ***/29***: *10.5.0.184 - 10.5.0.240*

Per quanto riguarda i link punto-punto, le assegnazioni sono state eseguite partendo dall'ultima rete ***/30*** → *10.5.1.252*

ISP_POP1

DEVICE	PORT	IP	LOOPBACK
ISP_POP1	gi0/2	10.5.0.1/28	1.0.0.1/32
	s0/3/1	10.5.1.253/30	

exp3_topolgyMap_1.1

Su *R_Internet* sono state impostate le seguenti rotte statiche in modo da minimizzare il numero di rotte e garantire comunque la connettività:

- *ip route 10.5.0.0 255.255.254.0 209.164.0.1*
- *ip route 10.5.0.0 255.255.254.0 209.164.0.5*

OSPF

Per abilitare il processo OSPF su *R1* ed *R2* includendo le VLAN nel processo di routing, sono state eseguite le seguenti configurazioni:

R1

```
network 172.16.1.20    0.0.0.3  area 0 ← R1 s0/3/0 - PE1 s0/3/1
network 172.16.1.28    0.0.0.3  area 0 ← R1 gi0/1 - R2 gi0/1
network 192.168.1.0    0.0.0.63 area 0 ← VLAN 10 (192.168.1.62/26)
network 192.168.1.64   0.0.0.63 area 0 ← VLAN 20 (192.168.1.126/26)
network 192.168.1.128  0.0.0.15 area 0 ← VLAN 30 (192.168.1.142/28)
network 192.168.1.144  0.0.0.15 area 0 ← VLAN 99 (192.168.1.158/28)
network 192.168.1.160  0.0.0.7  area 0 ← VLAN 100 (192.168.1.166/29)
```

R2

```
network 172.16.1.24    0.0.0.3  area 0 ← R2 s0/3/0 - PE1 s0/3/0
network 172.16.1.28    0.0.0.3  area 0 ← R2 gi0/1 - R1 gi0/1
network 192.168.1.64   0.0.0.63 area 0 ← VLAN 20 (192.168.1.126/26)
network 192.168.1.144  0.0.0.15 area 0 ← VLAN 99 (192.168.1.158/28)
network 192.168.1.160  0.0.0.7  area 0 ← VLAN 100 (192.168.1.166/29)
```

PE1

```
network 172.16.1.24    0.0.0.3  area 0 ← PE1 s0/3/0 - R2 s0/3/0
network 172.16.1.20    0.0.0.3  area 0 ← PE1 s0/3/1 - R1 s0/3/0
network 10.5.0.0       0.0.0.15 area 0 ← PE1 gi0/2 - MA_Switch gi0/2
```

PE2

```
network 10.5.0.0       0.0.0.15 area 0 ← PE2 gi0/2 - MA_Switch fa0/24
```

PE3

```
network 10.5.0.0       0.0.0.15 area 0 ← PE3 gi0/2 - MA_Switch fa0/23
```

ISP_POP1

```
network 10.5.1.252     0.0.0.3  area 0 ← POP1 s0/3/1 - Core1_2 s0/3/1
network 10.5.0.0       0.0.0.15 area 0 ← POP1 gi0/2 - MA_Switch gi0/1
```

Core1_2

```
router-id 99.0.1.2
network 10.5.1.252     0.0.0.3  area 0 ← Core1_2 s0/3/1 - POP1 s0/3/1
network 10.5.1.240     0.0.0.3  area 0 ← Core1_2 s0/3/0 - Core2_2 s0/3/1
network 10.5.1.232     0.0.0.3  area 0 ← Core1_2 gi0/2 - Core2_2 gi0/2
network 10.5.1.236     0.0.0.3  area 0 ← Core1_2 gi0/1 - Core1_1 gi0/2
```

Core2_2

router-id 99.0.2.2
network 10.5.1.248 0.0.0.3 area 0 ← Core2_2 s0/3/0 - ISP_POP2 s0/3/1
network 10.5.1.240 0.0.0.3 area 0 ← Core2_2 s0/3/1 - Core1_2 s0/3/0
network 10.5.1.232 0.0.0.3 area 0 ← Core2_2 gi0/2 - Core1_2 gi0/2
network 10.5.1.228 0.0.0.3 area 0 ← Core2_2 gi0/1 - Core2_1 gi0/2

ISP_POP2

network 10.5.1.248 0.0.0.3 area 0 ← ISP_POP2 s0/3/1 - Core2_2 s0/3/0
network 10.5.0.184 0.0.0.7 area 0 ← ISP_POP2 gi0/2 - Server3 fa0

Core1_1

router-id 99.0.1.1
network 10.5.1.224 0.0.0.3 area 0 ← Core1_1 s0/3/1 - Core2_1 s0/3/1
network 10.5.1.216 0.0.0.3 area 0 ← Core1_1 gi0/1 - Core2_1 gi0/1
network 10.5.1.236 0.0.0.3 area 0 ← Core1_1 gi0/2 - Core1_2 gi0/1
network 10.5.1.220 0.0.0.3 area 0 ← Core1_1 gi0/0 - BR1 gi0/2

Core2_1

router-id 99.0.2.1
network 10.5.1.212 0.0.0.3 area 0 ← Core2_1 s0/2/1 - BR2 s0/3/1
network 10.5.1.244 0.0.0.3 area 0 ← Core2_1 s0/3/0 - POP3 s0/3/1
network 10.5.1.216 0.0.0.3 area 0 ← Core2_1 gi0/1 - Core1_1 gi0/1
network 10.5.1.224 0.0.0.3 area 0 ← Core2_1 s0/3/1 - Core1_1 s0/3/1
network 10.5.1.228 0.0.0.3 area 0 ← Core2_1 gi0/2 - Core2_2gi0/1

ISP_POP3

network 10.5.1.244 0.0.0.3 area 0 ← POP3 s0/3/1 - Core2_1 s0/3/0
network 10.5.0.240 0.0.0.7 area 0 ← POP3 gi0/2 - Server0 fa0

BR1

ip route 0.0.0.0 0.0.0.0 209.164.0.2
router-id 99.1.1.1
network 10.5.1.220 0.0.0.3 area 0 ← BR1 gi0/2 - Core1_1 gi0/0
default-information originate

BR2

ip route 0.0.0.0 0.0.0.0 209.164.0.6
router-id 9.2.2.2
network 10.5.1.212 0.0.0.3 area 0 ← BR2 s0/3/1 - Core2_1 s0/2/1
default-information originate

La configurazione manuale del *Router-ID* è stata eseguita tramite il comando *router-id x.x.x.x*.

Invece, per quanto riguarda la selezione automatica del *Router-ID*, quest'ultima viene determinata seguendo delle regole:

- Il più alto indirizzo IP attivo tra le interfacce *loopback* (se presenti).

- Il più alto indirizzo IP attivo tra le interfacce fisiche (**se non ci sono loopback**).

Ad esempio, per il router *ISP_POP1*, il *Router-ID* è 1.0.0.1 perché corrisponde all'indirizzo IP più alto tra le sue interfacce attive, indirizzo di *loopback*.
Se nessuna loopback fosse configurata, il *Router-ID* sarebbe invece il più alto indirizzo IP tra le interfacce fisiche.

Per garantire che:

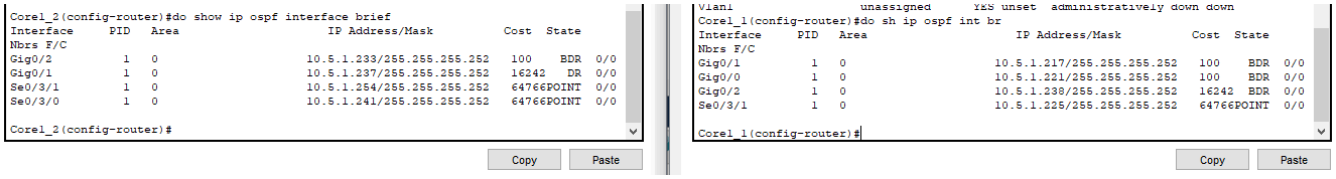
1. Il link tra Core1_2 e Core1_1 non sia preferito (usato solo come backup).
2. I link Gigabit siano preferiti rispetto a quelli FastEthernet,

sono state applicate le seguenti configurazioni.

Su entrambi i router (Core1_1 e Core1_2), è stata impostata una bandwidth bassa sull'interfaccia collegata al link tramite il comando:

Corex_x(config-if)#**bandwidth** *56*

Come mostrato nell'output, il costo del link risulta effettivamente più alto, motivo per cui non verrà selezionato come percorso preferito da OSPF:



Inoltre, su tutti i router della rete è stato eseguito il seguente comando:

auto-cost reference-bandwidth *100000*

Questo serve a garantire che OSPF possa differenziare correttamente tra interfacce FastEthernet, GigabitEthernet e superiori (come 10 Gbps), mantenendo accurate le decisioni di instradamento anche in reti con tecnologie più avanzate.