

**2014 - 2015**

# LABORATORI DEL CORSO TPIN2



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**2014 – 2015**

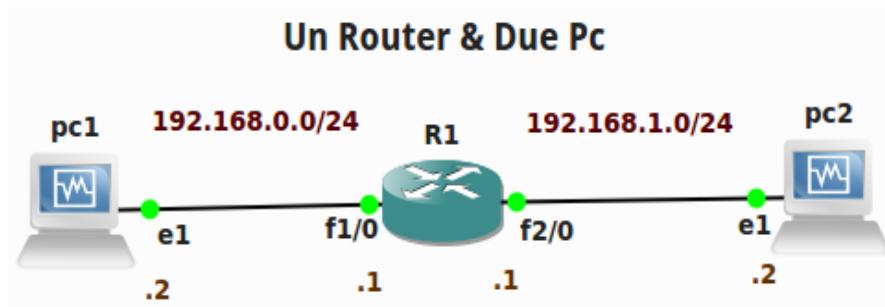
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## UN ROUTER & DUE PC



R1#show ip interface brief

*//vediamo che le interfacce sono down e non hanno gli indirizzi assegnati//*

```
R1#show ip interface brief
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES unset    administratively down down
FastEthernet0/1    unassigned      YES unset    administratively down down
FastEthernet1/0    unassigned      YES unset    administratively down down
FastEthernet2/0    unassigned      YES unset    administratively down down
```

### configuriamo R1

R1#conf t

R1(config)#int f1/0

R1(config-if)#ip address 192.168.0.1 255.255.255.252

R1(config-if)#no shut

R1(config-if)#exit

R1(config)#int f2/0

R1(config-if)#ip address 192.168.1.1 255.255.255.0

R1(config-if)#no shut

R1(config-if)#exit

R1(config)#end

R1#show ip interface brief

*//una volta abilitate le interfacce tramite il comando «no shut» vediamo che da down //*

*//passano ad up, di conseguenza avendo assegnato degli indirizzi ip questi compariranno (ps //*

*//se non avessimo dato «no shut» l'indirizzamento sarebbe sempre comparso ma l'interfaccia //*

*//non avrebbe funzionato //*

```
R1#show ip interface brief
Interface          IP-Address      OK? Method Status      Protocol
FastEthernet0/0    unassigned      YES unset    administratively down down
FastEthernet0/1    unassigned      YES unset    administratively down down
FastEthernet1/0    192.168.0.1     YES manual    up
FastEthernet2/0    192.168.1.1     YES manual    up
R1#
```

### Configurazione pc1

box login: tc

```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.2/24 dev eth1
root@box:~# route -n
```

```
root@box:~# route -n
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
0.0.0.0 10.0.2.2 0.0.0.0 UG 0 0 0 eth0
10.0.2.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0
127.0.0.1 0.0.0.0 255.255.255.255 UH 0 0 0 lo
192.168.0.0 0.0.0.0 255.255.255.0 U 0 0 0 eth1
```

```
root@box:~# ip r d default
root@box:~# route -n
```

```
root@box:~# route -n
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
10.0.2.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0
127.0.0.1 0.0.0.0 255.255.255.255 UH 0 0 0 lo
192.168.0.0 0.0.0.0 255.255.255.0 U 0 0 0 eth1
```

```
root@box:~# ip r a default via 192.168.0.1
root@box:~# route -n
```

```
root@box:~# route -n
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
0.0.0.0 192.168.0.1 0.0.0.0 UG 0 0 0 eth1
10.0.2.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0
127.0.0.1 0.0.0.0 255.255.255.255 UH 0 0 0 lo
192.168.0.0 0.0.0.0 255.255.255.0 U 0 0 0 eth1
```

### Configurazione pc2

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.1.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.1.1
```

```
//vediamo se i due pc comunicano//
//lanciamo il ping da pc1//
```

```
root@box:~# ping 192.168.1.2
```

```
root@box:~# ping 192.168.1.2
PING 192.168.1.2 (192.168.1.2): 56 data bytes
64 bytes from 192.168.1.2: seq=1 ttl=63 time=15.172 ms
64 bytes from 192.168.1.2: seq=2 ttl=63 time=13.630 ms
64 bytes from 192.168.1.2: seq=3 ttl=63 time=12.272 ms

--- 192.168.1.2 ping statistics ---
4 packets transmitted, 3 packets received, 25% packet loss
round-trip min/avg/max = 12.272/13.691/15.172 ms
```

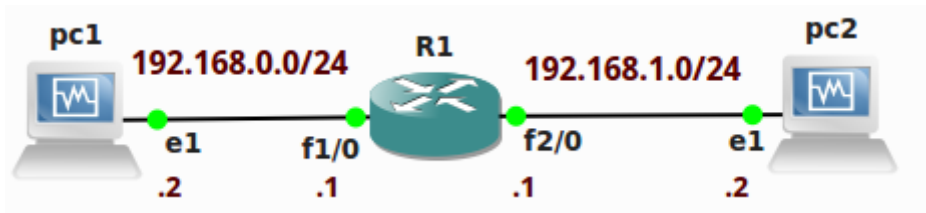
```
//facendo un iperf tra pc1 e pc2 potremmo vedere anche la banda a disposizione//
//PS lanciare prima il Server "s" e poi il Client "c"//
//come server è stato scelto pc2 mentre come client pc1//
```

```
pc2
root@box:~# iperf -s -i 2
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 4] local 192.168.1.2 port 5001 connected with 192.168.0.2 port 53243
[ ID] Interval      Transfer    Bandwidth
[ 4] 0.0- 2.0 sec  4.17 MBytes 17.5 Mbits/sec
[ 4] 2.0- 4.0 sec  4.24 MBytes 17.8 Mbits/sec
[ 4] 4.0- 6.0 sec  4.22 MBytes 17.7 Mbits/sec
[ 4] 6.0- 8.0 sec  4.26 MBytes 17.9 Mbits/sec
[ 4] 0.0- 9.3 sec 19.6 MBytes 17.7 Mbits/sec
```

```
pc1
root@box:~# iperf -c 192.168.1.2 -t 30
-----
Client connecting to 192.168.1.2, TCP port 5001
TCP window size: 16.0 KByte (default)
-----
[ 3] local 192.168.0.2 port 53243 connected with 192.168.1.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 9.3 sec 19.6 MBytes 17.8 Mbits/sec
root@box:~#
```

## OUTPUT SHAPER f2/0 @2Mbps

va applicato in uscita



*//riprendiamo l'esercizio di prima//*

*//verifichiamo le class-map//*

R1#show class-map

```
R1#show class-map
Class Map match-any class-default (id 0)
Match any
```

*//configuriamo la policy-map shaper//*

R1#conf t

```
R1(config)#policy-map shaper
R1(config-pmap)#class class-default
R1(config-pmap-c)#shape average 2000000
R1(config-pmap-c)#end
```

*//vediamo che sulle interfacce non è applicata nessuna la policy-map //*

R1#show policy-map interface

```
R1#show policy-map interface
```

*//vediamo la configurazione della policy-map chiamata shaper//*

R1#show policy-map

```
R1#show policy-map
Policy Map shaper
Class class-default
Traffic Shaping
Average Rate Traffic Shaping
CIR 2000000 (bps) Max. Buffers Limit 1000 (Packets)
```

*//mettiamo lo shaper sull'interfaccia f2/0 //*

R1#conf t

```
R1(config)#int f2/0
R1(config-if)#service-policy output shaper
R1(config-if)#end
```

*//vediamo che sulle interfacce f2/0 è applicata la policy shaper //*

R1#show policy-map interface

```
R1#show policy-map interface
FastEthernet2/0

Service-policy output: shaper

Class-map: class-default (match-any)
 1 packets, 60 bytes
 5 minute offered rate 0 bps, drop rate 0 bps
 Match: any
 Traffic Shaping
   Target/Average      Byte      Sustain    Excess     Interval   Increment
   Rate                Limit     bits/int  bits/int   (ms)      (bytes)
 2000000/2000000     12500    50000     50000     25        6250

Adapt Queue      Packets  Bytes    Packets  Bytes
Active Depth                               Delayed  Delayed  Shaping
-         0          1        60       0        0        no
```

//per vedere il funzionamento dello shaper applichiamo l'iperf//

//NOTA BENE: lo shaper funziona in uscita quindi da PC1 a PC2 e NON da PC2 a PC1//

//questo perchè lo abbiamo applicato sull'interfaccia f2/0//

```
pc1
root@box:~# iperf -c 192.168.1.2 -t 10
-----
Client connecting to 192.168.1.2, TCP port 5001
TCP window size: 16.0 KByte (default)
-----
[ 3] local 192.168.0.2 port 43951 connected with 192.168.1.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 6.8 sec  1.62 MBytes 1.99 Mbits/sec
root@box:~#
```

```
pc2
root@box:~# iperf -s -i 2
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 4] local 192.168.1.2 port 5001 connected with 192.168.0.2 port 43951
[ ID] Interval      Transfer    Bandwidth
[ 4] 0.0- 2.0 sec   473 KBytes 1.94 Mbits/sec
[ 4] 2.0- 4.0 sec   472 KBytes 1.93 Mbits/sec
[ 4] 4.0- 6.0 sec   464 KBytes 1.90 Mbits/sec
[ 4] 0.0- 7.1 sec  1.62 MBytes 1.91 Mbits/sec
```

//verifichiamo anche che da PC2 a PC1 lo shaper non funziona//

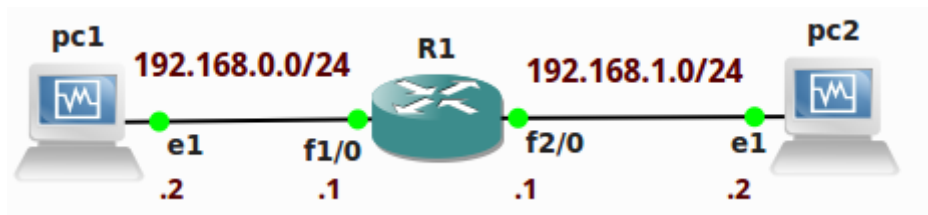
```
pc1
root@box:~# iperf -s -i 2
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 4] local 192.168.0.2 port 5001 connected with 192.168.1.2 port 53910
[ ID] Interval      Transfer    Bandwidth
[ 4] 0.0- 2.0 sec   4.06 MBytes 17.0 Mbits/sec
[ 4] 2.0- 4.0 sec   3.96 MBytes 16.6 Mbits/sec
[ 4] 0.0- 4.7 sec   9.38 MBytes 16.9 Mbits/sec
```

```
pc2
root@box:~# iperf -c 192.168.0.2 -t 10
-----
Client connecting to 192.168.0.2, TCP port 5001
TCP window size: 16.0 KByte (default)
-----
[ 3] local 192.168.1.2 port 53910 connected with 192.168.0.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 4.6 sec   9.38 MBytes 17.0 Mbits/sec
root@box:~# █
```



## INPUT POLICER f1/0 @2Mbps

va applicato in ingresso



*//utilizzando come base il primo esercizio//*

*//sul router R1 creiamo il policer//*

```
R1#conf t
R1(config)#policy-map policer
R1(config-pmap)#class class-default
R1(config)#police 2000000 15000 conform-action transmit exceed-action drop
R1(config-pmap-c-police)#end
```

*//vediamo il policer appena creato//*

```
R1#show policy-map
R1#show policy-map
  Policy Map policer
    Class class-default
      police cir 2000000 bc 15000
        conform-action transmit
        exceed-action drop
```

*//verifichiamo l'eventuale presenza di policy-map sulle interfacce//*

*//non vedremo nulla perchè non abbiamo ancora configurato policy sulle interfacce//*

```
R1#show policy-map interface
R1#show policy-map interface
```

*//configuriamo il policer sull'interfaccia f1/0//*

*//NOTA il policer va applicato in ingresso quindi considerando pc1 l'host da cui partono i //*

*//pacchetti e l'interfaccia di ingresso che incontra dal router è f1/0//*

```
R1#conf t
R1(config)#int f1/0
R1(config-if)#service-policy input policer
R1(config-if)#end
```

*//vediamo la policy-map configurate sulle varie interfacce//*

```
R1#show policy-map interface
```

```

R1#show policy-map interface
FastEthernet1/0
Service-policy input: policer
Class-map: class-default (match-any)
  0 packets, 0 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
Match: any
  police:
    cir 2000000 bps, bc 15000 bytes
    conformed 0 packets, 0 bytes; actions:
      transmit
    exceeded 0 packets, 0 bytes; actions:
      drop
    conformed 0 bps, exceed 0 bps

```

*//tramite iperf da pc1 a pc2 ( impostando pc1 come client e pc2 come server)//  
//il funzionamento del policer che troncherà la banda a 2Mbs//*

```

pc1
root@box:~# iperf -c 192.168.1.2 -t 30
-----
Client connecting to 192.168.1.2, TCP port 5001
TCP window size: 16.0 KByte (default)
-----
[ 3] local 192.168.0.2 port 57097 connected with 192.168.1.2 port 5001
[ ID] Interval      Transfer      Bandwidth
[ 3] 0.0- 5.4 sec  1.25 MBytes  1.94 Mbits/sec
root@box:~#

```

```

pc2
root@box:~# iperf -s -i 2
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 4] local 192.168.1.2 port 5001 connected with 192.168.0.2 port 57097
[ ID] Interval      Transfer      Bandwidth
[ 4] 0.0- 2.0 sec   479 KBytes   1.96 Mbits/sec
[ 4] 2.0- 4.0 sec   450 KBytes   1.84 Mbits/sec
[ 4] 0.0- 5.5 sec  1.25 MBytes  1.90 Mbits/sec

```

*//tramite iperf verificiamo che il policer non funziona da pc2 a pc1 (impostando pc1//  
// come server e pc2 come client)//*

```

pc1
root@box:~# iperf -s -i 2
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 4] local 192.168.0.2 port 5001 connected with 192.168.1.2 port 48890
[ ID] Interval      Transfer      Bandwidth
[ 4] 0.0- 2.0 sec   4.09 MBytes  17.2 Mbits/sec
[ 4] 2.0- 4.0 sec   4.24 MBytes  17.8 Mbits/sec

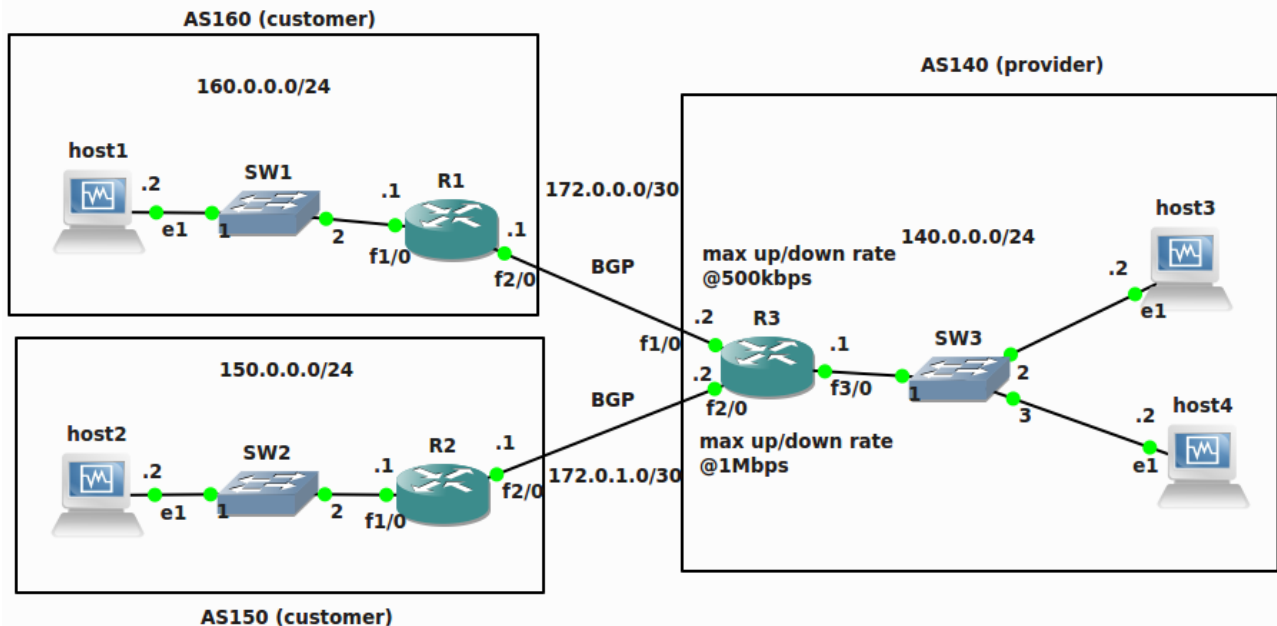
```

```

pc2
root@box:~# iperf -c 192.168.0.2 -t 30
-----
Client connecting to 192.168.0.2, TCP port 5001
TCP window size: 16.0 KByte (default)
-----
[ 3] local 192.168.1.2 port 48890 connected with 192.168.0.2 port 5001
[ ID] Interval      Transfer      Bandwidth
[ 3] 0.0- 9.5 sec  20.0 MBytes  17.6 Mbits/sec
root@box:~#

```

## POLICER & SHAPER



### Configurazione delle interfacce dei router

```
R1#conf t
R1(config)#int f1/0
R1(config-if)#ip address 160.0.0.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#int f2/0
R1(config-if)#ip address 172.0.0.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
```

```
R2#conf t
R2(config)#int f1/0
R2(config-if)#ip address 150.0.0.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#int f2/0
R2(config-if)#ip address 172.0.1.1 255.255.255.252
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
```

```
R3#conf t
R3(config)#int f1/0
R3(config-if)#ip address 172.0.0.2 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int f2/0
```

```
R3(config-if)#ip address 172.0.1.2 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int f3/0
R3(config-if)#ip address 140.0.0.1 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#
```

### ***Configurazione di BGP***

```
R1(config)#router bgp 160
R1(config-router)#net
R1(config-router)#network 160.0.0.0 mask 255.255.255.0
R1(config-router)#neighbor 172.0.0.2 remote-as 140
R1(config-router)#exit
R1(config)#
```

```
R2(config)#router bgp 150
R2(config-router)#network 150.0.0.0 mask 255.255.255.0
R2(config-router)#neighbor 172.0.1.2 remote-as 140
R2(config-router)#exit
R2(config)#
```

```
R3(config)#router bgp 140
R3(config-router)#network 140.0.0.0 mask 255.255.255.0
R3(config-router)#neighbor 172.0.0.1 remote-as 160
R3(config-router)#neighbor 172.0.1.1 remote-as 150
R3(config-router)#exit
R3(config)#
```

### **Configurazione degli host**

#### **Host1**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 160.0.0.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 160.0.0.1
root@box:~#
```

#### **Host2**

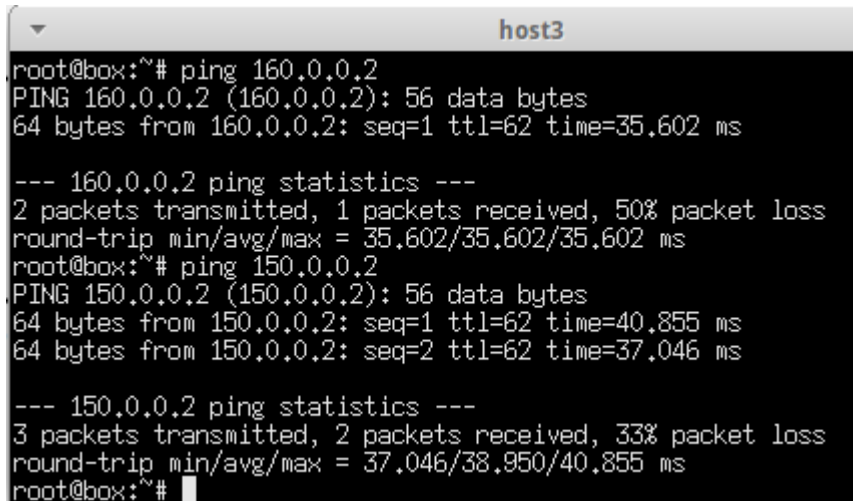
```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 150.0.0.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 150.0.0.1
root@box:~#
```

#### **Host3**

```
box login: tc
```

```
tc@box:~$ sudo su
root@box:~# ip a a 140.0.0.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 140.0.0.1
root@box:~#
```

*verifichiamo i ping*



```

root@box:~# ping 160.0.0.2
PING 160.0.0.2 (160.0.0.2): 56 data bytes
64 bytes from 160.0.0.2: seq=1 ttl=62 time=35.602 ms

--- 160.0.0.2 ping statistics ---
2 packets transmitted, 1 packets received, 50% packet loss
round-trip min/avg/max = 35.602/35.602/35.602 ms
root@box:~# ping 150.0.0.2
PING 150.0.0.2 (150.0.0.2): 56 data bytes
64 bytes from 150.0.0.2: seq=1 ttl=62 time=40.855 ms
64 bytes from 150.0.0.2: seq=2 ttl=62 time=37.046 ms

--- 150.0.0.2 ping statistics ---
3 packets transmitted, 2 packets received, 33% packet loss
round-trip min/avg/max = 37.046/38.950/40.855 ms
root@box:~# █

```

***Sul provider R3 applichiamo le richieste di banda dell'esercizio***

```
R3(config)#policy-map shaper1
R3(config-pmap)#class class-default
R3(config-pmap-c)#shape average 500000
R3(config-pmap-c)#exit
R3(config-pmap)#exit
```

```
R3(config)#policy-map shaper2
R3(config-pmap)#class class-default
R3(config-pmap-c)#shape average 1000000
R3(config-pmap-c)#exit
R3(config-pmap)#exit
```

```
R3(config)#policy-map policer1
R3(config-pmap)#class class-default
R3(config-pmap-c)#$tion transmit exceed-action drop violate-action drop
R3(config-pmap-c-police)#exit
R3(config-pmap-c)#exit
R3(config-pmap)#exit
```

```
R3(config)#policy-map policer2
R3(config-pmap)#class class-default
R3(config-pmap-c)#$tion transmit exceed-action drop violate-action drop
R3(config-pmap-c-police)#exit
R3(config-pmap-c)#exit
R3(config-pmap)#exit
```

*Applichiamo le service-policy sulle interfacce di R3*

```
R3(config)#int f1/0
R3(config-if)#service-policy input policer1
R3(config-if)#service-policy output shaper1
R3(config-if)#exit
```

```
R3(config)#int f2/0
R3(config-if)#service-policy input policer2
R3(config-if)#service-policy output shaper2
R3(config-if)#exit
R3(config)#
```

```
R3
R3#show policy-map
  Policy Map shaper1
    Class class-default
      Traffic Shaping
        Average Rate Traffic Shaping
          CIR 500000 (bps) Max. Buffers Limit 1000 (Packets)
  Policy Map shaper2
    Class class-default
      Traffic Shaping
        Average Rate Traffic Shaping
          CIR 1000000 (bps) Max. Buffers Limit 1000 (Packets)
  Policy Map policer2
    Class class-default
      police cir 1000000 bc 15000 be 15000
        conform-action transmit
        exceed-action drop
        violate-action drop
  Policy Map policer1
    Class class-default
      police cir 500000 bc 15000 be 15000
        conform-action transmit
        exceed-action drop
        violate-action drop
R3#
```

```
R3
R3#show policy-map interface f1/0
FastEthernet1/0

Service-policy input: policer1

Class-map: class-default (match-any)
  8 packets, 584 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
  Match: any
  police:
    cir 500000 bps, bc 15000 bytes, be 15000 bytes
    conformed 8 packets, 584 bytes; actions:
      transmit
    exceeded 0 packets, 0 bytes; actions:
      drop
    violated 0 packets, 0 bytes; actions:
      drop
    conformed 0 bps, exceed 0 bps, violate 0 bps

Service-policy output: shaper1

Class-map: class-default (match-any)
  76 packets, 7265 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
  Match: any
  Traffic Shaping
    Target/Average Rate      Byte Limit  Sustain Excess Interval Increment
    500000/500000           3000      12000  12000  24      1500

    Adapt Queue Packets Bytes Packets Bytes Shaping
    Active Depth          76      7265  0      0      Delayed Active
    -         0
R3#
```

*Tramite iperf controlliamo se le policy map funzionano:*

in un verso

```

host1
root@box:~# iperf -s -i 2
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 4] local 160.0.0.2 port 5001 connected with 140.0.0.2 port 58163
[ ID] Interval      Transfer    Bandwidth
[ 4] 0.0- 2.0 sec   120 KBytes  492 Kbits/sec
[ 4] 2.0- 4.0 sec   117 KBytes  481 Kbits/sec
[ 4] 4.0- 6.0 sec   115 KBytes  469 Kbits/sec
[ 4] 0.0- 6.5 sec   384 KBytes  481 Kbits/sec
root@box:~#

```

```

host3
root@box:~# iperf -c 160.0.0.2 -t 4
-----
Client connecting to 160.0.0.2, TCP port 5001
TCP window size: 16.0 KByte (default)
-----
[ 3] local 140.0.0.2 port 58164 connected with 160.0.0.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 5.5 sec   384 KBytes  575 Kbits/sec
root@box:~#

```

E nell' altro

```

host3
TCP window size: 85.3 KByte (default)
-----
[ 4] local 140.0.0.2 port 5001 connected with 160.0.0.2 port 42852
[ ID] Interval      Transfer    Bandwidth
[ 4] 0.0- 2.0 sec   124 KBytes  510 Kbits/sec
[ 4] 2.0- 4.0 sec   115 KBytes  469 Kbits/sec
[ 4] 4.0- 6.0 sec   100 KBytes  411 Kbits/sec
[ 4] 0.0- 6.6 sec   384 KBytes  475 Kbits/sec

```

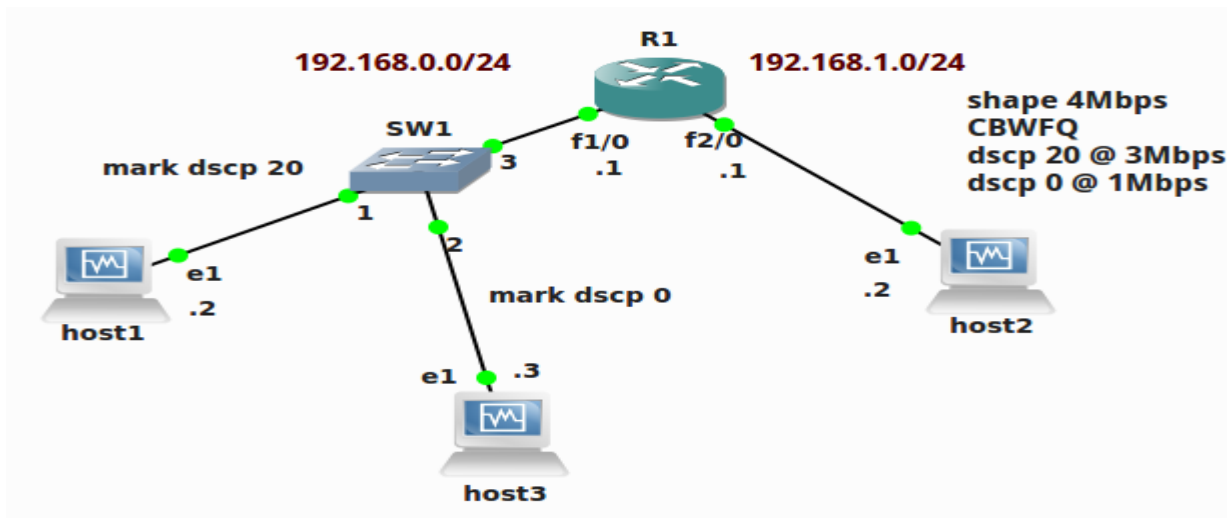
```

host1
root@box:~# iperf -c 140.0.0.2 -t 4
-----
Client connecting to 140.0.0.2, TCP port 5001
TCP window size: 16.0 KByte (default)
-----
[ 3] local 160.0.0.2 port 42852 connected with 140.0.0.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0- 6.4 sec   384 KBytes  493 Kbits/sec
root@box:~#

```

Fare lo stesso con Host2 e Host3

## MARKING & QoS



### Configurazione R1

```
R1#conf t
R1(config)#int f1/0
R1(config-if)#ip address 192.168.0.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#int f2/0
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#no shutdown
R1(config-if)#end
```

```
R1#conf t
R1(config)#class-map match-all dscp20
R1(config-cmap)#match dscp af22
R1(config-cmap)#exit
R1(config)#class-map match-all host1
R1(config-cmap)#match access-group 101
R1(config-cmap)#exit
R1(config)#policy-map marker
R1(config-pmap)#class host1
R1(config-pmap-c)#set dscp af22
R1(config-pmap-c)#exit
R1(config-pmap)#class class-default
R1(config-pmap-c)#set dscp default
R1(config-pmap-c)#exit
R1(config-pmap)#exit
```

```
R1(config)#policy-map sched
R1(config-pmap)#class dscp20
R1(config-pmap-c)#bandwidth 3000
R1(config-pmap-c)#exit
R1(config-pmap)#class class-default
```



```
R1(config-pmap-c)#bandwidth 1000
R1(config-pmap-c)#exit
R1(config-pmap)#exit
```

```
R1(config)#policy-map shaper
R1(config-pmap)#class class-default
R1(config-pmap-c)#shape average 4000000
R1(config-pmap-c)#service-policy sched
R1(config-pmap-c)#end
```

```
R1#conf t
R1(config)#int f1/0
R1(config-if)#service-policy input marker
R1(config-if)#exit
R1(config)#int f2/0
R1(config-if)#bandwidth 100000
R1(config-if)#service-policy output shaper
R1(config-if)#exit
```

```
R1(config)#access-list 101 permit ip host 192.168.0.2 any
```

### ***Configurazione Host1***

```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.0.1
root@box:~# ping 192.168.1.2
```

### ***Configurazione Host2***

```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.1.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.1.1
root@box:~# ping 192.168.0.2
```

### ***Configurazione Host3***

```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.3/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.0.1
root@box:~# ping 192.168.0.2
```

```

host2
root@box:~# iperf -s -i 2
-----
Server listening on TCP port 5001
TCP window size: 85,3 KByte (default)
-----
[ 4] local 192.168.1.2 port 5001 connected with 192.168.0.3 port 35847
[ ID] Interval      Transfer    Bandwidth
[ 4] 0.0- 2.0 sec   946 KBytes  3.88 Mbits/sec
[ 4] 2.0- 4.0 sec   896 KBytes  3.67 Mbits/sec
[ 4] 4.0- 6.0 sec   935 KBytes  3.83 Mbits/sec
[ 5] local 192.168.1.2 port 5001 connected with 192.168.0.2 port 59079
[ 4] 6.0- 8.0 sec   582 KBytes  2.38 Mbits/sec
[ 5] 0.0- 2.0 sec   704 KBytes  2.88 Mbits/sec
[ 4] 8.0-10.0 sec   232 KBytes   950 Kbits/sec
[ 5] 2.0- 4.0 sec   711 KBytes  2.91 Mbits/sec
[ 4] 10.0-12.0 sec   228 KBytes   936 Kbits/sec
[ 5] 4.0- 6.0 sec   697 KBytes  2.85 Mbits/sec
[ 4] 12.0-14.0 sec   232 KBytes   950 Kbits/sec
[ 5] 6.0- 8.0 sec   694 KBytes  2.84 Mbits/sec
[ 4] 14.0-16.0 sec   232 KBytes   950 Kbits/sec
[ 5] 8.0-10.0 sec   720 KBytes  2.95 Mbits/sec
[ 4] 16.0-18.0 sec   232 KBytes   950 Kbits/sec
[ 5] 0.0-11.7 sec   4.00 MBytes  2.88 Mbits/sec
[ 4] 0.0-19.5 sec   4.88 MBytes  2.09 Mbits/sec

```

```

host1
root@box:~# iperf -c 192.168.1.2 -p 5001 -t 3600
-----
Client connecting to 192.168.1.2, TCP port 5001
TCP window size: 16.0 KByte (default)
-----
[ 3] local 192.168.0.2 port 59079 connected with 192.168.1.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0-11.5 sec   4.00 MBytes  2.92 Mbits/sec
root@box:~# █

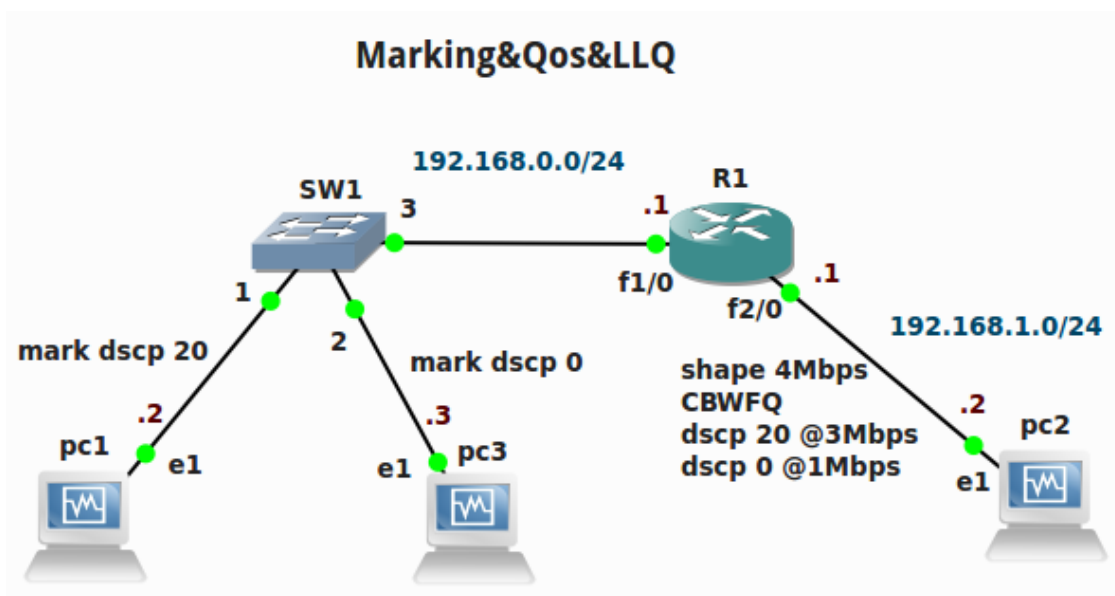
```

```

host3
root@box:~# iperf -c 192.168.1.2 -p 5001 -t 3600
-----
Client connecting to 192.168.1.2, TCP port 5001
TCP window size: 16.0 KByte (default)
-----
[ 3] local 192.168.0.3 port 35847 connected with 192.168.1.2 port 5001
[ ID] Interval      Transfer    Bandwidth
[ 3] 0.0-19.4 sec   4.88 MBytes  2.11 Mbits/sec
root@box:~# █

```

## MARKING & QoS & LLQ



R1#conf t

```
R1(config)#int f1/0
R1(config-if)#ip address 192.168.0.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
```

```
R1(config)#int f2/0
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
```

```
R1(config)#class-map match-all dscp20
R1(config-cmap)#match dscp af22
R1(config-cmap)#exit
```

```
R1(config)#class-map match-all pc1
R1(config-cmap)#match access-group 101
R1(config-cmap)#exit
R1(config)#end
```

R1#show class-map

```
R1#show class-map
Class Map match-all dscp20 (id 1)
  Match dscp af22 (20)

Class Map match-all pc1 (id 2)
  Match access-group 101

Class Map match-any class-default (id 0)
  Match any
```

R1#conf t

```
R1(config)#policy-map marker
R1(config-pmap)#class pc1
R1(config-pmap-c)#set dscp af22
R1(config-pmap-c)#exit
R1(config-pmap)#class class-default
R1(config-pmap-c)#set dscp default
R1(config-pmap-c)#exit
```

```
R1(config)#policy-map sched
R1(config-pmap)#class dscp20
R1(config-pmap-c)#bandwidth 3000
R1(config-pmap-c)#exit
R1(config-pmap)#class class-default
R1(config-pmap-c)#bandwidth 1000
R1(config-pmap-c)#exit
R1(config-pmap)#exit
R1(config)#policy-map shaper
R1(config-pmap)#class class-default
R1(config-pmap-c)#shape average 4000000
R1(config-pmap-c)#service-policy sched
R1(config-pmap-c)#end
```

```
R1#show policy-map
```

```
R1#show policy-map
  Policy Map marker
    Class pc1
      set dscp af22
    Class class-default
      set dscp default
  Policy Map shaper
    Class class-default
      Traffic Shaping
        Average Rate Traffic Shaping
          CIR 4000000 (bps) Max. Buffers Limit 1000 (Packets)
        service-policy sched
  Policy Map sched
    Class dscp20
      Bandwidth 3000 (kbps) Max Threshold 64 (packets)
    Class class-default
      Bandwidth 1000 (kbps) Max Threshold 64 (packets)
```

```
R1#conf t
R1(config)#int f1/0
R1(config-if)#service-policy input marker
R1(config-if)#exit
R1(config)#int f2/0
R1(config-if)#bandwidth 100000
R1(config-if)#service-policy output shaper
R1(config-if)#end
```

```
R1#show policy-map interface f1/0
```

```

R1#show policy-map interface f1/0
FastEthernet1/0

Service-policy input: marker

Class-map: pc1 (match-all)
  0 packets, 0 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
  Match: access-group 101
  QoS Set
    dscp af22
    Packets marked 0

Class-map: class-default (match-any)
  20 packets, 6540 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
  Match: any
  QoS Set
    dscp default
    Packets marked 20

```

R1#show policy-map interface f2/0

```

R1#show policy-map interface f2/0
FastEthernet2/0

Service-policy output: shaper

Class-map: class-default (match-any)
  22 packets, 2231 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
  Match: any
  Traffic Shaping
    Target/Average      Byte   Sustain   Excess   Interval   Increment
    Rate                Limit  bits/int  bits/int  (ms)      (bytes)
    4000000/4000000    25000  100000   100000   25        12500

Adapt Queue   Packets  Bytes   Packets  Bytes  Shaping
Active Depth  22      2231    0        0      Active
-         0
no

Service-policy : sched

Class-map: dscp20 (match-all)
  0 packets, 0 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
  Match: dscp af22 (20)
  Queueing
    Output Queue: Conversation 137
    Bandwidth 3000 (kbps)Max Threshold 64 (packets)
    (pkts matched/bytes matched) 0/0
    (depth/total drops/no-buffer drops) 0/0/0

Class-map: class-default (match-any)
  22 packets, 2231 bytes
  5 minute offered rate 0 bps, drop rate 0 bps
  Match: any
  Queueing
    Output Queue: Conversation 138
    Bandwidth 1000 (kbps)Max Threshold 64 (packets)
    (pkts matched/bytes matched) 0/0
    (depth/total drops/no-buffer drops) 0/0/0
R1#

```

R1#conf t

R1(config)#access-list 101 permit ip host 192.168.0.2 any

R1(config)#do show access-list

```

R1(config)#do show access-list
Extended IP access list 101
  10 permit ip host 192.168.0.2 any

```

R1(config)#policy-map sched

R1(config-pmap)#class dscp20

```
R1(config-pmap-c)#no bandwidth 3000
R1(config-pmap-c)#priority 3000
R1(config-pmap-c)#end
```

```
R1#show policy-map interface f2/0
```

```
R1#show policy-map interface f2/0
FastEthernet2/0

Service-policy output: shaper

Class-map: class-default (match-any)
 92 packets, 9428 bytes
 5 minute offered rate 0 bps, drop rate 0 bps
 Match: any
 Traffic Shaping
   Target/Average      Byte      Sustain    Excess    Interval  Increment
   Rate                Limit     bits/int  bits/int  (ms)      (bytes)
 4000000/4000000      25000    100000    100000    25        12500

Adapt Queue      Packets  Bytes    Packets  Bytes    Shaping
Active Depth    92       9428    Delayed  Delayed  Active
-           0
no

Service-policy : sched

Class-map: dscp20 (match-all)
 0 packets, 0 bytes
 5 minute offered rate 0 bps, drop rate 0 bps
 Match: dscp af22 (20)
 Queueing
   Strict Priority
   Output Queue: Conversation 136
   Bandwidth 3000 (kbps) Burst 75000 (Bytes)
   (pkts matched/bytes matched) 0/0
   (total drops/bytes drops) 0/0

Class-map: class-default (match-any)
 92 packets, 9428 bytes
 5 minute offered rate 0 bps, drop rate 0 bps
 Match: any
 Queueing
   Output Queue: Conversation 138
   Bandwidth 1000 (kbps)Max Threshold 64 (packets)
   (pkts matched/bytes matched) 0/0
   (depth/total drops/no-buffer drops) 0/0/0
```

### PC1

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.0.1
```

### PC2

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.1.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.1.1
```

### PC3

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.3/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.0.1
```

**PC1**

```
root@box:~# iperf -c 192.168.1.2 -p 5003 -t 3600
```

**PC2**

```
screen
```

```
root@box:~# iperf -s -p 5001 -i 2
```

```
ctrl+a ---> c
```

```
root@box:~# iperf -s -p 5003 -i 2
```

**PC3**

```
root@box:~# iperf -c 192.168.1.2 -t 3600
```

```
pc1
root@box:~# iperf -c 192.168.1.2 -p 5003 -t 3600
-----
Client connecting to 192.168.1.2, TCP port 5003
TCP window size: 16.0 KByte (default)
-----
[ 3] local 192.168.0.2 port 54262 connected with 192.168.1.2 port 5003
[ ID] Interval      Transfer      Bandwidth
[ 3] 0.0- 4.5 sec  2.12 MBytes  3.93 Mbits/sec
root@box:~#
```

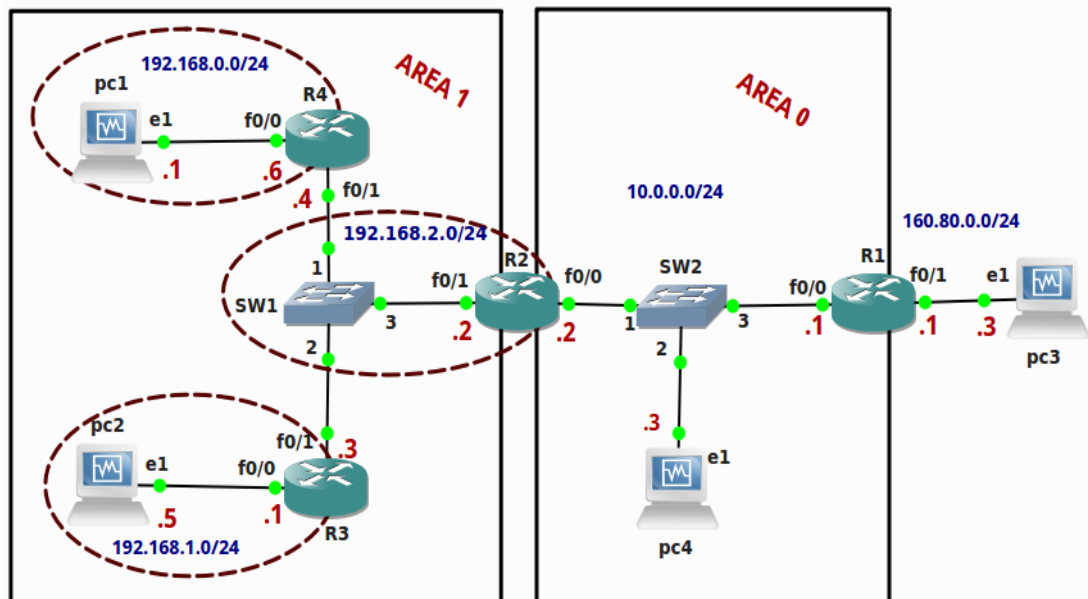
```
pc3
root@box:~# iperf -c 192.168.1.2 -t 3600
-----
Client connecting to 192.168.1.2, TCP port 5001
TCP window size: 16.0 KByte (default)
-----
[ 3] local 192.168.0.3 port 34612 connected with 192.168.1.2 port 5001
[ ID] Interval      Transfer      Bandwidth
[ 3] 0.0- 4.8 sec  2.25 MBytes  3.96 Mbits/sec
root@box:~#
```

```
pc2
root@box:~# iperf -s -p 5003 -i 2
-----
Server listening on TCP port 5003
TCP window size: 85.3 KByte (default)
-----
[ 4] local 192.168.1.2 port 5003 connected with 192.168.0.2 port 54262
[ ID] Interval      Transfer      Bandwidth
[ 4] 0.0- 2.0 sec   946 KBytes    3.87 Mbits/sec
[ 4] 2.0- 4.0 sec   935 KBytes    3.83 Mbits/sec
[ 4] 0.0- 4.6 sec  2.12 MBytes    3.85 Mbits/sec
```

```
pc2
root@box:~# iperf -s -p 5001 -i 2
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[ 4] local 192.168.1.2 port 5001 connected with 192.168.0.3 port 34613
[ ID] Interval      Transfer      Bandwidth
[ 4] 0.0- 2.0 sec   957 KBytes    3.92 Mbits/sec
[ 4] 2.0- 4.0 sec   891 KBytes    3.65 Mbits/sec
[ 4] 0.0- 5.0 sec  2.25 MBytes    3.78 Mbits/sec
```

# OSPF-1

## OSPF



### //Configurazione delle interfacce dei router//

```
R1#conf t
R1(config)#int f0/0
R1(config-if)#ip address 10.0.0.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#int f0/1
R1(config-if)#ip address 160.80.0.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
```

```
R2#conf t
R2(config)#int f0/1
R2(config-if)#ip address 192.168.2.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#int f0/0
R2(config-if)#ip address 10.0.0.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
```

```
R3#conf t
R3(config)#int f0/0
R3(config-if)#ip address 192.168.1.1 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int f0/1
R3(config-if)#ip address 192.168.2.3 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
```



```
R4#conf t
R4(config)#int f0/0
R4(config-if)#ip address 192.168.0.6 255.255.255.0
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#int f0/1
R4(config-if)#ip address 192.168.2.4 255.255.255.0
R4(config-if)#no shut
R4(config-if)#exit
```

*//configurazione OSPF sui router interessati//*

```
R1(config)#router ospf 1
R1(config-router)#router-id 1.1.1.1
R1(config-router)#network 10.0.0.1 0.0.0.0 area 0
```

```
R2(config)#router ospf 1
R2(config-router)#router-id 2.2.2.2
R2(config-router)#network 10.0.0.2 0.0.0.0 area 0
R2(config-router)#network 192.168.2.2 0.0.0.0 area 1
```

```
R3(config)#router ospf 1
R3(config-router)#router-id 3.3.3.3
R3(config-router)#network 192.168.1.1 0.0.0.0 area 1
R3(config-router)#network 192.168.2.3 0.0.0.0 area 1
```

```
R4(config)#router ospf 1
R4(config-router)#router-id 4.4.4.4
R4(config-router)#network 192.168.2.4 0.0.0.0 area 1
```

```
R1(config-router)#ip route 0.0.0.0 0.0.0.0 160.80.0.3
R1(config-router)#default-information originate
```

```
R4(config-router)#redistribute connected
% Only classful networks will be redistributed
```

*//configurazione dei PC//*

**PC1**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.1/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.0.6
```

**PC2**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.1.5/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.1.1
```

**PC3**

```

box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 160.80.0.3/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 160.80.0.1

```

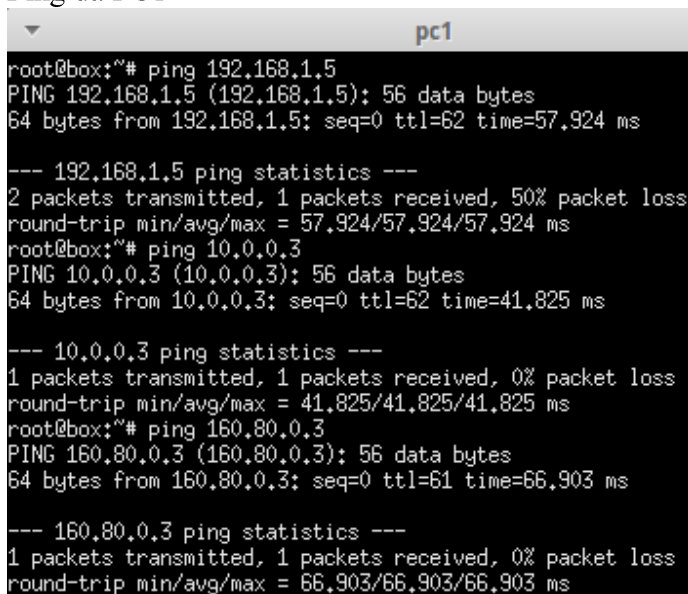
**PC4**

```

box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 10.0.0.3/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 10.0.0.2

```

Ping da PC1



```

pc1
root@box:~# ping 192.168.1.5
PING 192.168.1.5 (192.168.1.5): 56 data bytes
64 bytes from 192.168.1.5: seq=0 ttl=62 time=57.924 ms

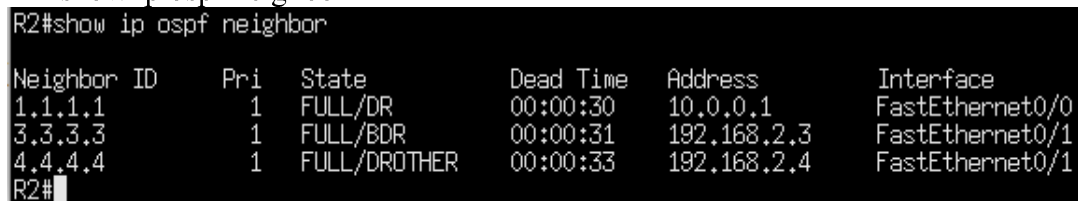
--- 192.168.1.5 ping statistics ---
2 packets transmitted, 1 packets received, 50% packet loss
round-trip min/avg/max = 57.924/57.924/57.924 ms
root@box:~# ping 10.0.0.3
PING 10.0.0.3 (10.0.0.3): 56 data bytes
64 bytes from 10.0.0.3: seq=0 ttl=62 time=41.825 ms

--- 10.0.0.3 ping statistics ---
1 packets transmitted, 1 packets received, 0% packet loss
round-trip min/avg/max = 41.825/41.825/41.825 ms
root@box:~# ping 160.80.0.3
PING 160.80.0.3 (160.80.0.3): 56 data bytes
64 bytes from 160.80.0.3: seq=0 ttl=61 time=66.903 ms

--- 160.80.0.3 ping statistics ---
1 packets transmitted, 1 packets received, 0% packet loss
round-trip min/avg/max = 66.903/66.903/66.903 ms

```

R2#show ip ospf neighbor



```

R2#show ip ospf neighbor
Neighbor ID      Pri   State           Dead Time   Address        Interface
1.1.1.1          1     FULL/DR         00:00:30   10.0.0.1      FastEthernet0/0
3.3.3.3          1     FULL/BDR        00:00:31   192.168.2.3   FastEthernet0/1
4.4.4.4          1     FULL/DROTHER    00:00:33   192.168.2.4   FastEthernet0/1
R2#

```

R2#show ip protocols

```

R2#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 2.2.2.2
  It is an area border router
  Number of areas in this router is 2. 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    10.0.0.2 0.0.0.0 area 0
    192.168.2.2 0.0.0.0 area 1
  Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway         Distance      Last Update
    1.1.1.1          110           00:11:47
    4.4.4.4          110           00:11:47
    3.3.3.3          110           00:19:52
  Distance: (default is 110)

```

R2#show ip route

```

R2#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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 10.0.0.1 to network 0.0.0.0

 10.0.0.0/24 is subnetted, 1 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
O E2 192.168.0.0/24 [110/20] via 192.168.2.4, 00:12:24, FastEthernet0/1
O     192.168.1.0/24 [110/20] via 192.168.2.3, 00:20:28, FastEthernet0/1
C     192.168.2.0/24 is directly connected, FastEthernet0/1
O*E2 0.0.0.0/0 [110/1] via 10.0.0.1, 00:12:24, FastEthernet0/0
R2#

```

R2#show ip route connected

```

R2#show ip route connected
 10.0.0.0/24 is subnetted, 1 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
C     192.168.2.0/24 is directly connected, FastEthernet0/1

```

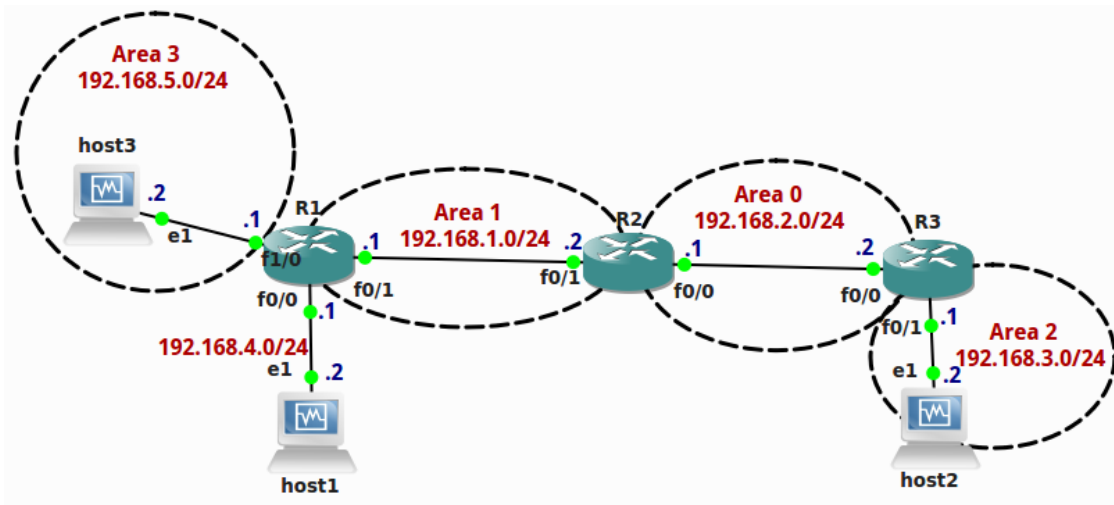
R2#show ip route ospf

```

R2#show ip route ospf
O E2 192.168.0.0/24 [110/20] via 192.168.2.4, 00:14:28, FastEthernet0/1
O     192.168.1.0/24 [110/20] via 192.168.2.3, 00:22:32, FastEthernet0/1
O*E2 0.0.0.0/0 [110/1] via 10.0.0.1, 00:14:28, FastEthernet0/0

```

## OSPF-2



### **ROUTER R1**

```
R1#conf t
R1(config)#int f0/0
R1(config-if)#ip address 192.168.4.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit

R1(config)#int f0/1
R1(config-if)#ip address 192.168.1.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit

R1(config)#router ospf 1
R1(config-router)#router-id 1.1.1.1
R1(config-router)#network 192.168.5.1 0.0.0.0 area 3
R1(config-router)#network 192.168.1.1 0.0.0.0 area 1
R1(config-router)#ip route 0.0.0.0 0.0.0.0 192.168.4.2
R1(config)#router ospf 1
R1(config-router)#default-information originate
R1(config-router)#end
```

### **ROUTER 2**

```
R2#conf t

R2(config)#int f0/0
R2(config-if)#ip address 192.168.2.1 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit

R2(config)#int f0/1
R2(config-if)#ip address 192.168.1.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
```

```
R2(config)#router ospf 1
R2(config-router)#router-id 2.2.2.2
R2(config-router)#network 192.168.1.2 0.0.0.0 area 1
R2(config-router)#network 192.168.2.1 0.0.0.0 area 0
R2(config-router)#end
```

**ROUTER 3**

```
R3#conf t
```

```
R3(config)#int f0/0
R3(config-if)#ip address 192.168.2.2 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
```

```
R3(config)#int f0/1
R3(config-if)#ip address 192.168.3.1 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
```

```
R3(config)#router ospf 1
R3(config-router)#router-id 3.3.3.3
R3(config-router)#network 192.168.2.2 0.0.0.0 area 0
R3(config-router)#network 192.168.3.1 0.0.0.0 area 2
R3(config-router)#end
```

**HOST1**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.4.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.4.1
root@box:~# ping 192.168.3.2
```

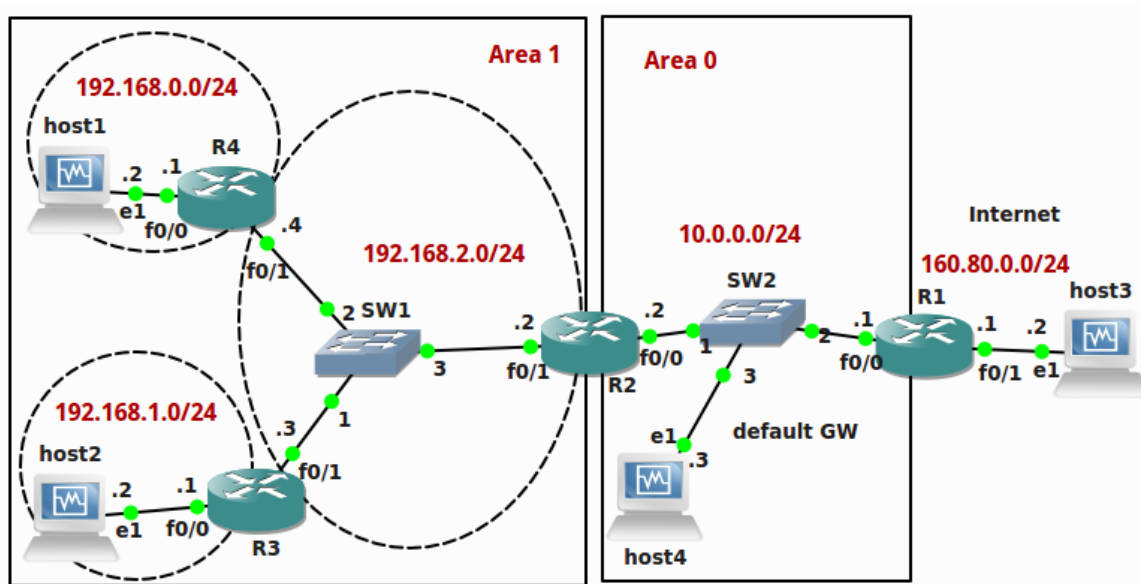
**HOST2**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.3.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.3.1
root@box:~# ping 192.168.4.2
```

**HOST3**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.5.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.5.1
```

## OSPF-lab



*//configurazione interfacce dei router//*

```
R1#conf t
R1(config)#int f0/0
R1(config-if)#ip address 10.0.0.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#int f0/1
R1(config-if)#ip address 160.80.0.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
```

```
R2#conf t
R2(config)#int f0/0
R2(config-if)#ip address 10.0.0.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#int f0/1
R2(config-if)#ip address 192.168.2.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
```

```
R3#conf t
R3(config)#int f0/0
R3(config-if)#ip address 192.168.1.1 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int f0/1
R3(config-if)#ip address 192.168.2.3 255.255.255.0
R3(config-if)#no shut
```

```
R3(config-if)#exit
R3(config)#
```

```
R4#conf t
R4(config)#int f0/0
R4(config-if)#ip address 192.168.0.1 255.255.255.0
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#int f0/1
R4(config-if)#ip address 192.168.2.4 255.255.255.0
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#
```

*//una volta configurate le interfacce andiamo ad abilitare il protocollo di routing OSPF//*

```
R1(config)#router ospf 1
R1(config-router)#router-id 1.1.1.1
R1(config-router)#network 10.0.0.1 0.0.0.0 area 0
R1(config-router)#exit
```

```
R2(config)#router ospf 1
R2(config-router)#router-id 2.2.2.2
R2(config-router)#network 10.0.0.2 0.0.0.0 area 0
R2(config-router)#network 192.168.2.2 0.0.0.0 area 1
R2(config-router)#exit
```

```
R3(config)#router ospf 1
R3(config-router)#router-id 3.3.3.3
R3(config-router)#network 192.168.1.1 0.0.0.0 area 1
R3(config-router)#network 192.168.2.3 0.0.0.0 area 1
R3(config-router)#exit
```

```
R4(config)#router ospf 1
R4(config-router)#router-id 4.4.4.4
R4(config-router)#network 192.168.0.1 0.0.0.0 area 1
R4(config-router)#network 192.168.2.4 0.0.0.0 area 1
R4(config-router)#exit
```

*//configurazione degli host//*

### **HOST1**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.0.1
root@box:~#
```

### **HOST2**

```
box login: tc
```

```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.1.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.1.1
```

**HOST3**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 160.80.0.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 160.80.0.1
root@box:~#
```

**HOST4**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 10.0.0.3/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 10.0.0.2
```

*//con la seguente configurazione possiamo notare che pingano solamente gli host appartenenti alla stessa area:*

*quindi host1 e host2 comunicano perchè appartengono alla stessa Area 1 mentre se volessimo pingare da host1 a host3 o host4 non ci riusciremmo perchè le aree sono differenti//*

***//sulle interfacce dei router abilitiamo Ospf//***

```
R2(config)#int f0/1
R2(config-if)#ip ospf network broadcast
R2(config-if)#end
```

```
R3(config)#int f0/1
R3(config-if)#ip ospf network broadcast
R3(config-if)#end
```

```
R4(config)#int f0/1
R4(config-if)#ip ospf network broadcast
R4(config-if)#end
```

*//ci accorgiamo che ora si pingano anche host3 con host4 e viceversa ma non host3 con host1 o host2 e viceversa//*

*//per rendere host3 raggiungibile dall'esterno o per far sì che host1 e host2 raggiungano host3//*

```
R1(config)#router ospf 1
R1(config-router)#default-information originate
R1(config-router)#exit
R1(config)#ip route 0.0.0.0 0.0.0.0 160.80.0.3
```

```
R2#show ip route
```



```

R2
R2#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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 10.0.0.1 to network 0.0.0.0

    10.0.0.0/24 is subnetted, 1 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
O       192.168.0.0/24 [110/20] via 192.168.2.4, 00:14:34, FastEthernet0/1
O       192.168.1.0/24 [110/20] via 192.168.2.3, 00:14:34, FastEthernet0/1
C       192.168.2.0/24 is directly connected, FastEthernet0/1
O*E2 0.0.0.0/0 [110/1] via 10.0.0.1, 00:10:25, FastEthernet0/0
R2#

```

R2#show ip ospf neighbor

```

R2#show ip ospf neighbor
Neighbor ID    Pri  State           Dead Time   Address      Interface
1.1.1.1        1    FULL/DR         00:00:32   10.0.0.1    FastEthernet0/0
3.3.3.3        1    FULL/BDR        00:00:32   192.168.2.3 FastEthernet0/1
4.4.4.4        1    FULL/DR         00:00:38   192.168.2.4 FastEthernet0/1
R2#

```

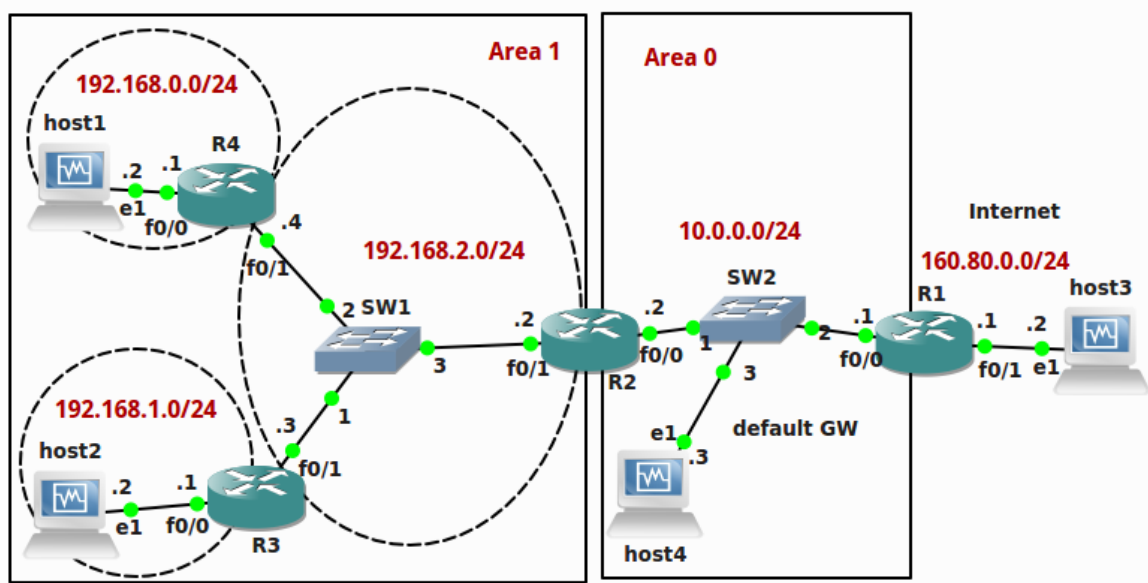
R2#show ip protocols

```

R2#show ip protocols
Routing Protocol is "ospf 1"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  Router ID 2.2.2.2
  It is an area border router
  Number of areas in this router is 2, 2 normal 0 stub 0 nssa
  Maximum path: 4
  Routing for Networks:
    10.0.0.2 0.0.0.0 area 0
    192.168.2.2 0.0.0.0 area 1
  Reference bandwidth unit is 100 mbps
  Routing Information Sources:
    Gateway         Distance      Last Update
    1.1.1.1          110          00:15:35
    3.3.3.3          110          00:19:44
    4.4.4.4          110          00:19:44
  Distance: (default is 110)

```

## OSPF



*//configuriamo le interfacce dei router//*

```
R1#conf t
R1(config)#int f0/0
R1(config-if)#ip address 10.0.0.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#int f0/1
R1(config-if)#ip address 160.80.0.1 255.255.255.0
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#
```

```
R2#conf t
R2(config)#int f0/0
R2(config-if)#ip address 10.0.0.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#int f0/1
R2(config-if)#ip address 192.168.2.2 255.255.255.0
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#
```

```
R3#conf t
R3(config)#int f0/0
R3(config-if)#ip address 192.168.1.1 255.255.255.0
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int f0/1
R3(config-if)#ip address 192.168.2.3 255.255.255.0
```

```
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#
```

```
R4#conf t
R4(config)#int f0/0
R4(config-if)#ip address 192.168.0.1 255.255.255.0
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#int f0/1
R4(config-if)#ip address 192.168.2.4 255.255.255.0
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#
```

*//una volta configurate le interfacce andiamo ad abilitare il protocollo di routing OSPF//*

```
R1(config)#router ospf 1
R1(config-router)#router-id 1.1.1.1
R1(config-router)#network 10.0.0.1 0.0.0.0 area 0
R1(config-router)#exit
```

```
R2(config)#router ospf 1
R2(config-router)#router-id 2.2.2.2
R2(config-router)#network 10.0.0.2 0.0.0.0 area 0
R2(config-router)#network 192.168.2.2 0.0.0.0 area 1
R2(config-router)#exit
```

```
R3(config)#router ospf 1
R3(config-router)#router-id 3.3.3.3
R3(config-router)#network 192.168.1.1 0.0.0.0 area 1
R3(config-router)#network 192.168.2.3 0.0.0.0 area 1
R3(config-router)#exit
```

```
R4(config)#router ospf 1
R4(config-router)#router-id 4.4.4.4
R4(config-router)#network 192.168.2.4 0.0.0.0 area 1
R4(config-router)#exit
```

*//configuriamo gli host//*

### **HOST1**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.0.1
root@box:~#
```

### **HOST2**

```
box login: tc
```

```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.1.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.1.1
```

**HOST3**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 160.80.0.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 160.80.0.1
root@box:~#
```

**HOST4**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 10.0.0.3/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 10.0.0.2
```

*//vediamo che gli host non riescono a comunicare tra di loro//*  
*//per far comunicare gli host delle aree possiamo dare sul router R4//*

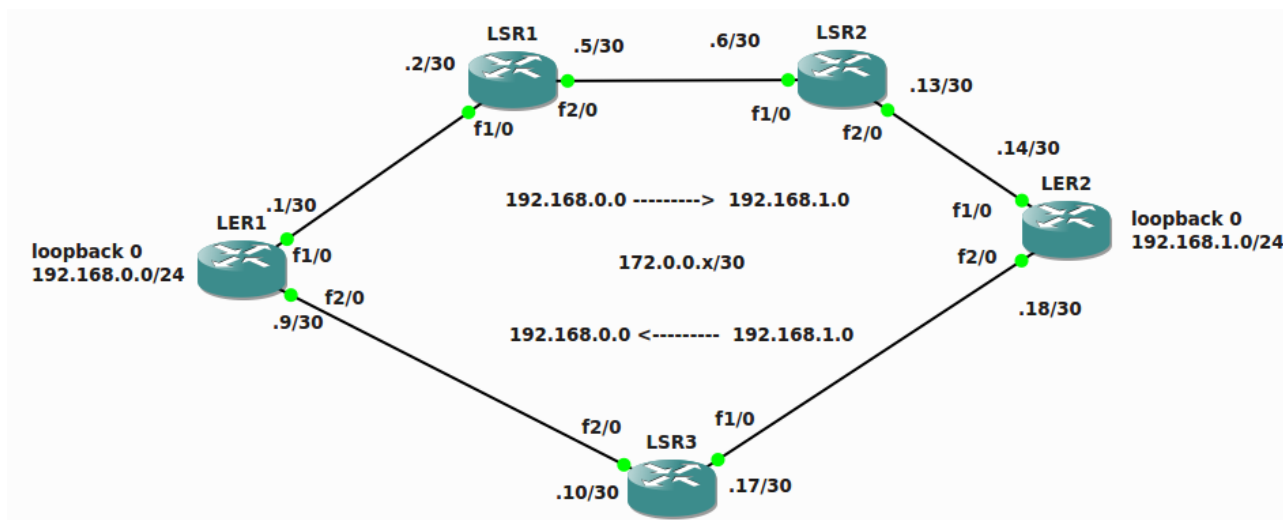
```
R4(config)#router ospf 1
R4(config-router)#redistribute connected
% Only classful networks will be redistributed
R4(config-router)#
```

*//ora solamente host3 non è raggiungibile//*  
*// per rendere raggiungibile host3 e far si che host3 raggiunga gli altri host//*

```
R1(config)#router ospf 1
R1(config-router)#default-information originate
R1(config-router)#exit
R1(config)#ip route 0.0.0.0 0.0.0.0 160.80.0.3
R1(config)#
```

*//fare dei ping per verificare il tutto !!!//*

## MPLS



### Configurazione LER1

```

LER1#conf t
LER1(config)#interface loopback0
LER1(config-if)#ip address 192.168.0.1 255.255.255.0
LER1(config-if)#ip ospf network point-to-point
LER1(config-if)#exit

LER1(config)#int f1/0
LER1(config-if)#ip address 172.0.0.1 255.255.255.252
LER1(config-if)#no shut
LER1(config-if)#mpls ip
LER1(config-if)#exit

LER1(config)#int f2/0
LER1(config-if)#ip address 172.0.0.9 255.255.255.252
LER1(config-if)#no shut
LER1(config-if)#exit

LER1(config)#mpls label range 32 200 static 16 31
LER1(config)#router ospf 1
LER1(config-router)#network 0.0.0.0 255.255.255.255 area 0

```

### Configurazione LER2

```

LER2#conf t
LER2(config)#mpls label range 32 200 static 16 31
LER2(config)#int loopback0
LER2(config-if)#ip address 192.168.1.1 255.255.255.0
LER2(config-if)#ip ospf network point-to-point
LER2(config-if)#exit

LER2(config)#int f1/0
LER2(config-if)#ip address 172.0.0.14 255.255.255.252
LER2(config-if)#no shut
LER2(config-if)#mpls ip
LER2(config-if)#exit

```

```
LER2(config)#int f2/0
LER2(config-if)#ip address 172.0.0.18 255.255.255.252
LER2(config-if)#no shut
LER2(config-if)#mpls ip
LER2(config-if)#exit

LER2(config)#router ospf 1
LER2(config-router)#network 0.0.0.0 255.255.255.255 area 0
LER2(config-router)#end
```

### **Configurazione LSR1**

```
LSR1#conf t

LSR1(config)#mpls label range 32 200 static 16 31

LSR1(config)#int f1/0
LSR1(config-if)#ip address 172.0.0.2 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#exit

LSR1(config)#int f2/0
LSR1(config-if)#ip address 172.0.0.5 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#exit

LSR1(config)#router ospf 1
LSR1(config-router)#network 0.0.0.0 255.255.255.255 area 0
LSR1(config-router)#end
```

### **Configurazione LSR2**

```
LSR2#conf t

LSR2(config)#mpls label range 32 200 static 16 31

LSR2(config)#int f1/0
LSR2(config-if)#ip address 172.0.0.6 255.255.255.252
LSR2(config-if)#mpls ip
LSR2(config-if)#no shut
LSR2(config-if)#exit

LSR2(config)#int f2/0
LSR2(config-if)#ip address 172.0.0.13 255.255.255.252
LSR2(config-if)#no shut
LSR2(config-if)#mpls ip
LSR2(config-if)#exit

LSR2(config)#router ospf 1
LSR2(config-router)#network 0.0.0.0 255.255.255.255 area 0
LSR2(config-router)#end
```

### **Configurazione LSR3**

```
LSR3#conf t

LSR3(config)#mpls label range 32 200 static 16 31
```

```

LSR3(config)#int f1/0
LSR3(config-if)#ip address 172.0.0.17 255.255.255.252
LSR3(config-if)#no shut
LSR3(config-if)#mpls ip
LSR3(config-if)#exit

LSR3(config)#int f2/0
LSR3(config-if)#ip address 172.0.0.10 255.255.255.252
LSR3(config-if)#no shut
LSR3(config-if)#mpls ip
LSR3(config-if)#exit

LSR3(config)#router ospf 1
LSR3(config-router)#network 0.0.0.0 255.255.255.255 area 0
LSR3(config-router)#end

```

```

LER1
LER1#traceroute 192.168.1.1 source 192.168.0.1

Type escape sequence to abort.
Tracing the route to 192.168.1.1

 0 172.0.0.10 [MPLS: Label 32 Exp 0] 36 msec 40 msec 40 msec
 1 172.0.0.18 40 msec 40 msec 20 msec
LER1#

```

```

LER1
LER1#show mpls forwarding-table

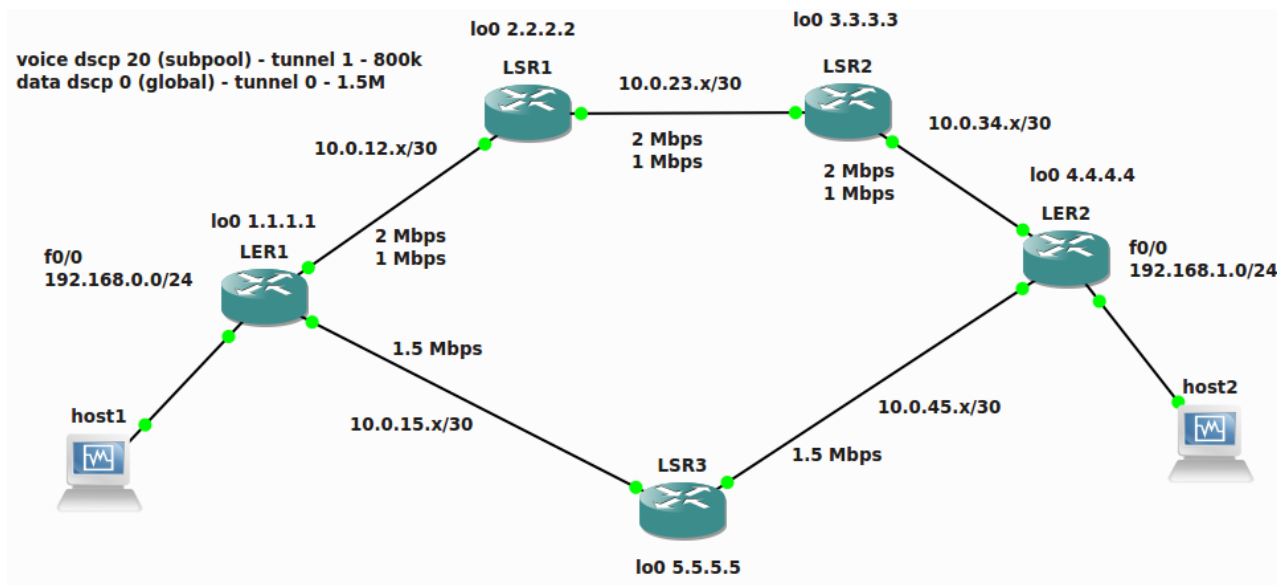
Local  Outgoing  Prefix          Bytes tag  Outgoing     Next Hop
tag    tag or VC  or Tunnel Id   switched  interface
32     32         192.168.1.0/24 0          Fa2/0        172.0.0.10
33     36         172.0.0.12/30 0          Fa2/0        172.0.0.10
34     32         172.0.0.12/30 0          Fa1/0        172.0.0.2
35     Pop tag    172.0.0.16/30 0          Fa2/0        172.0.0.10
36     Pop tag    172.0.0.4/30  0          Fa1/0        172.0.0.2
LER1#

```

```
LER1
LER1#show mpls ldp bindings
tib entry: 172.0.0.0/30, rev 5
  local binding: tag: imp-null
  remote binding: tsr: 172.0.0.17:0, tag: 34
  remote binding: tsr: 172.0.0.5:0, tag: imp-null
tib entry: 172.0.0.4/30, rev 14
  local binding: tag: 35
  remote binding: tsr: 172.0.0.17:0, tag: 35
  remote binding: tsr: 172.0.0.5:0, tag: imp-null
tib entry: 172.0.0.8/30, rev 4
  local binding: tag: imp-null
  remote binding: tsr: 172.0.0.17:0, tag: imp-null
  remote binding: tsr: 172.0.0.5:0, tag: 36
tib entry: 172.0.0.12/30, rev 10
  local binding: tag: 33
  remote binding: tsr: 172.0.0.17:0, tag: 36
  remote binding: tsr: 172.0.0.5:0, tag: 32
tib entry: 172.0.0.16/30, rev 12
  local binding: tag: 34
  remote binding: tsr: 172.0.0.17:0, tag: imp-null
  remote binding: tsr: 172.0.0.5:0, tag: 35
tib entry: 192.168.0.0/24, rev 6
  local binding: tag: imp-null
  remote binding: tsr: 172.0.0.17:0, tag: 33
LER1#
```



## MPLS-DS-TE



### Configurazione LER1

```
LER1#conf t
```

```
LER1(config)#mpls label range 32 200 static 16 31
```

```
LER1(config)#mpls ldp grace
```

```
LER1(config)#mpls ldp graceful-restart
```

```
% Previously established LDP sessions may not have graceful restart protection.
```

```
LER1(config)#mpls traffic-eng tunnels
```

```
LER1(config)#multilink bundle-name authenticated
```

```
LER1(config)#class-map match-all voice
```

```
LER1(config-cmap)#match access-group 101
```

```
LER1(config-cmap)#exit
```

```
LER1(config)#policy-map set-exp5
```

```
LER1(config-pmap)#class class-default
```

```
LER1(config-pmap-c)#set mpls experimental imposition 5
```

```
LER1(config-pmap-c)#exit
```

```
LER1(config-pmap)#exit
```

```
LER1(config)#policy-map set-exp5t
```

```
LER1(config-pmap)#class voice
```

```
LER1(config-pmap-c)#set mpls experimental imposition 5
```

```
LER1(config-pmap-c)#exit
```

```
LER1(config-pmap)#exit
```

```
LER1(config)#policy-map voice
```

```
LER1(config-pmap)#class voice
```

```
LER1(config-pmap-c)#exit
```

```
LER1(config-pmap)#exit
```

```
LER1(config)#int loopback0
```

```
LER1(config-if)#ip address 1.1.1.1 255.255.255.255
```

```
LER1(config-if)#exit
```

```
LER1(config)#int Tunnel0
```

```
LER1(config-if)#ip unnumbered loopback 0
LER1(config-if)#tunnel destination 4.4.4.4
LER1(config-if)#tunnel mode mpls traffic-eng
LER1(config-if)#tunnel mpls traffic-eng priority 7 7
LER1(config-if)#tunnel mpls traffic-eng bandwidth 1500
LER1(config-if)#tunnel mpls traffic-eng path-option 10 dynamic
LER1(config-if)#exit

LER1(config)#int Tunnel1
LER1(config-if)#ip unnumbered loopback 0
LER1(config-if)#tunnel destination 4.4.4.4
LER1(config-if)#tunnel mode mpls traffic-eng
LER1(config-if)#tunnel mpls traffic-eng priority 6 6
LER1(config-if)#tunnel mpls traffic-eng bandwidth sub-pool 800
LER1(config-if)#tunnel mpls traffic-eng path-option 10 dynamic
LER1(config-if)#no routing dynamic
LER1(config-if)#exit

LER1(config)#int Tunnel0
LER1(config-if)#no routing dynamic
LER1(config-if)#exit

LER1(config)#int Tunnel2
LER1(config-if)#ip unnumbered loopback 0
LER1(config-if)#tunnel destination 4.4.4.4
LER1(config-if)#tunnel mode mpls traffic-eng
LER1(config-if)#tunnel mpls traffic-eng priority 7 7
LER1(config-if)#tunnel mpls traffic-eng bandwidth 1200
LER1(config-if)#tunnel mpls traffic-eng path-option 10 dynamic
LER1(config-if)#no routing dynamic
LER1(config-if)#exit

LER1(config)#int f2/0
LER1(config-if)#ip address 192.168.0.1 255.255.255.0
LER1(config-if)#no shut
LER1(config-if)#ip policy route-map intf00
LER1(config-if)#service-policy input set-exp5t
LER1(config-if)#exit

LER1(config)#int f1/0
LER1(config-if)#ip address 10.0.12.1 255.255.255.252
LER1(config-if)#no shut
LER1(config-if)#mpls ip
LER1(config-if)#mpls traffic-eng tunnels
LER1(config-if)#ip rsvp bandwidth 2000 sub-pool 1000
LER1(config-if)#exit

LER1(config)#int f0/0
LER1(config-if)#ip address 10.0.15.1 255.255.255.252
LER1(config-if)#no shut
LER1(config-if)#mpls ip
LER1(config-if)#mpls traffic-eng tunnels
LER1(config-if)#ip rsvp bandwidth 1500
LER1(config-if)#exit
```

```

LER1(config)#router ospf 1
LER1(config-router)#mpls traffic-eng router-id loopback 0
LER1(config-router)#mpls traffic-eng area 0
LER1(config-router)#router-id 1.1.1.1
LER1(config-router)#network 1.1.1.1 0.0.0.0 area 0
LER1(config-router)#network 10.0.0.0 0.0.255.255 area 0
LER1(config-router)#exit

LER1(config)#ip route 0.0.0.0 0.0.0.0 null 0
LER1(config)#access-list 101 permit ip any any dscp af22
LER1(config)#access-list 102 permit ip any any dscp default

LER1(config)#route-map intf00 permit 10
LER1(config-route-map)#match ip address 101
LER1(config-route-map)#set interface tunnel 1
LER1(config-route-map)#exit
LER1(config)#route-map intf00 permit 20
LER1(config-route-map)#match ip address 102
LER1(config-route-map)#set interface tunnel 2
LER1(config-route-map)#exit

LER1(config)#mpls ldp router-id loopbac
LER1(config)#mpls ldp router-id loopback 0 force
LER1(config)#end

```

## Configurazione LER2

```

LER2#conf t

LER2(config)#mpls label range 32 200 static 16 31
LER2(config)#mpls ldp graceful-restart
LER2(config)#mpls traffic-eng tunnels
LER2(config)#multilink bundle-name authenticated

LER2(config)#int loopback 0
LER2(config-if)#ip address 4.4.4.4 255.255.255.255
LER2(config-if)#no shut
LER2(config-if)#exit

LER2(config)#int tunnel 0
LER2(config-if)#ip unnumbered loopback 0
LER2(config-if)#tunnel destination 1.1.1.1
LER2(config-if)#tunnel mode mpls traffic-eng
LER2(config-if)#tunnel mpls traffic-eng priority 7 7
LER2(config-if)#tunnel mpls traffic-eng bandwidth 1500
LER2(config-if)#tunnel mpls traffic-eng path-option 10 dynamic
LER2(config-if)#no routing dynamic
LER2(config-if)#exit

LER2(config)#int tunnel 1
LER2(config-if)#ip unnumbered loopback 0
LER2(config-if)#tunnel destination 1.1.1.1
LER2(config-if)#tunnel mode mpls traffic-eng
LER2(config-if)#tunnel mpls traffic-eng priority 6 6
LER2(config-if)#tunnel mpls traffic-eng bandwidth sub-pool 800
LER2(config-if)#tunnel mpls traffic-eng path-option 10 dynamic

```

```

LER2(config-if)#no routing dynamic
LER2(config-if)#exit

LER2(config)#int f2/0
LER2(config-if)#ip address 192.168.1.1 255.255.255.0
LER2(config-if)#no shut
LER2(config-if)#ip policy route-map intf00
LER2(config-if)#exit

LER2(config)#int f1/0
LER2(config-if)#ip address 10.0.34.2 255.255.255.252
LER2(config-if)#no shut
LER2(config-if)#mpls ip
LER2(config-if)#mpls traffic-eng tunnels
LER2(config-if)#ip rsvp bandwidth 1500
LER2(config-if)#ip rsvp resource-provider none
LER2(config-if)#exit

LER2(config)#router ospf 1
LER2(config-router)#mpls traffic-eng router-id loopback 0
LER2(config-router)#mpls traffic-eng area 0
LER2(config-router)#router-id 4.4.4.4
LER2(config-router)#network 4.4.4.4 0.0.0.0 area 0
LER2(config-router)#network 10.0.0.0 0.0.255.255 area 0
LER2(config-router)#exit

LER2(config)#ip route 0.0.0.0 0.0.0.0 null 0
LER2(config)#access-list 101 permit ip any any dscp af22
LER2(config)#access-list 102 permit ip any any dscp default

LER2(config)#route-map intf00 permit 10
LER2(config-route-map)#match ip address 101
LER2(config-route-map)#set interface tunnel 1
LER2(config-route-map)#exit

LER2(config)#route-map intf00 permit 20
LER2(config-route-map)#match ip address 102
LER2(config-route-map)#set interface tunnel 0
LER2(config-route-map)#exit

LER2(config)#mpls ldp router-id loopback 0 force
LER2(config)#end

```

### **Configurazione LSR1**

```

LSR1#conf t

LSR1(config)#mpls traffic-eng tunnels
LSR1(config)#multilink bundle-name authenticated

LSR1(config)#int loopback 0
LSR1(config-if)#ip address 2.2.2.2 255.255.255.255
LSR1(config-if)#exit

LSR1(config)#int f1/0
LSR1(config-if)#ip address 10.0.12.2 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip

```

```

LSR1(config-if)#mpls traffic-eng tunnels
LSR1(config-if)#ip rsvp bandwidth 2000 sub-pool 1000
LSR1(config-if)#exit

LSR1(config)#int f2/0
LSR1(config-if)#ip address 10.0.23.1 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#mpls traffic-eng tunnels
LSR1(config-if)#ip rsvp bandwidth 2000 sub

LSR1(config)#mpls traffic-eng tunnels
LSR1(config)#multilink bundle-name authenticated

LSR1(config)#int loopback 0
LSR1(config-if)#ip address 2.2.2.2 255.255.255.255
LSR1(config-if)#exit

LSR1(config)#int f1/0
LSR1(config-if)#ip address 10.0.12.2 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#mpls traffic-eng tunnels
LSR1(config-if)#ip rsvp bandwidth 2000 sub-pool 1000
LSR1(config-if)#exit

LSR1(config)#int f2/0
LSR1(config-if)#ip address 10.0.23.1 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#mpls traffic-eng tunnels
LSR1(config-if)#ip rsvp bandwidth 2000 sub-pool 1000
LSR1(config-if)#exit

LSR1(config)#router ospf 1
LSR1(config-router)#mpls traffic-eng router-id loopback 0
LSR1(config-router)#mpls traffic-eng area 0
LSR1(config-router)#network 2.2.2.2 0.0.0.0 area 0
LSR1(config-router)#network 10.0.0.0 0.0.255.255 area 0
LSR1(config-router)#end

```

## Configurazione LSR2

```

LSR2#conf t

LSR2(config)#mpls label range 32 200 static 16 31
LSR2(config)#mpls traffic-eng tunnels
LSR2(config)#multilink bundle-name authenticated
LSR2(config)#mpls ldp graceful-restart

LSR2(config)#int loopback 0
LSR2(config-if)#ip address 3.3.3.3 255.255.255.255
LSR2(config-if)#exit

LSR2(config)#int f0/0
LSR2(config-if)#exit

LSR2(config)#int f1/0

```

```
LSR2(config-if)#ip address 10.0.23.2 255.255.255.252
LSR2(config-if)#no shut
LSR2(config-if)#mpls ip
LSR2(config-if)#mpls traffic-eng tunnels
LSR2(config-if)#ip rsvp bandwidth 2000 sub-pool 1000
LSR2(config-if)#exit

LSR2(config)#int f2/0
LSR2(config-if)#ip address 10.0.34.1 255.255.255.252
LSR2(config-if)#no shut
LSR2(config-if)#mpls ip
LSR2(config-if)#mpls traffic-eng tunnels
LSR2(config-if)#ip rsvp bandwidth 2000 sub-pool 1000
LSR2(config-if)#exit

LSR2(config)#router ospf 1
LSR2(config-router)#mpls traffic-eng router-id loopback 0
LSR2(config-router)#mpls traffic-eng area 0
LSR2(config-router)#network 3.3.3.3 0.0.0.0 area 0
LSR2(config-router)#network 10.0.0.0 0.0.255.255 area 0
LSR2(config-router)#exit
LSR2(config)#end
```

### Configurazione LSR3

```
LSR3#conf t

LSR3(config)#mpls label range 32 200 static 16 31
LSR3(config)#mpls traffic-eng tunnels
LSR3(config)#multilink bundle-name authenticated
LSR3(config)#mpls ldp graceful-restart

LSR3(config)#int loopback 0
LSR3(config-if)#ip address 5.5.5.5 255.255.255.255
LSR3(config-if)#exit

LSR3(config)#int f1/0
LSR3(config-if)#ip address 10.0.45.2 255.255.255.252
LSR3(config-if)#no shut
LSR3(config-if)#mpls ip
LSR3(config-if)#mpls traffic-eng tunnels
LSR3(config-if)#ip rsvp bandwidth 1500
LSR3(config-if)#exit

LSR3(config)#int f2/0
LSR3(config-if)#ip address 10.0.15.2 255.255.255.252
LSR3(config-if)#no shut
LSR3(config-if)#mpls ip
LSR3(config-if)#mpls traffic-eng tunnels
LSR3(config-if)#ip rsvp bandwidth 1500
LSR3(config-if)#exit

LSR3(config)#router ospf 1
LSR3(config-router)#mpls traffic-eng router-id loopback 0
LSR3(config-router)#mpls traffic-eng area 0
LSR3(config-router)#network 5.5.5.5 0.0.0.0 area 0
```

```
LSR3(config-router)#network 10.0.0.0 0.0.255.255 area 0
LSR3(config-router)#exit
LSR3(config)#end
```

### Configurazione Host1

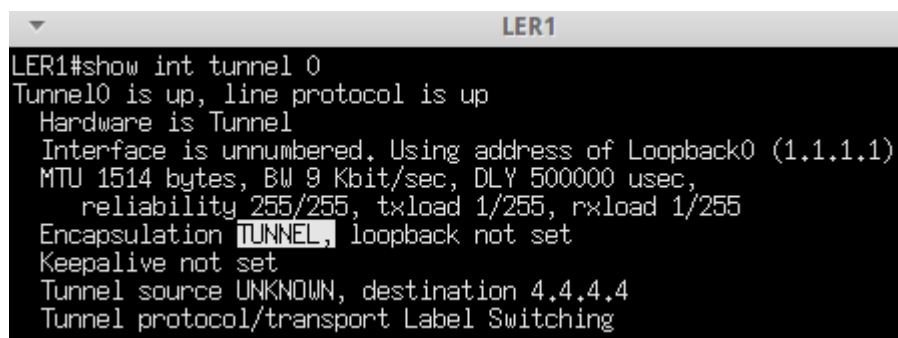
```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.2/24 dev eth1
root@box:~# ip r del default
root@box:~# ip r a default via 192.168.0.1
```

### Configurazione Host2

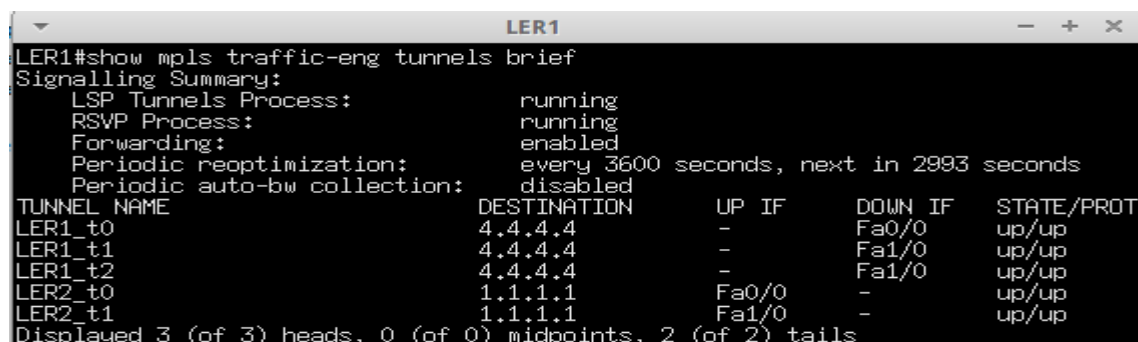
```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.1.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.1.1
```

### TROUBLESHOOTING da qualunque router MPLS

```
LSR1#show mpls traffic-eng topology
LSR1#show mpls traffic-eng tunnels
LER1#show mpls traffic-eng link-management advertisements
LER1#debug mpls traffic-eng link-management preemption
LER1#show mpls traffic-eng link-management summary
LER1#show mpls traffic-eng link-management admission-control
LER1#show mpls traffic-eng link-management interfaces
LER1#show mpls traffic-eng link-management bandwidth-allocation
LER1#show ip rsvp reservation
```

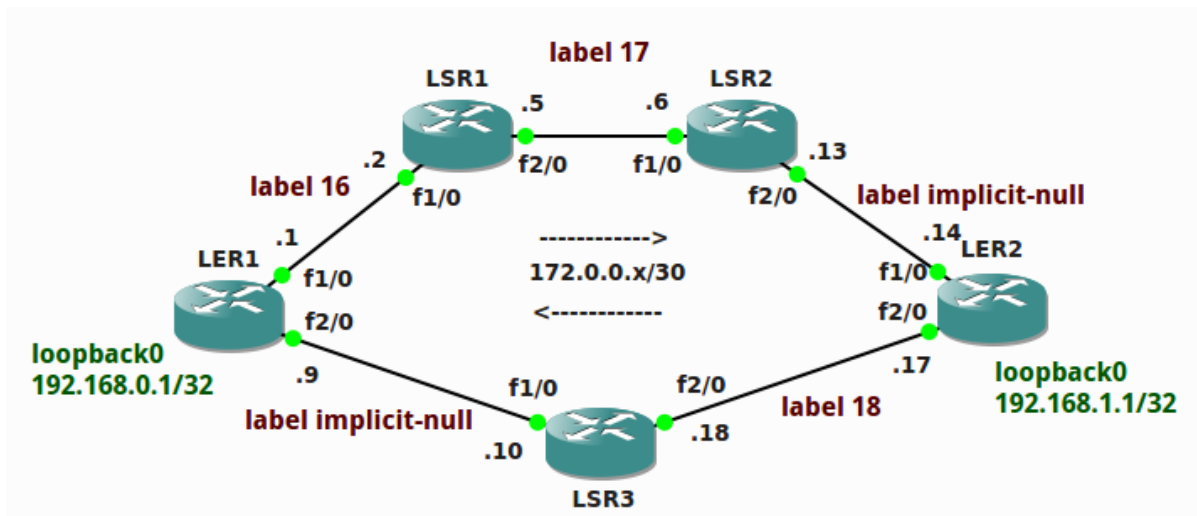


```
LER1
LER1#show int tunnel 0
Tunnel0 is up, line protocol is up
  Hardware is Tunnel
  Interface is unnumbered. Using address of Loopback0 (1.1.1.1)
  MTU 1514 bytes, BW 9 Kbit/sec, DLY 5000000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source UNKNOWN, destination 4.4.4.4
  Tunnel protocol/transport Label Switching
```



```
LER1
LER1#show mpls traffic-eng tunnels brief
Signalling Summary:
  LSP Tunnels Process:      running
  RSVP Process:            running
  Forwarding:              enabled
  Periodic reoptimization: every 3600 seconds, next in 2993 seconds
  Periodic auto-bw collection: disabled
TUNNEL NAME      DESTINATION      UP IF      DOWN IF      STATE/PROT
LER1_t0          4.4.4.4          -          Fa0/0        up/up
LER1_t1          4.4.4.4          -          Fa1/0        up/up
LER1_t2          4.4.4.4          -          Fa1/0        up/up
LER2_t0          1.1.1.1          Fa0/0     -            up/up
LER2_t1          1.1.1.1          Fa1/0     -            up/up
Displayed 3 (of 3) heads, 0 (of 0) midpoints, 2 (of 2) tails
```

## MPLS STATIC



### Configurazione LER1

```
LER1#conf t
```

```
LER1(config)#mpls label range 32 200 static 16 31
```

```
LER1(config)#int loopback 0
LER1(config-if)#ip address 192.168.0.1 255.255.255.255
LER1(config-if)#exit
LER1(config)#int f1/0
LER1(config-if)#ip address 172.0.0.1 255.255.255.252
LER1(config-if)#no shut
LER1(config-if)#mpls ip
LER1(config-if)#exit
LER1(config)#int f2/0
LER1(config-if)#ip address 172.0.0.9 255.255.255.252
LER1(config-if)#no shut
LER1(config-if)#mpls ip
LER1(config-if)#exit
```

```
LER1(config)#ip route 192.168.1.1 255.255.255.255 172.0.0.2
```

```
LER1(config)#mpls static binding ipv4 192.168.1.1 255.255.255.255 output 172.0.0.2 16
LER1(config)#exit
```

### Configurazione LER2

```
LER2#conf t
```

```
LER2(config)#mpls label range 32 200 static 16 31
```

```
LER2(config)#int loopback 0
LER2(config-if)#ip address 192.168.1.1 255.255.255.255
LER2(config-if)#exit
LER2(config)#int f1/0
LER2(config-if)#ip address 172.0.0.14 255.255.255.252
```



```
LER2(config-if)#no shut
LER2(config-if)#mpls ip
LER2(config-if)#exit
LER2(config)#int f2/0
LER2(config-if)#ip address 172.0.0.17 255.255.255.252
LER2(config-if)#no shut
LER2(config-if)#mpls ip
LER2(config-if)#exit

LER2(config)#ip route 192.168.0.1 255.255.255.255 172.0.0.18

LER2(config)#mpls static binding ipv4 192.168.0.1 255.255.255.255 output 172.0.0.18 18
LER2(config)#exit
```

### **Configurazione LSR1**

```
LSR1#conf t

LSR1(config)#mpls label range 32 200 static 16 31

LSR1(config)#int f1/0
LSR1(config-if)#ip address 172.0.0.2 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#exit
LSR1(config)#int f2/0
LSR1(config-if)#ip address 172.0.0.5 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#exit

LSR1(config)#mpls static crossconnect 16 FastEthernet2/0 172.0.0.6 17
LSR1(config)#exit
```

### **Configurazione LSR2**

```
LSR2#conf t

LSR2(config)#mpls label range 32 200 static 16 31

LSR2(config)#int f1/0
LSR2(config-if)#ip address 172.0.0.6 255.255.255.252
LSR2(config-if)#no shut
LSR2(config-if)#mpls ip
LSR2(config-if)#exit
LSR2(config)#int f2/0
LSR2(config-if)#ip address 172.0.0.13 255.255.255.252
LSR2(config-if)#no shut
LSR2(config-if)#mpls ip
LSR2(config-if)#exit

LSR2(config)#mpls static crossconnect 17 FastEthernet2/0 172.0.0.14 implicit-null
```

```
LSR2(config)#exit
```

### Configurazione LSR3

```
LSR3#conf t
```

```
LSR3(config)#mpls label range 32 200 static 16 31
```

```
LSR3(config)#int f1/0
```

```
LSR3(config-if)#ip address 172.0.0.10 255.255.255.252
```

```
LSR3(config-if)#no shut
```

```
LSR3(config-if)#mpls ip
```

```
LSR3(config-if)#exit
```

```
LSR3(config)#int f2/0
```

```
LSR3(config-if)#ip address 172.0.0.18 255.255.255.252
```

```
LSR3(config-if)#no shut
```

```
LSR3(config-if)#mpls ip
```

```
LSR3(config-if)#exit
```

```
LSR3(config)#mpls static crossconnect 18 FastEthernet1/0 172.0.0.9 implicit-null
```

```
LSR3(config)#exit
```

```
LER1
LER1#traceroute 192.168.1.1 source 192.168.0.1
Type escape sequence to abort.
Tracing the route to 192.168.1.1
 0/0  172.0.0.2 [MPLS: Label 16 Exp 0] 68 msec 36 msec 60 msec
 1/0  172.0.0.6 [MPLS: Label 17 Exp 0] 52 msec 48 msec 44 msec
 2/0  172.0.0.14 36 msec 56 msec 40 msec
LER1#
```

```
LER2
LER2#traceroute 192.168.0.1 source 192.168.1.1
Type escape sequence to abort.
Tracing the route to 192.168.0.1
 0/0  172.0.0.18 [MPLS: Label 18 Exp 0] 44 msec 40 msec 52 msec
 1/0  172.0.0.9 36 msec 60 msec 48 msec
LER2#
```

```

LER1
LER1#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

    172.0.0.0/30 is subnetted, 2 subnets
C       172.0.0.8 is directly connected, FastEthernet2/0
C       172.0.0.0 is directly connected, FastEthernet1/0
    192.168.0.0/32 is subnetted, 1 subnets
C       192.168.0.1 is directly connected, Loopback0
    192.168.1.0/32 is subnetted, 1 subnets
S       192.168.1.1 [1/0] via 172.0.0.2
LER1#

```

```

LER1
LER1#show mpls label range
Downstream Generic label region: Min/Max label: 32/200
Range for static labels: Min/Max Number: 16/31
LER1#

```

```

LER1
LER1#show mpls static binding
192.168.1.1/32: Incoming label: none;
  Outgoing labels:
    172.0.0.2          16
LER1#

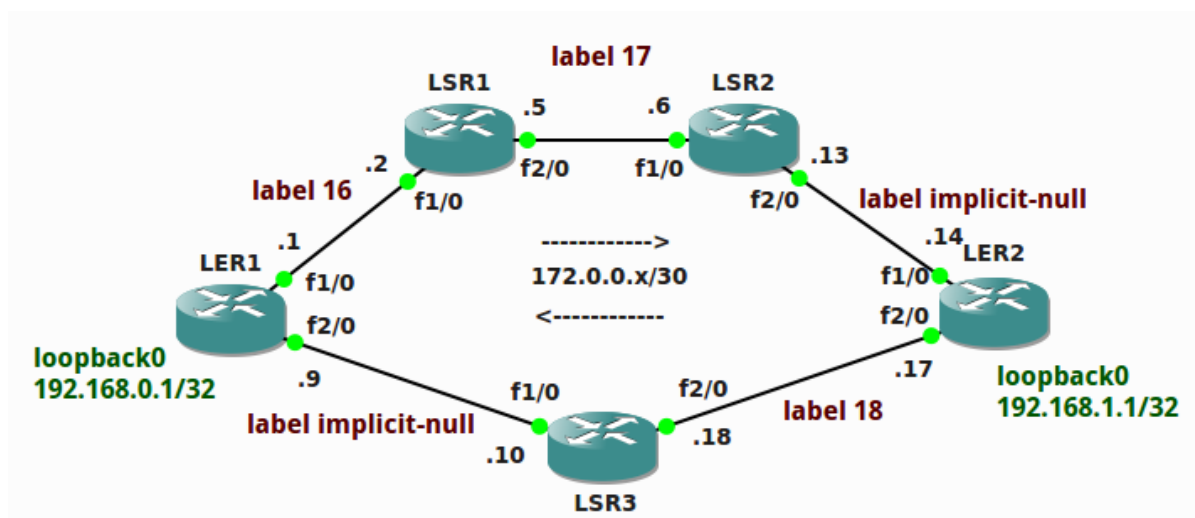
```

```

LSR3
LSR3#show mpls static crossconnect
Local  Outgoing  Outgoing  Next Hop
label label      interface
18    Pop Label  Fa1/0     172.0.0.9   (in LFIB) [Outgoing label is implicit-null]
LSR3#

```

## MPLS LDP



### Configurazione LER1

```
LER1#conf t
```

```
LER1(config)#mpls label range 32 200 static 16 31
```

```
LER1(config)#int loopback 0
```

```
LER1(config-if)#ip address 192.168.0.1 255.255.255.255
```

```
LER1(config-if)#exit
```

```
LER1(config)#int f1/0
```

```
LER1(config-if)#ip address 172.0.0.1 255.255.255.252
```

```
LER1(config-if)#no shut
```

```
LER1(config-if)#mpls ip
```

```
LER1(config-if)#exit
```

```
LER1(config)#int f2/0
```

```
LER1(config-if)#ip address 172.0.0.9 255.255.255.252
```

```
LER1(config-if)#no shut
```

```
LER1(config-if)#mpls ip
```

```
LER1(config-if)#exit
```

```
LER1(config)#router ospf 1
```

```
LER1(config-router)#router-id 1.1.1.1
```

```
LER1(config-router)#network 0.0.0.0 255.255.255.255 area 0
```

```
LER1(config)#exit
```

### Configurazione LER2

```
LER2#conf t
```

```
LER2(config)#mpls label range 32 200 static 16 31
```

```
LER2(config)#int loopback 0
```

```
LER2(config-if)#ip address 192.168.1.1 255.255.255.255
```

```
LER2(config-if)#exit
```

```
LER2(config)#int loopback 1
```

```
LER2(config-if)#ip address 192.168.2.1 255.255.255.255
```

```
LER2(config-if)#exit
```

```
LER2(config)#int f1/0
LER2(config-if)#ip address 172.0.0.14 255.255.255.252
LER2(config-if)#no shut
LER2(config-if)#mpls ip
LER2(config-if)#exit
LER2(config)#int f2/0
LER2(config-if)#ip address 172.0.0.17 255.255.255.252
LER2(config-if)#no shut
LER2(config-if)#mpls ip
LER2(config-if)#exit
```

```
LER1(config)#router ospf 1
LER1(config-router)#router-id 1.1.1.2
LER1(config-router)#network 0.0.0.0 255.255.255.255 area 0
LER2(config)#exit
```

### **Configurazione LSR1**

```
LSR1#conf t
```

```
LSR1(config)#mpls label range 32 200 static 16 31
```

```
LSR1(config)#int f1/0
LSR1(config-if)#ip address 172.0.0.2 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#exit
LSR1(config)#int f2/0
LSR1(config-if)#ip address 172.0.0.5 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#exit
```

```
LSR1(config)#router ospf 1
LSR1(config-router)#router-id 2.2.2.1
LSR1(config-router)#network 0.0.0.0 255.255.255.255 area 0
LSR1(config)#exit
```

### **Configurazione LSR2**

```
LSR2#conf t
```

```
LSR2(config)#mpls label range 32 200 static 16 31
```

```
LSR2(config)#int f1/0
LSR2(config-if)#ip address 172.0.0.6 255.255.255.252
LSR2(config-if)#no shut
LSR2(config-if)#mpls ip
LSR2(config-if)#exit
LSR2(config)#int f2/0
LSR2(config-if)#ip address 172.0.0.13 255.255.255.252
LSR2(config-if)#no shut
LSR2(config-if)#mpls ip
```

```
LSR2(config-if)#exit
```

```
LSR2(config)#router ospf 1
LSR2(config-router)#router-id 2.2.2.2
LSR2(config-router)#network 0.0.0.0 255.255.255.255 area 0
LSR2(config)#exit
```

### Configurazione LSR3

```
LSR3#conf t
```

```
LSR3(config)#mpls label range 32 200 static 16 31
```

```
LSR3(config)#int f1/0
LSR3(config-if)#ip address 172.0.0.10 255.255.255.252
LSR3(config-if)#no shut
LSR3(config-if)#mpls ip
LSR3(config-if)#exit
LSR3(config)#int f2/0
LSR3(config-if)#ip address 172.0.0.18 255.255.255.252
LSR3(config-if)#no shut
LSR3(config-if)#mpls ip
LSR3(config-if)#exit
```

```
LSR3(config)#router ospf 1
LSR3(config-router)#router-id 2.2.2.3
LSR3(config-router)#network 0.0.0.0 255.255.255.255 area 0
LSR3(config)#exit
```

```
LER1
LER1#traceroute 192.168.1.1 source 192.168.0.1
Type escape sequence to abort.
Tracing the route to 192.168.1.1
 0/0  1 172.0.0.10 [MPLS: Label 33 Exp 0] 24 msec 36 msec 32 msec
 1/0  2 172.0.0.17 48 msec 32 msec 40 msec
LER1#
```

```
LER2
LER2#traceroute 192.168.0.1 source 192.168.2.1
Type escape sequence to abort.
Tracing the route to 192.168.0.1
 0/0  1 172.0.0.18 [MPLS: Label 34 Exp 0] 28 msec 40 msec 36 msec
 1/0  2 172.0.0.9 44 msec 28 msec 36 msec
LER2#
```

```

LER1
LER1#show mpls ldp neighbor
Peer LDP Ident: 172.0.0.18:0; Local LDP Ident 192.168.0.1:0
TCP connection: 172.0.0.18.646 - 192.168.0.1.13620
State: Oper; Msgs sent/rcvd: 24/23; Downstream
Up time: 00:11:20
LDP discovery sources:
FastEthernet2/0, Src IP addr: 172.0.0.10
Addresses bound to peer LDP Ident:
172.0.0.10      172.0.0.18
Peer LDP Ident: 172.0.0.5:0; Local LDP Ident 192.168.0.1:0
TCP connection: 172.0.0.5.646 - 192.168.0.1.13640
State: Oper; Msgs sent/rcvd: 24/23; Downstream
Up time: 00:11:10
LDP discovery sources:
FastEthernet1/0, Src IP addr: 172.0.0.2
Addresses bound to peer LDP Ident:
172.0.0.2      172.0.0.5
LER1#

```

```

LER1
LER1#show mpls ldp bindings
tib entry: 172.0.0.0/30, rev 5
local binding: tag: imp-null
remote binding: tsr: 172.0.0.18:0, tag: 36
remote binding: tsr: 172.0.0.5:0, tag: imp-null
tib entry: 172.0.0.4/30, rev 16
local binding: tag: 36
remote binding: tsr: 172.0.0.5:0, tag: imp-null
remote binding: tsr: 172.0.0.18:0, tag: 37
tib entry: 172.0.0.8/30, rev 4
local binding: tag: imp-null
remote binding: tsr: 172.0.0.18:0, tag: imp-null
remote binding: tsr: 172.0.0.5:0, tag: 37
tib entry: 172.0.0.12/30, rev 12
local binding: tag: 34
remote binding: tsr: 172.0.0.18:0, tag: 35
remote binding: tsr: 172.0.0.5:0, tag: 32
tib entry: 172.0.0.16/30, rev 14
local binding: tag: 35
remote binding: tsr: 172.0.0.18:0, tag: imp-null
remote binding: tsr: 172.0.0.5:0, tag: 36
tib entry: 192.168.0.1/32, rev 6
local binding: tag: imp-null
remote binding: tsr: 172.0.0.18:0, tag: 34
remote binding: tsr: 172.0.0.5:0, tag: 35
tib entry: 192.168.1.1/32, rev 10
local binding: tag: 33
remote binding: tsr: 172.0.0.18:0, tag: 33
remote binding: tsr: 172.0.0.5:0, tag: 34
tib entry: 192.168.2.1/32, rev 8
local binding: tag: 32
remote binding: tsr: 172.0.0.18:0, tag: 32
remote binding: tsr: 172.0.0.5:0, tag: 33
LER1#

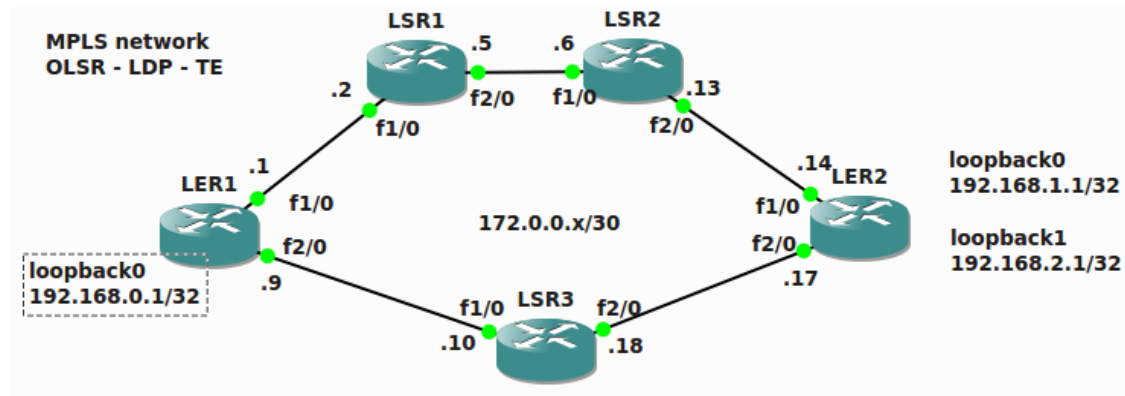
```

```

LER1
LER1#show ip ospf neighbor
Neighbor ID    Pri   State           Dead Time   Address        Interface
2.2.2.3        1     FULL/DR         00:00:29   172.0.0.10    FastEthernet2/0
2.2.2.1        1     FULL/DR         00:00:37   172.0.0.2     FastEthernet1/0
LER1#

```

## MPLS LDP TE



```

LER1#conf t
LER1(config)#mpls label range 32 200 static 16 31
LER1(config)#mpls traffic-eng tunnels

LER1(config)#int loopback 0
LER1(config-if)#ip address 192.168.0.1 255.255.255.255
LER1(config-if)#exit
LER1(config)#int loopback 254
LER1(config-if)#ip address 10.0.0.1 255.255.255.255
LER1(config-if)#exit

LER1(config)#int tunnel 12
LER1(config-if)#ip unnumbered loopback 254
LER1(config-if)#tunnel destination 10.0.0.14
LER1(config-if)#tunnel mode mpls traffic-eng
LER1(config-if)#tunnel mpls traffic-eng priority 7 7
LER1(config-if)#tunnel mpls traffic-eng bandwidth 200
LER1(config-if)#tunnel mpls traffic-eng path-option 1 explicit name path12
LER1(config-if)#no routing dynamic
LER1(config-if)#exit

LER1(config)#int f1/0
LER1(config-if)#ip address 172.0.0.1 255.255.255.252
LER1(config-if)#no shut
LER1(config-if)#mpls ip
LER1(config-if)#mpls traffic-eng tunnels
LER1(config-if)#ip rsvp bandwidth 1000
LER1(config-if)#exit
LER1(config)#int f2/0
LER1(config-if)#ip address 172.0.0.9 255.255.255.252
LER1(config-if)#no shut
LER1(config-if)#mpls ip
LER1(config-if)#mpls traffic-eng tunnels
LER1(config-if)#ip rsvp bandwidth 1000
LER1(config-if)#exit

LER1(config)#router ospf 1

```



```

LER1(config-router)#mpls traffic-eng router-id loopback 254
LER1(config-router)#mpls traffic-eng area 0
LER1(config-router)#router-id 10.0.0.1
LER1(config-router)#network 0.0.0.0 255.255.255.255 area 0
LER1(config-router)#exit

```

```

LER1(config)#ip explicit-path name path12 enable
LER1(cfg-ip-expl-path)#next-address 10.0.0.2
LER1(cfg-ip-expl-path)#next-address 10.0.0.6
LER1(cfg-ip-expl-path)#next-address 10.0.0.14
LER1(cfg-ip-expl-path)#exit

```

```

LER1(config)#ip route 192.168.1.1 255.255.255.255 Tunnel12
LER1(config)#end

```

### Configurazione LER2

```

LER2#conf t
LER2(config)#mpls label range 32 200 static 16 31
LER2(config)#mpls traffic-eng tunnels

```

```

LER2(config)#int loopback 0
LER2(config-if)#ip address 192.168.1.1 255.255.255.255
LER2(config-if)#exit
LER2(config)#int loopback 1
LER2(config-if)#ip address 192.168.2.1 255.255.255.255
LER2(config-if)#exit
LER2(config)#int loopback 254
LER2(config-if)#ip address 10.0.0.14 255.255.255.255
LER2(config-if)#exit

```

```

LER2(config)#int tunnel 21
LER2(config-if)#ip unnumbered loopback 254
LER2(config-if)#tunnel destination 10.0.0.1
LER2(config-if)#tunnel mode mpls traffic-eng
LER2(config-if)#tunnel mpls traffic-eng priority 7 7
LER2(config-if)#tunnel mpls traffic-eng bandwidth 200
LER2(config-if)#tunnel mpls traffic-eng path-option 1 dynamic
LER2(config-if)#no routing dynamic
LER2(config-if)#exit

```

```

LER2(config)#int f1/0
LER2(config-if)#ip address 172.0.0.14 255.255.255.252
LER2(config-if)#no shut
LER2(config-if)#mpls ip
LER2(config-if)#mpls traffic-eng tunnels
LER2(config-if)#ip rsvp bandwidth 1000
LER2(config-if)#exit
LER2(config)#int f2/0
LER2(config-if)#ip address 172.0.0.17 255.255.255.252
LER2(config-if)#no shut
LER2(config-if)#mpls ip

```

```
LER2(config-if)#mpls traffic-eng tunnels
LER2(config-if)#ip rsvp bandwidth 1000
LER2(config-if)#exit
```

```
LER2(config)#router ospf 1
LER2(config-router)#mpls traffic-eng router-id loopback 254
LER2(config-router)#mpls traffic-eng area 0
LER2(config-router)#router-id 10.0.0.14
LER2(config-router)#network 0.0.0.0 255.255.255.255 area 0
LER2(config-router)#exit
```

```
LER2(config)#ip route 192.168.0.1 255.255.255.255 tunnel 21
LER2(config)#end
```

#### Configurazione LSR1

```
LSR1#conf t
LSR1(config)#mpls label range 32 200 static 16 31
LSR1(config)#mpls traffic-eng tunnels
```

```
LSR1(config)#int loopback 254
LSR1(config-if)#ip address 10.0.0.2 255.255.255.255
LSR1(config-if)#exit
```

```
LSR1(config)#int f1/0
LSR1(config-if)#ip address 172.0.0.2 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#mpls traffic-eng tunnels
LSR1(config-if)#ip rsvp bandwidth 1000
LSR1(config-if)#exit
LSR1(config)#int f2/0
LSR1(config-if)#ip address 172.0.0.5 255.255.255.252
LSR1(config-if)#no shut
LSR1(config-if)#mpls ip
LSR1(config-if)#mpls traffic-eng tunnels
LSR1(config-if)#ip rsvp bandwidth 1000
LSR1(config-if)#exit
```

```
LSR1(config)#router ospf 1
LSR1(config-router)#mpls traffic-eng router-id loopback 254
LSR1(config-router)#mpls traffic-eng area 0
LSR1(config-router)#router-id 10.0.0.2
LSR1(config-router)#network 0.0.0.0 255.255.255.255 area 0
LSR1(config-router)#exit
LSR1(config)#
```

#### Configurazione LSR2

```
LSR2#conf t
LSR2(config)#mpls label range 32 200 static 16 31
LSR2(config)#mpls traffic-eng tunnels
```

```
LSR2(config)#int loopback 254
LSR2(config-if)#ip address 10.0.0.6 255.255.255.255
LSR2(config-if)#exit
LSR2(config)#int f1/0
LSR2(config-if)#ip address 172.0.0.6 255.255.255.252
LSR2(config-if)#no shut
LSR2(config-if)#mpls ip
LSR2(config-if)#mpls traffic-eng tunnels
LSR2(config-if)#ip rsvp bandwidth 1000
LSR2(config-if)#exit
LSR2(config)#int f2/0
LSR2(config-if)#ip address 172.0.0.13 255.255.255.252
LSR2(config-if)#no shut
LSR2(config-if)#mpls ip
LSR2(config-if)#mpls traffic-eng tunnels
LSR2(config-if)#ip rsvp bandwidth 1000
LSR2(config-if)#exit

LSR2(config)#router ospf 1
LSR2(config-router)#mpls traffic-eng router-id loopback 254
LSR2(config-router)#mpls traffic-eng area 0
LSR2(config-router)#router-id 10.0.0.6
LSR2(config-router)#network 0.0.0.0 255.255.255.255 area 0
LSR2(config-router)#exit
LSR2(config)#
```

### Configurazione LSR3

```
LSR3#conf t
LSR3(config)#mpls label range 32 200 static 16 31
LSR3(config)#mpls traffic-eng tunnels

LSR3(config)#interface loopback 254
LSR3(config-if)#ip address 10.0.0.10 255.255.255.255
LSR3(config-if)#exit

LSR3(config)#int f1/0
LSR3(config-if)#ip address 172.0.0.10 255.255.255.252
LSR3(config-if)#no shut
LSR3(config-if)#mpls ip
LSR3(config-if)#mpls traffic-eng tunnels
LSR3(config-if)#ip rsvp bandwidth 1000
LSR3(config-if)#exit
LSR3(config)#int f2/0
LSR3(config-if)#ip address 172.0.0.18 255.255.255.252
LSR3(config-if)#no shut
LSR3(config-if)#mpls ip
LSR3(config-if)#mpls traffic-eng tunnels
LSR3(config-if)#ip rsvp bandwidth 1000
LSR3(config-if)#exit

LSR3(config)#router ospf 1
```

```

LSR3(config-router)#mpls traffic-eng router-id loopback 254
LSR3(config-router)#mpls traffic-eng area 0
LSR3(config-router)#router-id 10.0.0.10
LSR3(config-router)#network 0.0.0.0 255.255.255.255 area 0
LSR3(config-router)#exit
LSR3(config)#

```

```

LER1
LER1#traceroute 192.168.1.1 source 192.168.0.1

Type escape sequence to abort.
Tracing the route to 192.168.1.1

 0 172.0.0.2 [MPLS: Label 36 Exp 0] 52 msec 64 msec 40 msec
 1 172.0.0.6 [MPLS: Label 32 Exp 0] 56 msec 84 msec 60 msec
 2 172.0.0.14 60 msec 56 msec 64 msec

```

```

LER1
LER1#traceroute 192.168.2.1 source 192.168.0.1

Type escape sequence to abort.
Tracing the route to 192.168.2.1

 0 172.0.0.10 [MPLS: Label 32 Exp 0] 48 msec 48 msec 52 msec
 1 172.0.0.17 40 msec 56 msec 52 msec

```

```

LER1
LER1#show mpls traffic-eng topology
My_System_id: 10.0.0.1, Globl Link Generation 21
Signalling error holddown: 10 sec

IGP Id: 10.0.0.1, MPLS TE Id:10.0.0.1 Router Node
  link[0 ]:DR Intf Address: 172.0.0.1, gen:13
    frag_id 0, Intf Address:172.0.0.1
    TE metric:1, IGP metric:1, attribute_flags:0x0
    physical_bw: 100000 (kbps), max_reservable_bw_global: 1000 (kbps)
    max_reservable_bw_sub: 0 (kbps)

          Total Allocated      Global Pool      Sub Pool
          BW (kbps)            Reservable      Reservable
          -----            -----            -----
bw[0]:           0             1000             0
bw[1]:           0             1000             0
bw[2]:           0             1000             0
bw[3]:           0             1000             0
bw[4]:           0             1000             0
bw[5]:           0             1000             0
bw[6]:           0             1000             0
bw[7]:          200             800              0

--More-- █

```

```

LER1
LER1#show mpls traffic-eng tunnels
Name: LER1_t12 (Tunnel12) Destination: 10.0.0.14
Status:
  Admin: up      Oper: up      Path: valid      Signalling: connected
  path option 1, type explicit path12 (Basis for Setup, path weight 3)

Config Parameters:
  Bandwidth: 200 kbps (Global) Priority: 7 7 Affinity: 0x0/0xFFFF
  Metric Type: TE (default)
  AutoRoute: disabled LockDown: disabled Loadshare: 200 bw-based
  auto-bw: disabled

InLabel : -
OutLabel : FastEthernet1/0, 36
RSVP Signalling Info:
  Src 10.0.0.1, Dst 10.0.0.14, Tun_Id 12, Tun_Instance 46
RSVP Path Info:
  My Address: 172.0.0.1
  Explicit Route: 172.0.0.2 172.0.0.5 172.0.0.6 172.0.0.13
                  172.0.0.14 10.0.0.14
  Record Route: NONE
  Tspec: ave rate=200 kbits, burst=1000 bytes, peak rate=200 kbits
RSVP Resv Info:
  Record Route: NONE
  Fspec: ave rate=200 kbits, burst=1000 bytes, peak rate=200 kbits
History:
  Tunnel:
    Time since created: 28 minutes, 13 seconds
    Time since path change: 7 minutes, 59 seconds
  Current LSP:
    Uptime: 7 minutes, 59 seconds

LSP Tunnel LER2_t21 is signalled, connection is up
InLabel : FastEthernet1/0, implicit-null
OutLabel : -
RSVP Signalling Info:
  Src 10.0.0.14, Dst 10.0.0.1, Tun_Id 21, Tun_Instance 34
RSVP Path Info:
  My Address: 10.0.0.1
  Explicit Route: NONE
  Record Route: NONE
  Tspec: ave rate=200 kbits, burst=1000 bytes, peak rate=200 kbits
RSVP Resv Info:
  Record Route: NONE
  Fspec: ave rate=200 kbits, burst=1000 bytes, peak rate=200 kbits
LER1#

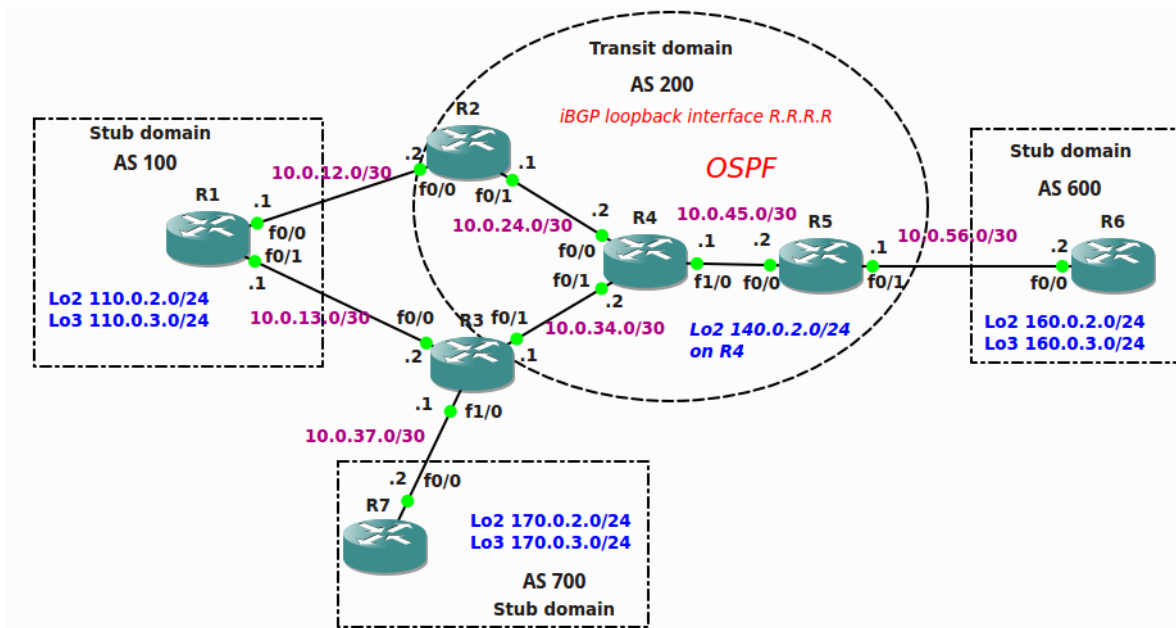
```

```

LER1
LER1#show ip route 192.168.1.1
Routing entry for 192.168.1.1/32
  Known via "static", distance 1, metric 0 (connected)
  Routing Descriptor Blocks:
  * directly connected, via Tunnel12
    Route metric is 0, traffic share count is 1
LER1#

```

## BGP LAB DEFAULT



*//Configuriamo le interfacce dei router//*

```
R1#conf t
R1(config)#int f0/0
R1(config-if)#ip address 10.0.12.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#int f0/1
R1(config-if)#ip address 10.0.13.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#int loopback 2
R1(config-if)#ip address 110.0.2.1 255.255.255.0
R1(config-if)#exit
R1(config)#int loopback 3
R1(config-if)#ip address 110.0.3.1 255.255.255.0
R1(config-if)#exit
R1(config)#
```

```
R2#conf t
R2(config)#int f0/0
R2(config-if)#ip address 10.0.12.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#int f0/1
R2(config-if)#ip address 10.0.24.1 255.255.255.252
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#int loopback 1
R2(config-if)#ip address 2.2.2.2 255.255.255.255
R2(config-if)#exit
```

```
R2(config)#

R3#conf t
R3(config)#int f0/0
R3(config-if)#ip address 10.0.13.2 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int f0/1
R3(config-if)#ip address 10.0.34.1 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int f1/0
R3(config-if)#ip address 10.0.37.1 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int loopback 1
R3(config-if)#ip address 3.3.3.3 255.255.255.255
R3(config-if)#exit
R3(config)#

R4#conf t
R4(config)#int f0/0
R4(config-if)#ip address 10.0.24.2 255.255.255.252
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#int f0/1
R4(config-if)#ip address 10.0.34.2 255.255.255.252
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#int f1/0
R4(config-if)#ip address 10.0.45.1 255.255.255.252
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#int loopback 1
R4(config-if)#ip address 4.4.4.4 255.255.255.255
R4(config-if)#exit
R4(config)#int loopback 2
R4(config-if)#ip address 140.0.2.1 255.255.255.0
R4(config-if)#exit
R4(config)#

R5#conf t
R5(config)#int f0/0
R5(config-if)#ip address 10.0.45.2 255.255.255.252
R5(config-if)#no shut
R5(config-if)#exit
R5(config)#int f0/1
R5(config-if)#ip address 10.0.56.1 255.255.255.252
R5(config-if)#no shut
R5(config-if)#exit
R5(config)#int loopback 1
```

```
R5(config-if)#ip address 5.5.5.5 255.255.255.255
R5(config-if)#exit
R5(config)#
```

```
R6#conf t
R6(config)#int f0/0
R6(config-if)#ip address 10.0.56.2 255.255.255.252
R6(config-if)#no shut
R6(config-if)#exit
R6(config)#int loopback 2
R6(config-if)#ip address 160.0.2.1 255.255.255.0
R6(config-if)#exit
R6(config)#int loopback 3
R6(config-if)#ip address 160.0.3.1 255.255.255.0
R6(config-if)#exit
R6(config)#
```

```
R7#conf t
R7(config)#int f0/0
R7(config-if)#ip address 10.0.37.2 255.255.255.252
R7(config-if)#no shut
R7(config-if)#exit
R7(config)#int loopback 2
R7(config-if)#ip address 170.0.2.1 255.255.255.0
R7(config-if)#exit
R7(config)#int loopback 3
R7(config-if)#ip address 170.0.3.1 255.255.255.0
R7(config-if)#exit
R7(config)#end
```

**//siccome la velocità delle interfacce a cui sono collegate, le interfacce f1/0 dei router R3 e R4, è differente, bisogna dare il seguente comando//**

///*altrimenti comparirebbe il messaggio della figura sottostante*//

```
R3(config)#int f1/0
R3(config-if)#speed 10
R3(config-if)#half-duplex
R3(config-if)#exit
R3(config)#
```

```
R4(config)#int f1/0
R4(config-if)#speed 10
R4(config-if)#half-duplex
R4(config-if)#exit
```

```
*Mar 1 00:49:43.367: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet1/0 (not half duplex), with R5 FastEthernet0/0 (half duplex).
R4(config)#
*Mar 1 00:50:43.359: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet1/0 (not half duplex), with R5 FastEthernet0/0 (half duplex).
R4(config)#
*Mar 1 00:51:43.347: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet1/0 (not half duplex), with R5 FastEthernet0/0 (half duplex).
```



```
//configuriamo OSPF all'interno dell'AS-200//
```

```
R2(config)#router ospf 1
R2(config-router)#network 2.2.2.2 0.0.0.0 area 0
R2(config-router)#network 10.0.24.1 0.0.0.0 area 0
R2(config-router)#exit
R2(config)#
```

```
R3(config)#router ospf 1
R3(config-router)#network 3.3.3.3 0.0.0.0 area 0
R3(config-router)#network 10.0.34.1 0.0.0.0 area 0
R3(config-router)#exit
R3(config)#
```

```
R4(config)#router ospf 1
R4(config-router)#network 4.4.4.4 0.0.0.0 area 0
R4(config-router)#network 10.0.0.0 0.0.255.255 area 0
R4(config-router)#exit
R4(config)#
```

```
R5(config)#router ospf 1
R5(config-router)#network 5.5.5.5 0.0.0.0 area 0
R5(config-router)#network 10.0.45.2 0.0.0.0 area 0
R5(config-router)#exit
R5(config)#
```

```
R2#traceroute 5.5.5.5 source 2.2.2.2
```

```
R2#traceroute 5.5.5.5 source 2.2.2.2
Type escape sequence to abort.
Tracing the route to 5.5.5.5
  1 10.0.24.2 8 msec 16 msec 20 msec
  2 10.0.45.2 32 msec 32 msec 24 msec
R2#ping 5.5.5.5 source 2.2.2.2
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 5.5.5.5, timeout is 2 seconds:
Packet sent with a source address of 2.2.2.2
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/28/44 ms
```

```
R2#show ip route
```

```
R2#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

 2.0.0.0/32 is subnetted, 1 subnets
C       2.2.2.2 is directly connected, Loopback1
 3.0.0.0/32 is subnetted, 1 subnets
O       3.3.3.3 [110/21] via 10.0.24.2, 00:11:04, FastEthernet0/1
 4.0.0.0/32 is subnetted, 1 subnets
O       4.4.4.4 [110/11] via 10.0.24.2, 00:11:04, FastEthernet0/1
 5.0.0.0/32 is subnetted, 1 subnets
O       5.5.5.5 [110/12] via 10.0.24.2, 00:11:04, FastEthernet0/1
10.0.0.0/30 is subnetted, 4 subnets
C       10.0.12.0 is directly connected, FastEthernet0/0
C       10.0.24.0 is directly connected, FastEthernet0/1
O       10.0.45.0 [110/11] via 10.0.24.2, 00:11:05, FastEthernet0/1
O       10.0.34.0 [110/20] via 10.0.24.2, 00:11:05, FastEthernet0/1
R2#
```

```
R4#show ip neighbor
```

```
R4#show ip ospf neighbor
Neighbor ID      Pri   State           Dead Time   Address        Interface
5.5.5.5          1     FULL/BDR        00:00:30   10.0.45.2     FastEthernet1/0
3.3.3.3          1     FULL/DR         00:00:37   10.0.34.1     FastEthernet0/1
2.2.2.2          1     FULL/DR         00:00:38   10.0.24.1     FastEthernet0/0
R4#
```

*//configuriamo BGP//*

```
R1(config)#router bgp 100
```

```
R1(config-router)#net
```

```
R1(config-router)#network 110.0.2.0 mask 255.255.255.0
```

```
R1(config-router)#network 110.0.3.0 mask 255.255.255.0
```

```
R1(config-router)#neighbor 10.0.12.2 remote-as 200
```

```
R1(config-router)#exit
```

```
R1(config)#
```

```
R2(config)#router bgp 200
```

```
R2(config-router)#neighbor 3.3.3.3 remote-as 200
```

```
R2(config-router)#neighbor 3.3.3.3 update-source loopback1
```

```
R2(config-router)#neighbor 3.3.3.3 next-hop-self
```

```
R2(config-router)#neighbor 4.4.4.4 remote-as 200
```

```
R2(config-router)#neighbor 4.4.4.4 update-source loopback1
```

```
R2(config-router)#neighbor 4.4.4.4 next-hop-self
```

```
R2(config-router)#neighbor 5.5.5.5 remote-as 200
```

```
R2(config-router)#neighbor 5.5.5.5 update-source loopback1
```

```
R2(config-router)#neighbor 5.5.5.5 next-hop-self
```

```
R2(config-router)#neighbor 10.0.12.1 remote-as 100
```

```
R2(config-router)#exit
```

```
R2(config)#
```

```
R3(config)#router bgp 200
```

```
R3(config-router)#neighbor 2.2.2.2 remote-as 200
```

```
R3(config-router)#neighbor 2.2.2.2 update-source loopback1
```

```
R3(config-router)#neighbor 2.2.2.2 next-hop-self
```

```
R3(config-router)#neighbor 4.4.4.4 remote-as 200
```

```
R3(config-router)#neighbor 4.4.4.4 update-source loopback1
```

```
R3(config-router)#neighbor 4.4.4.4 next-hop-self
```

```
R3(config-router)#neighbor 5.5.5.5 remote-as 200
```

```
R3(config-router)#neighbor 5.5.5.5 update-source loopback1
```

```
R3(config-router)#neighbor 5.5.5.5 next-hop-self
```

```
R3(config-router)#neighbor 10.0.37.2 remote-as 700
```

```
R3(config-router)#exit
```

```
R3(config)#
```

```
R4(config)#router bgp 200
```

```
R4(config-router)#network 140.0.2.0 mask 255.255.255.0
```

```
R4(config-router)#neighbor 2.2.2.2 remote-as 200
```

```
R4(config-router)#neighbor 2.2.2.2 update-source loopback1
```

```
R4(config-router)#neighbor 3.3.3.3 remote-as 200
```

```
R4(config-router)#neighbor 3.3.3.3 update-source loopback1
```

```
R4(config-router)#neighbor 5.5.5.5 remote-as 200
R4(config-router)#neighbor 5.5.5.5 update-source loopback1
R4(config-router)#exit
R4(config)#
```

```
R5(config)#router bgp 200
R5(config-router)#neighbor 2.2.2.2 remote-as 200
R5(config-router)#neighbor 2.2.2.2 update-source loopback1
R5(config-router)#neighbor 2.2.2.2 next-hop-self
R5(config-router)#neighbor 3.3.3.3 remote-as 200
R5(config-router)#neighbor 3.3.3.3 update-source loopback1
R5(config-router)#neighbor 3.3.3.3 next-hop-self
R5(config-router)#neighbor 4.4.4.4 remote-as 200
R5(config-router)#neighbor 4.4.4.4 update-source loopback1
R5(config-router)#neighbor 4.4.4.4 next-hop-self
R5(config-router)#neighbor 10.0.56.2 remote-as 600
R5(config-router)#exit
R5(config)#
```

```
R6(config)#router bgp 600
R6(config-router)#network 160.0.2.0 mask 255.255.255.0
R6(config-router)#network 160.0.3.0 mask 255.255.255.0
R6(config-router)#neighbor 10.0.56.1 remote-as 200
R6(config-router)#exit
R6(config)#
```

```
R7(config)#router bgp 700
R7(config-router)#network 170.0.2.0 mask 255.255.255.0
R7(config-router)#network 170.0.3.0 mask 255.255.255.0
R7(config-router)#neighbor 10.0.37.1 remote-as 200
R7(config-router)#exit
R7(config)#
```

```
R1#traceroute 160.0.2.1 source 110.0.2.1
```

```
R1#traceroute 160.0.2.1 source 110.0.2.1
Type escape sequence to abort.
Tracing the route to 160.0.2.1

  1 10.0.12.2 16 msec 20 msec 16 msec
  2 10.0.24.2 52 msec 40 msec 40 msec
  3 10.0.45.2 56 msec 48 msec 52 msec
  4 10.0.56.2 80 msec 48 msec 80 msec
R1#ping 160.0.2.1 source 110.0.2.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 160.0.2.1, timeout is 2 seconds:
Packet sent with a source address of 110.0.2.1
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 60/68/76 ms
R1#
```

R2#show ip route

```

R2#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

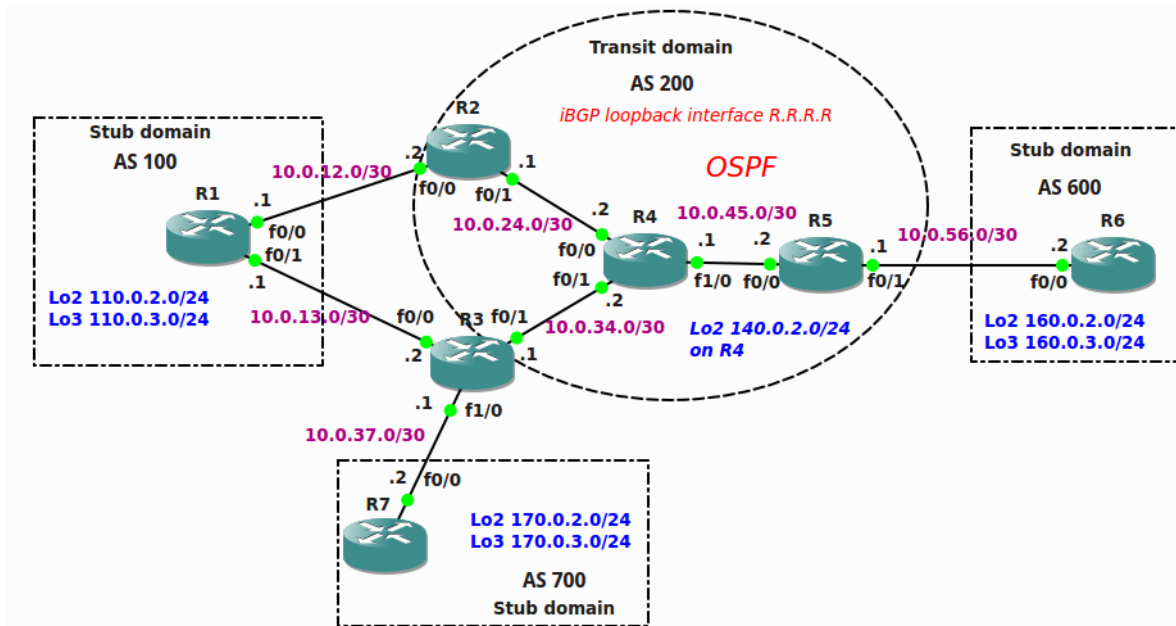
Gateway of last resort is not set

 170.0.0.0/24 is subnetted, 2 subnets
B    170.0.2.0 [200/0] via 3.3.3.3, 00:01:34
B    170.0.3.0 [200/0] via 3.3.3.3, 00:01:34
 2.0.0.0/32 is subnetted, 1 subnets
C    2.2.2.2 is directly connected, Loopback1
 3.0.0.0/32 is subnetted, 1 subnets
O    3.3.3.3 [110/21] via 10.0.24.2, 01:05:35, FastEthernet0/1
 4.0.0.0/32 is subnetted, 1 subnets
O    4.4.4.4 [110/11] via 10.0.24.2, 01:05:35, FastEthernet0/1
140.0.0.0/24 is subnetted, 1 subnets
B    140.0.2.0 [200/0] via 4.4.4.4, 00:35:01
 5.0.0.0/32 is subnetted, 1 subnets
O    5.5.5.5 [110/12] via 10.0.24.2, 01:05:37, FastEthernet0/1
110.0.0.0/24 is subnetted, 2 subnets
B    110.0.2.0 [20/0] via 10.0.12.1, 00:39:41
B    110.0.3.0 [20/0] via 10.0.12.1, 00:39:41
160.0.0.0/24 is subnetted, 2 subnets
B    160.0.2.0 [200/0] via 5.5.5.5, 00:22:57
B    160.0.3.0 [200/0] via 5.5.5.5, 00:22:57
10.0.0.0/30 is subnetted, 4 subnets
C    10.0.12.0 is directly connected, FastEthernet0/0
C    10.0.24.0 is directly connected, FastEthernet0/1
O    10.0.45.0 [110/11] via 10.0.24.2, 01:05:38, FastEthernet0/1
O    10.0.34.0 [110/20] via 10.0.24.2, 01:05:38, FastEthernet0/1
R2#

```

## BGP LAB PREPEND

L'AS path prepending serve a determinare il best path per l'inbound traffic. Sapendo che il percorso utilizzato è sempre quello che attraversa il minor numero di AS, la tecnica consiste nell'iniettare più volte nell'AS path il proprio AS per i percorsi da discriminare.



*//dall'esercizio di prima copiamo le configurazioni delle interfacce e OSPF//*

*//Configuriamo le interfacce dei router//*

```
R1#conf t
R1(config)#int f0/0
R1(config-if)#ip address 10.0.12.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#int f0/1
R1(config-if)#ip address 10.0.13.1 255.255.255.252
R1(config-if)#no shut
R1(config-if)#exit
R1(config)#int loopback 2
R1(config-if)#ip address 110.0.2.1 255.255.255.0
R1(config-if)#exit
R1(config)#int loopback 3
R1(config-if)#ip address 110.0.3.1 255.255.255.0
R1(config-if)#exit
R1(config)#
```

```
R2#conf t
R2(config)#int f0/0
R2(config-if)#ip address 10.0.12.2 255.255.255.252
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#int f0/1
R2(config-if)#ip address 10.0.24.1 255.255.255.252
```

```
R2(config-if)#no shut
R2(config-if)#exit
R2(config)#int loopback 1
R2(config-if)#ip address 2.2.2.2 255.255.255.255
R2(config-if)#exit
R2(config)#
```

```
R3#conf t
R3(config)#int f0/0
R3(config-if)#ip address 10.0.13.2 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int f0/1
R3(config-if)#ip address 10.0.34.1 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int f1/0
R3(config-if)#ip address 10.0.37.1 255.255.255.252
R3(config-if)#no shut
R3(config-if)#exit
R3(config)#int loopback 1
R3(config-if)#ip address 3.3.3.3 255.255.255.255
R3(config-if)#exit
R3(config)#
```

```
R4#conf t
R4(config)#int f0/0
R4(config-if)#ip address 10.0.24.2 255.255.255.252
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#int f0/1
R4(config-if)#ip address 10.0.34.2 255.255.255.252
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#int f1/0
R4(config-if)#ip address 10.0.45.1 255.255.255.252
R4(config-if)#no shut
R4(config-if)#exit
R4(config)#int loopback 1
R4(config-if)#ip address 4.4.4.4 255.255.255.255
R4(config-if)#exit
R4(config)#int loopback 2
R4(config-if)#ip address 140.0.2.1 255.255.255.0
R4(config-if)#exit
R4(config)#
```

```
R5#conf t
R5(config)#int f0/0
R5(config-if)#ip address 10.0.45.2 255.255.255.252
R5(config-if)#no shut
R5(config-if)#exit
```

```
R5(config)#int f0/1
R5(config-if)#ip address 10.0.56.1 255.255.255.252
R5(config-if)#no shut
R5(config-if)#exit
R5(config)#int loopback 1
R5(config-if)#ip address 5.5.5.5 255.255.255.255
R5(config-if)#exit
R5(config)#
```

```
R6#conf t
R6(config)#int f0/0
R6(config-if)#ip address 10.0.56.2 255.255.255.252
R6(config-if)#no shut
R6(config-if)#exit
R6(config)#int loopback 2
R6(config-if)#ip address 160.0.2.1 255.255.255.0
R6(config-if)#exit
R6(config)#int loopback 3
R6(config-if)#ip address 160.0.3.1 255.255.255.0
R6(config-if)#exit
R6(config)#
```

```
R7#conf t
R7(config)#int f0/0
R7(config-if)#ip address 10.0.37.2 255.255.255.252
R7(config-if)#no shut
R7(config-if)#exit
R7(config)#int loopback 2
R7(config-if)#ip address 170.0.2.1 255.255.255.0
R7(config-if)#exit
R7(config)#int loopback 3
R7(config-if)#ip address 170.0.3.1 255.255.255.0
R7(config-if)#exit
R7(config)#end
```

**//siccome la velocità delle interfacce a cui sono collegate, le interfacce f1/0 dei router R3 e R4, è differente, bisogna dare il seguente comando//**

*////altrimenti comparirebbe il messaggio della figura sottostante//*

```
R3(config)#int f1/0
R3(config-if)#speed 10
R3(config-if)#half-duplex
R3(config-if)#exit
R3(config)#
```

```
R4(config)#int f1/0
R4(config-if)#speed 10
R4(config-if)#half-duplex
R4(config-if)#exit
```

```

#Mar  1 00:49:43.367: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet1/0 (not half duplex), with R5 FastEthernet0/0 (half duplex).
R4(config)#
#Mar  1 00:50:43.359: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet1/0 (not half duplex), with R5 FastEthernet0/0 (half duplex).
R4(config)#
#Mar  1 00:51:43.347: %CDP-4-DUPLEX_MISMATCH: duplex mismatch discovered on Fast
Ethernet1/0 (not half duplex), with R5 FastEthernet0/0 (half duplex).

```

*//configuriamo OSPF all'interno dell'AS-200//*

```

R2(config)#router ospf 1
R2(config-router)#network 2.2.2.2 0.0.0.0 area 0
R2(config-router)#network 10.0.24.1 0.0.0.0 area 0
R2(config-router)#exit
R2(config)#

```

```

R3(config)#router ospf 1
R3(config-router)#network 3.3.3.3 0.0.0.0 area 0
R3(config-router)#network 10.0.34.1 0.0.0.0 area 0
R3(config-router)#exit
R3(config)#

```

```

R4(config)#router ospf 1
R4(config-router)#network 4.4.4.4 0.0.0.0 area 0
R4(config-router)#network 10.0.0.0 0.0.255.255 area 0
R4(config-router)#network 140.0.2.1 0.0.0.0 area 0
R4(config-router)#exit
R4(config)#

```

```

R5(config)#router ospf 1
R5(config-router)#network 5.5.5.5 0.0.0.0 area 0
R5(config-router)#network 10.0.45.2 0.0.0.0 area 0
R5(config-router)#exit
R5(config)#

```

*//configuriamo BGP//*

```

R1(config)#router bgp 100
R1(config-router)#network 110.0.2.0 mask 255.255.255.0
R1(config-router)#network 110.0.3.0 mask 255.255.255.0
R1(config-router)#neighbor 10.0.12.2 remote-as 200
R1(config-router)#neighbor 10.0.12.2 PREPEND200 in
R1(config-router)#neighbor 10.0.13.2 remote-as 200
R1(config-router)#exit
R1(config)#

```

```

R2(config)#router bgp 200
R2(config-router)#neighbor 3.3.3.3 remote-as 200
R2(config-router)#neighbor 3.3.3.3 update-source loopback1
R2(config-router)#neighbor 3.3.3.3 next-hop-self
R2(config-router)#neighbor 4.4.4.4 remote-as 200
R2(config-router)#neighbor 4.4.4.4 update-source loopback1

```



```
R2(config-router)#neighbor 4.4.4.4 next-hop-self
R2(config-router)#neighbor 5.5.5.5 remote-as 200
R2(config-router)#neighbor 5.5.5.5 update-source loopback1
R2(config-router)#neighbor 5.5.5.5 next-hop-self
R2(config-router)#neighbor 10.0.12.1 remote-as 100
R2(config-router)#exit
R2(config)#
```

```
R3(config)#router bgp 200
R3(config-router)#neighbor 2.2.2.2 remote-as 200
R3(config-router)#neighbor 2.2.2.2 update-source loopback1
R3(config-router)#neighbor 2.2.2.2 next-hop-self
R3(config-router)#neighbor 4.4.4.4 remote-as 200
R3(config-router)#neighbor 4.4.4.4 update-source loopback1
R3(config-router)#neighbor 4.4.4.4 next-hop-self
R3(config-router)#neighbor 5.5.5.5 remote-as 200
R3(config-router)#neighbor 5.5.5.5 update-source loopback1
R3(config-router)#neighbor 5.5.5.5 next-hop-self
R3(config-router)#neighbor 10.0.13.1 remote-as 100
R3(config-router)#neighbor 10.0.37.2 remote-as 700
R3(config-router)#exit
R3(config)#
```

```
R4(config)#router bgp 200
R4(config-router)#network 140.0.2.0 mask 255.255.255.0
R4(config-router)#neighbor 2.2.2.2 update-source loopback1
R4(config-router)#neighbor 3.3.3.3 remote-as 200
R4(config-router)#neighbor 3.3.3.3 update-source loopback1
R4(config-router)#neighbor 5.5.5.5 remote-as 2
R4(config-router)#neighbor 5.5.5.5 remote-as 200
R4(config-router)#neighbor 5.5.5.5 update-source loopback1
R4(config-router)#exit
R4(config)#
```

```
R5(config)#router bgp 200
R5(config-router)#neighbor 2.2.2.2 remote-as 200
R5(config-router)#neighbor 2.2.2.2 update-source loopback1
R5(config-router)#neighbor 2.2.2.2 next-hop-self
R5(config-router)#neighbor 3.3.3.3 remote-as 200
R5(config-router)#neighbor 3.3.3.3 update-source loopback1
R5(config-router)#neighbor 3.3.3.3 next-hop-self
R5(config-router)#neighbor 4.4.4.4 remote-as 200
R5(config-router)#neighbor 4.4.4.4 update-source loopback1
R5(config-router)#neighbor 4.4.4.4 next-hop-self
R5(config-router)#neighbor 10.0.56.2 remote-as 600
R5(config-router)#exit
R5(config)#
```

```
R6(config)#router bgp 600
R6(config-router)#network 160.0.2.0 mask 255.255.255.0
R6(config-router)#network 160.0.3.0 mask 255.255.255.0
```

```
R6(config-router)#neighbor 10.0.56.1 remote-as 200
R6(config-router)#exit
R6(config)#
```

```
R7(config)#router bgp 700
R7(config-router)#network 170.0.2.0 mask 255.255.255.0
R7(config-router)#network 170.0.3.0 mask 255.255.255.0
R7(config-router)#neighbor 10.0.37.1 remote-as 200
R7(config-router)#exit
R7(config)#
```

### ***Configuriamo le route-map PREPEND***

```
R1(config)#route-map PREPEND200 permit 10
R1(config-route-map)#set as-path prepend 200 200 200
R1(config-route-map)#exit
R1(config)#route-map PREPEND200 permit 20
R1(config-route-map)#exit
```

```
R1
R1#show route-map PREPEND200
route-map PREPEND200, permit, sequence 10
  Match clauses:
  Set clauses:
    as-path prepend 200 200 200
  Policy routing matches: 0 packets, 0 bytes
route-map PREPEND200, permit, sequence 20
  Match clauses:
  Set clauses:
  Policy routing matches: 0 packets, 0 bytes
R1#
```

//vediamo l'applicazione del prepend con la ripetizione del 200 200 200//

```
R1
R1#show ip bgp
BGP table version is 8, local router ID is 110.0.3.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
               r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network        Next Hop        Metric LocPrf Weight Path
*> 110.0.2.0/24    0.0.0.0          0         32768  i
*> 110.0.3.0/24    0.0.0.0          0         32768  i
* 140.0.2.0/24    10.0.12.2        0          0 200 200 200 200 i
*> 140.0.2.0/24    10.0.13.2        0          0 200  i
* 160.0.2.0/24    10.0.12.2        0          0 200 200 200 200 600
  i
*> 160.0.2.0/24    10.0.13.2        0          0 200 600  i
  i
* 160.0.3.0/24    10.0.12.2        0          0 200 200 200 200 600
  i
*> 160.0.3.0/24    10.0.13.2        0          0 200 600  i
  i
* 170.0.2.0/24    10.0.12.2        0          0 200 200 200 200 700
  i
*> 170.0.2.0/24    10.0.13.2        0          0 200 700  i
  i
* 170.0.3.0/24    10.0.12.2        0          0 200 200 200 200 700
  i
*> 170.0.3.0/24    10.0.13.2        0          0 200 700  i
```

//con l'applicazione del prepend abbiamo obbligato il percorso a passare per R3 e non R2, ossia il percorso più corto//

```
R1
R1#traceroute 160.0.2.1 source 110.0.2.1
Type escape sequence to abort.
Tracing the route to 160.0.2.1
 0 10.0.13.2 24 msec 4 msec 24 msec
 1 10.0.34.2 32 msec 36 msec 40 msec
 2 10.0.45.2 40 msec 48 msec 44 msec
 3 10.0.56.2 72 msec 64 msec 76 msec
R1#
```

//mentre da R6 a R1 non è applicator il prepend e il pacchetto passa per sopra //

```
R6
R6#traceroute 110.0.2.1 source 160.0.2.1
Type escape sequence to abort.
Tracing the route to 110.0.2.1
 0 10.0.56.1 24 msec 16 msec 24 msec
 1 10.0.45.1 20 msec 36 msec 44 msec
 2 10.0.24.1 48 msec 52 msec 40 msec
 3 10.0.12.1 76 msec 48 msec 80 msec
R6#
```

## BGPlab\_LOCPREF\_ACCESSLIST

Determina il best path per l'outbound traffic. Percorsi con local preference maggiore vincono (default:100).

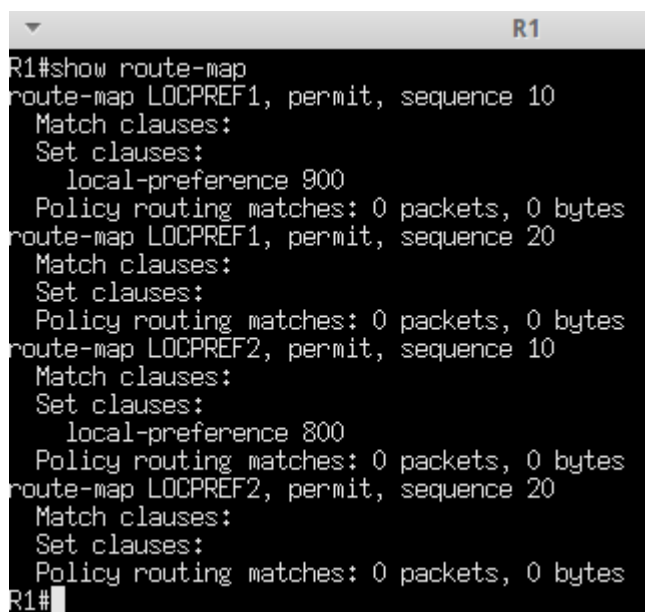
[//riprendiamo il laboratorio di prima \(fino al BGP\) e modifichiamo/aggiungiamo//](#)

```
R1(config)#router bgp 100
R1(config-router)#network 110.0.2.0 mask 255.255.255.0
R1(config-router)#network 110.0.3.0 mask 255.255.255.0
R1(config-router)#neighbor 10.0.12.2 remote-as 200
R1(config-router)#neighbor 10.0.12.2 LOCPREF1 in
R1(config-router)#neighbor 10.0.13.2 remote-as 200
R1(config-router)#neighbor 10.0.13.2 LOCPREF2 in
R1(config-router)#exit
R1(config)#
```

### *Configuriamo le route-map LOCPREF*

```
R1(config)#route-map LOCPREF1 permit 10
R1(config-route-map)#set local-preference 900
R1(config-route-map)#exit
R1(config)#route-map LOCPREF1 permit 20
R1(config-route-map)#exit
```

```
R1(config)#route-map LOCPREF2 permit 10
R1(config-route-map)#set local-preference 800
R1(config-route-map)#exit
R1(config)#route-map LOCPREF2 permit 20
R1(config-route-map)#exit
```



```
R1
R1#show route-map
route-map LOCPREF1, permit, sequence 10
  Match clauses:
  Set clauses:
    local-preference 900
  Policy routing matches: 0 packets, 0 bytes
route-map LOCPREF1, permit, sequence 20
  Match clauses:
  Set clauses:
  Policy routing matches: 0 packets, 0 bytes
route-map LOCPREF2, permit, sequence 10
  Match clauses:
  Set clauses:
    local-preference 800
  Policy routing matches: 0 packets, 0 bytes
route-map LOCPREF2, permit, sequence 20
  Match clauses:
  Set clauses:
  Policy routing matches: 0 packets, 0 bytes
R1#
```

Facciamo un traceroute ed il percorso scelto sarà quello con il LOCPREF avente preference più alto (in questo caso LOCPREF1 con preference 900)

```
R1
R1#traceroute 160.0.2.1 source 110.0.2.1
Type escape sequence to abort.
Tracing the route to 160.0.2.1
 0 10.0.12.2 16 msec 20 msec 24 msec
 1 10.0.24.2 32 msec 36 msec 40 msec
 2 10.0.45.2 40 msec 68 msec 48 msec
 3 10.0.56.2 80 msec 56 msec 88 msec
R1#
```

## BGPlab\_MED

Il MED `e uno dei metodi per determinare il best path per l'inbound traffic. Nel caso del MED vince il path con metrica minore.

[//continuazione lab BGP DEFAULT//](#)

```
R1#conf t
R1(config)#router bgp 100
R1(config-router)#neighbor 10.0.12.2 route-map MED100R2 out
R1(config-router)#neighbor 10.0.13.2 route-map MED100R3 out
R1(config-router)#exit
```

```
R1(config)#route-map MED100R3 permit 10
R1(config-route-map)#set metric 700
R1(config-route-map)#exit
```

```
R1(config)#route-map MED100R3 permit 100
R1(config-route-map)#exit
```

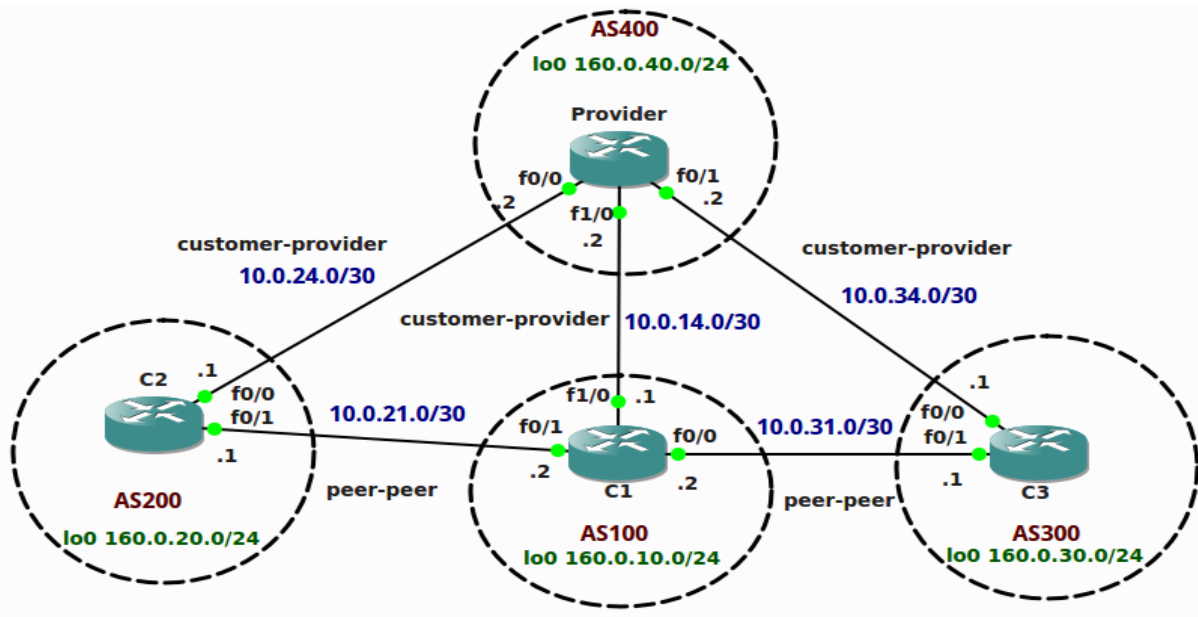
```
R1(config)#route-map MED100R2 permit 10
R1(config-route-map)#set metric 300
R1(config-route-map)#exit
```

```
R1(config)#route-map MED100R2 permit 100
R1(config-route-map)#exit
```

```
R1
R1#show route-map
route-map MED100R3, permit, sequence 10
  Match clauses:
  Set clauses:
    metric 700
  Policy routing matches: 0 packets, 0 bytes
route-map MED100R3, permit, sequence 100
  Match clauses:
  Set clauses:
  Policy routing matches: 0 packets, 0 bytes
route-map MED100R2, permit, sequence 10
  Match clauses:
  Set clauses:
    metric 300
  Policy routing matches: 0 packets, 0 bytes
route-map MED100R2, permit, sequence 100
  Match clauses:
  Set clauses:
  Policy routing matches: 0 packets, 0 bytes
R1#
```

```
R1
R1#traceroute 160.0.2.1 source 110.0.2.1
Type escape sequence to abort.
Tracing the route to 160.0.2.1
 0 10.0.0.0/24 is subnet 0, 0 hops, 0 msecs
 1 10.0.13.2 32 msec 40 msec 40 msec
 2 10.0.34.2 40 msec 40 msec 20 msec
 3 10.0.45.2 48 msec 64 msec 52 msec
 4 10.0.56.2 72 msec 72 msec 68 msec
R1#
```

## BGP POLICY



### Configurazione Provider

```

PROVIDER#conf t
PROVIDER(config)#int loopback 0
PROVIDER(config-if)#ip address 160.0.40.1 255.255.255.0
PROVIDER(config-if)#exit

PROVIDER(config)#int f0/0
PROVIDER(config-if)#ip address 10.0.24.2 255.255.255.252
PROVIDER(config-if)#no shut
PROVIDER(config-if)#exit

PROVIDER(config)#int f0/1
PROVIDER(config-if)#ip address 10.0.34.2 255.255.255.252
PROVIDER(config-if)#no shut
PROVIDER(config-if)#exit

PROVIDER(config)#int f1/0
PROVIDER(config-if)#ip address 10.0.14.2 255.255.255.252
PROVIDER(config-if)#no shut
PROVIDER(config-if)#exit

PROVIDER(config)#router bgp 400
PROVIDER(config-router)#network 160.0.40.0 mask 255.255.255.0
PROVIDER(config-router)#neighbor 10.0.14.1 remote-as 100
PROVIDER(config-router)#neighbor 10.0.24.1 remote-as 200
PROVIDER(config-router)#neighbor 10.0.34.1 remote-as 300
PROVIDER(config-router)#end
  
```

### Configurazione C1

```

C1#conf t
C1(config)#int loopback 0
C1(config-if)#ip address 160.0.10.1 255.255.255.0
C1(config-if)#exit
  
```

```
C1(config)#int f0/0
C1(config-if)#ip address 10.0.31.2 255.255.255.252
C1(config-if)#no shut
C1(config-if)#exit

C1(config)#int f0/1
C1(config-if)#ip address 10.0.21.2 255.255.255.252
C1(config-if)#no shut
C1(config-if)#exit

C1(config)#int f1/0
C1(config-if)#ip address 10.0.14.1 255.255.255.252
C1(config-if)#no shut
C1(config-if)#exit

C1(config)#router bgp 100
C1(config-router)#network 160.0.10.0 mask 255.255.255.0
C1(config-router)#neighbor 10.0.14.2 remote-as 400
C1(config-router)#neighbor 10.0.14.2 route-map forprovider out
C1(config-router)#neighbor 10.0.21.1 remote-as 200
C1(config-router)#neighbor 10.0.21.1 route-map forpeer out
C1(config-router)#neighbor 10.0.31.1 remote-as 300
C1(config-router)#neighbor 10.0.31.1 route-map forpeer out
C1(config-router)#exit

C1(config)#route-map forpeer permit 10
C1(config-route-map)#match as-path 10
C1(config-route-map)#exit

C1(config)#route-map forprovider permit 10
C1(config-route-map)#match as-path 10
C1(config-route-map)#end
```

## Configurazione C2

```
C2#conf t

C2(config)#int loopback 0
C2(config-if)#ip address 160.0.20.1 255.255.255.0
C2(config-if)#exit

C2(config)#int f0/0
C2(config-if)#ip address 10.0.24.1 255.255.255.252
C2(config-if)#no shut
C2(config-if)#exit

C2(config)#int f0/1
C2(config-if)#ip address 10.0.21.1 255.255.255.252
C2(config-if)#no shut
C2(config-if)#exit

C2(config)#router bgp 200
C2(config-router)#network 160.0.20.0 mask 255.255.255.0
C2(config-router)#neighbor 10.0.21.2 remote-as 100
C2(config-router)#neighbor 10.0.21.2 route-map forpeer out
C2(config-router)#neighbor 10.0.24.2 remote-as 400
C2(config-router)#neighbor 10.0.24.2 route-map forprovider out
```



```

C2(config-router)#exit
C2(config)#ip as-path access-list 10 permit ^$
C2(config)#route-map forpeer permit 10
C2(config-route-map)#match as-path 10
C2(config-route-map)#exit

C2(config)#route-map forprovider permit 10
C2(config-route-map)#match as-path 10
C2(config-route-map)#end

```

### Configurazione C3

```

C3#conf t
C3(config)#int loopback 0
C3(config-if)#ip address 160.0.30.1 255.255.255.0
C3(config-if)#exit

C3(config)#int f0/0
C3(config-if)#ip address 10.0.34.1 255.255.255.252
C3(config-if)#no shut
C3(config-if)#exit

C3(config)#int f0/1
C3(config-if)#ip address 10.0.31.1 255.255.255.252
C3(config-if)#no shut
C3(config-if)#exit

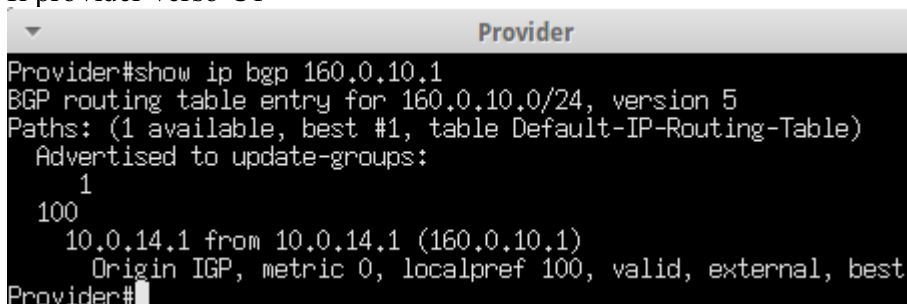
C3(config)#router bgp 300
C3(config-router)#network 160.0.30.0 mask 255.255.255.0
C3(config-router)#neighbor 10.0.31.2 remote-as 100
C3(config-router)#neighbor 10.0.31.2 route-map forpeer out
C3(config-router)#neighbor 10.0.34.2 remote-as 400
C3(config-router)#neighbor 10.0.34.2 route-map forprovider
C3(config-router)#neighbor 10.0.34.2 route-map forprovider out
C3(config-router)#exit

C3(config)#ip as-path access-list 10 permit ^$
C3(config)#route-map forpeer permit 10
C3(config-route-map)#match as-path 10
C3(config-route-map)#exit

C3(config)#route-map forprovider permit 10
C3(config-route-map)#match as-path 10
C3(config-route-map)#end

```

Il provider verso C1



```

Provider
Provider#show ip bgp 160.0.10.1
BGP routing table entry for 160.0.10.0/24, version 5
Paths: (1 available, best #1, table Default-IP-Routing-Table)
  Advertised to update-groups:
    1
    100
  10.0.14.1 from 10.0.14.1 (160.0.10.1)
    Origin IGP, metric 0, localpref 100, valid, external, best
Provider#

```

Dai customer al provider (in questo caso C1-provider)

```
C1
C1#show ip bgp 160.0.40.1
BGP routing table entry for 160.0.40.0/24, version 5
Paths: (1 available, best #1, table Default-IP-Routing-Table)
  Not advertised to any peer
  400
    10.0.14.2 from 10.0.14.2 (160.0.40.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
C1#
```

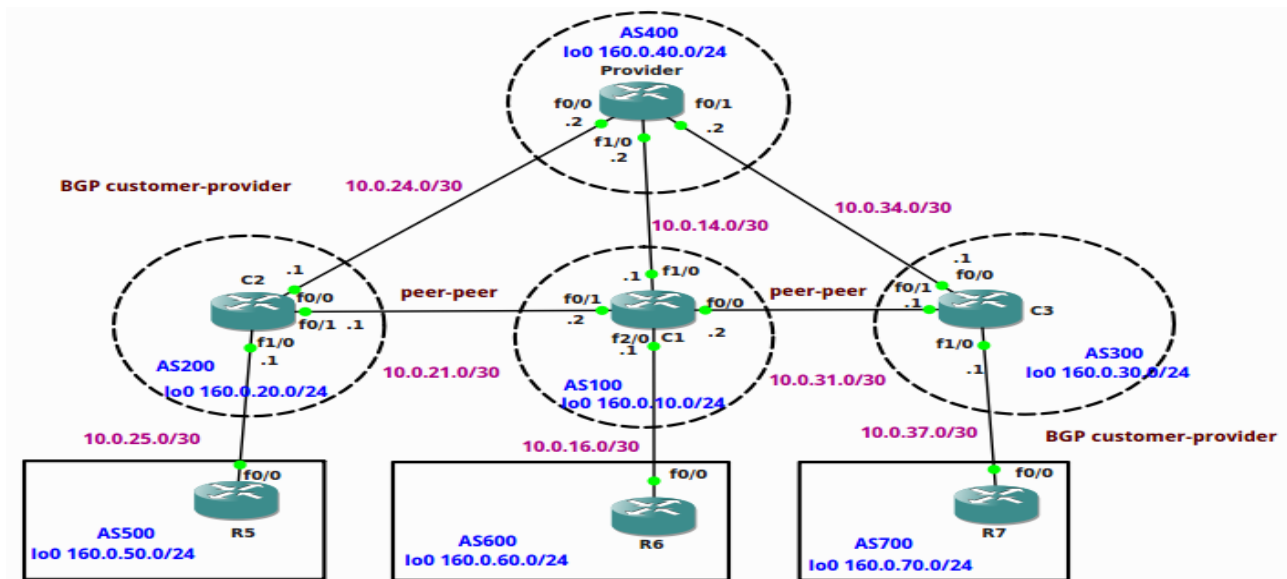
Da C1 a C2 o C1 a C3 (in questo caso C1 a C2)

```
C1
C1#show ip bgp 160.0.20.1
BGP routing table entry for 160.0.20.0/24, version 3
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Not advertised to any peer
  400 200
    10.0.14.2 from 10.0.14.2 (160.0.40.1)
      Origin IGP, localpref 100, valid, external
  200
    10.0.21.1 from 10.0.21.1 (160.0.20.1)
      Origin IGP, metric 0, localpref 100, valid, external, best
C1#
```

Da C2 a C3 o C3 a C2 (in questo caso C2 a C3)

```
C2
C2#show ip bgp 160.0.30.1
BGP routing table entry for 160.0.30.0/24, version 4
Paths: (1 available, best #1, table Default-IP-Routing-Table)
  Not advertised to any peer
  400 300
    10.0.24.2 from 10.0.24.2 (160.0.40.1)
      Origin IGP, localpref 100, valid, external, best
C2#
```

## BGP POLICY COMMUNITY



### Configurazione delle interfacce

```
C1#conf t
C1(config)#int loopback 0
C1(config-if)#ip address 160.0.10.1 255.255.255.0
C1(config-if)#exit
C1(config)#int f0/0
C1(config-if)#ip address 10.0.31.2 255.255.255.252
C1(config-if)#no shut
C1(config-if)#exit
C1(config)#int f1/0
C1(config-if)#ip address 10.0.14.1 255.255.255.252
C1(config-if)#no shut
C1(config-if)#exit
C1(config)#int f0/1
C1(config-if)#ip address 10.0.21.2 255.255.255.252
C1(config-if)#no shut
C1(config-if)#exit
C1(config)#int f2/0
C1(config-if)#ip address 10.0.16.1 255.255.255.252
C1(config-if)#no shut
C1(config-if)#speed 10
C1(config-if)#half-
C1(config-if)#half-duplex
C1(config-if)#exit
```

```
C2#conf t
C2(config)#int loopback 0
C2(config-if)#ip address 160.0.20.1 255.255.255.0
C2(config-if)#exit
C2(config)#int f0/0
```

```
C2(config-if)#ip address 10.0.24.1 255.255.255.252
C2(config-if)#no shut
C2(config-if)#exit
C2(config)#int f0/1
C2(config-if)#ip address 10.0.21.1 255.255.255.252
C2(config-if)#no shut
C2(config-if)#exit
C2(config)#int f1/0
C2(config-if)#ip address 10.0.25.1 255.255.255.252
C2(config-if)#no shut
C2(config-if)#speed 10
C2(config-if)#half-duplex
C2(config-if)#exit
```

```
C3#conf t
C3(config)#int loopback 0
C3(config-if)#ip address 160.0.30.1 255.255.255.0
C3(config-if)#exit
C3(config)#int f0/0
C3(config-if)#ip address 10.0.34.1 255.255.255.252
C3(config-if)#no shut
C3(config-if)#exit
C3(config)#int f0/1
C3(config-if)#ip address 10.0.31.1 255.255.255.252
C3(config-if)#no shut
C3(config-if)#exit
C3(config)#int f1/0
C3(config-if)#ip address 10.0.37.1 255.255.255.252
C3(config-if)#no shut
C3(config-if)#speed 10
C3(config-if)#half-duplex
C3(config-if)#exit
```

```
Provider#conf t
Provider(config)#int loopback 0
Provider(config-if)#ip address 160.0.40.1 255.255.255.0
Provider(config-if)#exit
Provider(config)#int f0/0
Provider(config-if)#ip address 10.0.24.2 255.255.255.252
Provider(config-if)#no shut
Provider(config-if)#exit
Provider(config)#int f1/0
Provider(config-if)#ip address 10.0.14.2 255.255.255.252
Provider(config-if)#no shut
Provider(config-if)#exit
Provider(config)#int f0/1
Provider(config-if)#ip address 10.0.34.2 255.255.255.252
Provider(config-if)#no shut
Provider(config-if)#exit
```

```
R5#conf t
```

```
R5(config)#int loopback 0
R5(config-if)#ip address 160.0.50.1 255.255.255.0
R5(config-if)#exit
R5(config)#int f0/0
R5(config-if)#ip address 10.0.25.2 255.255.255.252
R5(config-if)#no shut
R5(config-if)#exit
```

```
R6#conf t
R6(config)#int loopback 0
R6(config-if)#ip address 160.0.60.1 255.255.255.0
R6(config-if)#exit
R6(config)#int f0/0
R6(config-if)#ip address 10.0.16.2 255.255.255.252
R6(config-if)#no shut
R6(config-if)#exit
```

```
R7#conf t
R7(config)#int loopback 0
R7(config-if)#ip address 160.0.70.1 255.255.255.0
R7(config-if)#exit
R7(config)#int f0/0
R7(config-if)#ip address 10.0.37.2 255.255.255.252
R7(config-if)#no shut
R7(config-if)#exit
```

### ***Configurazione BGP***

```
C1#conf t
C1(config)#router bgp 100
C1(config-router)#network 160.0.10.0 mask 255.255.255.0
C1(config-router)#neighbor 10.0.21.1 remote-as 200
C1(config-router)#neighbor 10.0.31.1 remote-as 300
C1(config-router)#neighbor 10.0.14.2 remote-as 400
C1(config-router)#neighbor 10.0.16.2 remote-as 600
C1(config-router)#exit
```

```
C2#conf t
C2(config)#router bgp 200
C2(config-router)#network 160.0.20.0 mask 255.255.255.0
C2(config-router)#neighbor 10.0.21.2 remote-as 100
C2(config-router)#neighbor 10.0.24.2 remote-as 400
C2(config-router)#neighbor 10.0.25.2 remote-as 500
C2(config-router)#exit
```

```
C3#conf t
C3(config)#router bgp 300
C3(config-router)#network 160.0.30.0 mask 255.255.255.0
C3(config-router)#neighbor 10.0.31.2 remote-as 100
C3(config-router)#neighbor 10.0.34.2 remote-as 400
C3(config-router)#neighbor 10.0.37.2 remote-as 700
C3(config-router)#exit
```

```

Provider(config)#router bgp 400
Provider(config-router)#network 160.0.40.0 mask 255.255.255.0
Provider(config-router)#neighbor 10.0.14.1 remote-as 100
Provider(config-router)#neighbor 10.0.24.1 remote-as 200
Provider(config-router)#neighbor 10.0.34.1 remote-as 300
Provider(config-router)#exit

```

```

R5#conf t
R5(config)#router bgp 500
R5(config-router)#network 160.0.50.0 mask 255.255.255.0
R5(config-router)#neighbor 10.0.25.1 remote-as 200
R5(config-router)#exit

```

```

R6#conf t
R6(config)#router bgp 600
R6(config-router)#network 160.0.60.0 mask 255.255.255.0
R6(config-router)#neighbor 10.0.16.1 remote-as 100
R6(config-router)#exit

```

```

R7(config)#router bgp 700
R7(config-router)#network 160.0.70.0 mask 255.255.255.0
R7(config-router)#neighbor 10.0.37.1 remote-as 300
R7(config-router)#exit

```

```

C3#show ip bgp 160.0.50.0
BGP routing table entry for 160.0.50.0/24, version 9
Paths: (2 available, best #2, table Default-IP-Routing-Table)
  Advertised to update-groups:
    1
  400 200 500
    10.0.34.2 from 10.0.34.2 (160.0.40.1)
      Origin IGP, localpref 100, valid, external
  100 200 500
    10.0.31.2 from 10.0.31.2 (160.0.10.1)
      Origin IGP, localpref 100, valid, external, best
C3#

```

### *Configurazione relazioni*

```

C1(config)#route-map forpeer permit 10
C1(config-route-map)#match community 2
C1(config-route-map)#exit
C1(config)#route-map forprovider permit 10
C1(config-route-map)#match community 1
C1(config-route-map)#exit

```

```

C1(config)#ip community-list 1 permit 5000
C1(config)#ip community-list 1 permit 6000

```

```

C1(config)#ip community-list 2 permit 5000
C1(config)#ip community-list 2 permit 6000

```

```

C1(config)#route-map frompeer permit 10
C1(config-route-map)#set community 3000 additive
C1(config-route-map)#exit

```

```
C1(config)#route-map fromprovider permit 10
C1(config-route-map)#set community 4000 additive
C1(config-route-map)#exit
```

```
C1(config)#route-map fromcustomer permit 10
C1(config-route-map)#set community 5000 additive
C1(config-route-map)#exit
```

```
C1(config)#route-map fromlocal permit 10
C1(config-route-map)#set community 6000 additive
C1(config-route-map)#exit
```

```
C1(config)#router bgp 100
C1(config-router)#network 160.0.10.0 mask 255.255.255.0 route-map fromlocal
C1(config-router)#neighbor 10.0.14.2 route-map forprovider out
C1(config-router)#neighbor 10.0.14.2 route-map fromprovider in
C1(config-router)#neighbor 10.0.21.1 route-map forpeer out
C1(config-router)#neighbor 10.0.21.1 route-map frompeer in
C1(config-router)#neighbor 10.0.31.1 route-map forpeer out
C1(config-router)#neighbor 10.0.31.1 route-map frompeer in
C1(config-router)#neighbor 10.0.16.2 route-map fromcustomer in
C1(config-router)#exit
```

```
C2(config)#route-map forpeer permit 10
C2(config-route-map)#match community 2
C2(config-route-map)#exit
C2(config)#route-map forprovider permit 10
C2(config-route-map)#match community 1
C2(config-route-map)#exit
```

```
C2(config)#ip community-list 1 permit 5000
C2(config)#ip community-list 1 permit 6000
C2(config)#
C2(config)#ip community-list 2 permit 5000
C2(config)#ip community-list 2 permit 6000
C2(config)#
C2(config)#route-map frompeer permit 10
C2(config-route-map)#set community 3000 additive
C2(config-route-map)#exit
C2(config)#route-map fromprovider permit 10
C2(config-route-map)#set community 4000 additive
C2(config-route-map)#exit
C2(config)#route-map fromcustomer permit 10
C2(config-route-map)#set community 5000 additive
C2(config-route-map)#exit
C2(config)#route-map fromlocal permit 10
C2(config-route-map)#set community 6000 additive
C2(config-route-map)#exit
```

```
C2(config)#router bgp 200
C2(config-router)#network 160.0.20.0 mask 255.255.255.0 route-map fromlocal
C2(config-router)#neighbor 10.0.21.2 route-map forpeer out
C2(config-router)#neighbor 10.0.21.2 route-map frompeer in
C2(config-router)#neighbor 10.0.24.2 route-map forprovider out
C2(config-router)#neighbor 10.0.24.2 route-map fromprovider in
C2(config-router)#neighbor 10.0.25.2 route-map fromcustomer in
C2(config-router)#exit
```

```
C3#conf t
C3(config)#route-map forpeer permit 10
C3(config-route-map)#match community 2
C3(config-route-map)#exit
C3(config)#route-map forprovider permit 10
C3(config-route-map)#match community 1
C3(config-route-map)#exit
C3(config)#
C3(config)#ip community-list 1 permit 5000
C3(config)#ip community-list 1 permit 6000
C3(config)#ip community-list 2 permit 5000
C3(config)#ip community-list 2 permit 6000
C3(config)#
C3(config)#route-map frompeer permit 10
C3(config-route-map)#set community 3000 additive
C3(config-route-map)#exit
C3(config)#route-map fromprovider permit 10
C3(config-route-map)#set community 4000 additive
C3(config-route-map)#exit
C3(config)#route-map fromcustomer permit 10
C3(config-route-map)#set community 5000 additive
C3(config-route-map)#exit
C3(config)#route-map fromlocal permit 10
C3(config-route-map)#set community 6000 additive
C3(config-route-map)#exit
C3(config)#
C3(config)#router bgp 300
C3(config-router)#network 160.0.30.0 mask 255.255.255.0 route-map fromlocal
C3(config-router)#neighbor 10.0.31.2 route-map forpeer out
C3(config-router)#neighbor 10.0.31.2 route-map frompeer in
C3(config-router)#neighbor 10.0.34.2 route-map forprovider out
C3(config-router)#neighbor 10.0.34.2 route-map fromprovider in
C3(config-router)#neighbor 10.0.37.2 route-map fromcustomer in
C3(config-router)#exit
```



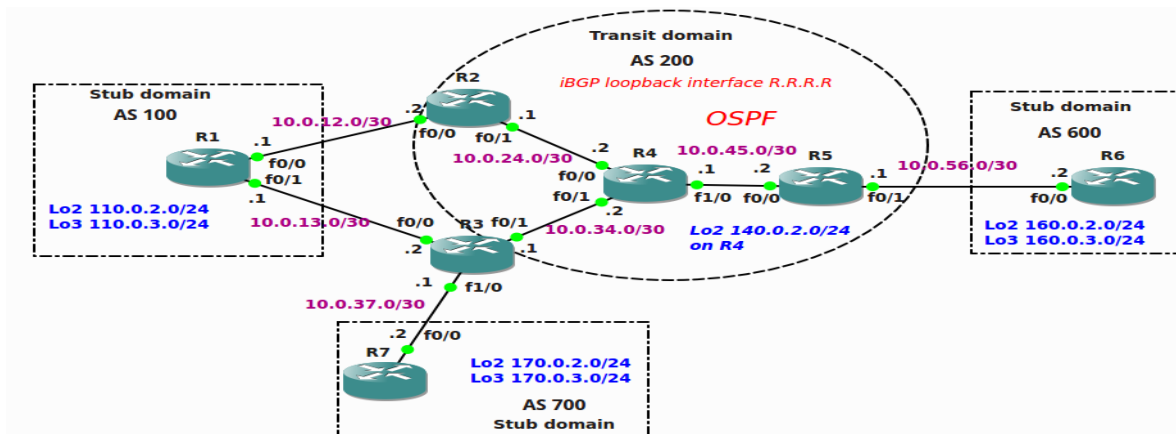
## Da Customer a Customer (R5 a R6)

```
R5
R5#show ip bgp 160.0.60.0
BGP routing table entry for 160.0.60.0/24, version 6
Paths: (1 available, best #1, table Default-IP-Routing-Table)
  Not advertised to any peer
  200 100 600
    10.0.25.1 from 10.0.25.1 (160.0.20.1)
      Origin IGP, localpref 100, valid, external, best
R5#
```

## Da Peer a Customer (C3 a R5)

```
C3
C3#show ip bgp 160.0.50.0
BGP routing table entry for 160.0.50.0/24, version 5
Paths: (1 available, best #1, table Default-IP-Routing-Table)
  Advertised to update-groups:
    1
  400 200 500
    10.0.34.2 from 10.0.34.2 (160.0.40.1)
      Origin IGP, localpref 100, valid, external, best
      Community: 4000
C3#
```

## BGP MPLS LDP



### [Partendo da BGP LAB DEFAULT](#)

Aggiungere:

```
R2(config)#mpls label range 32 200 static 16 31
R2(config)#int f0/1
R2(config-if)#mpls ip
```

```
R3(config)#mpls label range 32 200 static 16 31
R3(config)#int f0/1
R3(config-if)#mpls ip
```

```
R4(config)#mpls label range 32 200 static 16 31
R4(config)#mpls ldp graceful-restart
R4(config)#int f0/0
R4(config-if)#mpls ip
R4(config)#int f0/1
R4(config-if)#mpls ip
R4(config)#int f1/0
R4(config-if)#mpls ip
```

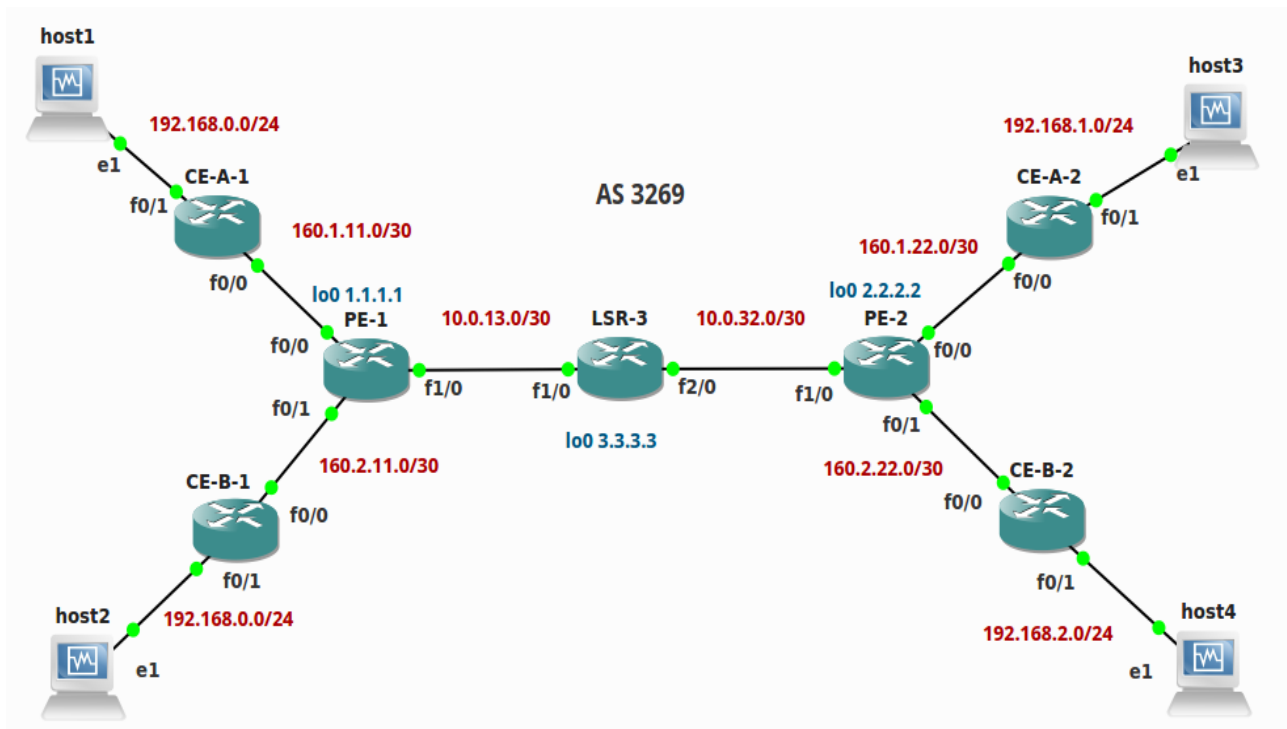
```
R5(config)#mpls label range 32 200 static 16 31
R5(config)#int f0/0
R5(config-if)#mpls ip
```

```

R1
R1#traceroute 160.0.2.1 source 110.0.2.1
Type escape sequence to abort.
Tracing the route to 160.0.2.1
 0 10.0.12.2 20 msec 16 msec 24 msec
 1 10.0.24.2 [MPLS: Label 32 Exp 0] 44 msec 52 msec 44 msec
 2 10.0.45.2 40 msec 52 msec 40 msec
 3 10.0.56.2 76 msec 60 msec 76 msec
R1#

```

## VPN MPLS



### Configurazione CE-A-1 CE-A-2 CE-B-1 CE-B-2

#### Configurazione CE-A-1

```
CE-A-1#conf t
CE-A-1(config)#int f0/0
CE-A-1(config-if)#ip address 160.1.11.2 255.255.255.252
CE-A-1(config-if)#no shut
CE-A-1(config-if)#exit
CE-A-1(config)#int f0/1
CE-A-1(config-if)#ip address 192.168.0.1 255.255.255.0
CE-A-1(config-if)#no shut
CE-A-1(config-if)#exit

CE-A-1(config)#ip route 0.0.0.0 0.0.0.0 160.1.11.1
CE-A-1(config)#end
```

#### Configurazione CE-A-2

```
CE-A-2#conf t
CE-A-2(config)#int f0/0
CE-A-2(config-if)#ip address 160.1.22.2 255.255.255.252
CE-A-2(config-if)#no shut
CE-A-2(config-if)#exit
CE-A-2(config)#int f0/1
CE-A-2(config-if)#ip address 192.168.1.1 255.255.255.0
CE-A-2(config-if)#no shut
CE-A-2(config-if)#exit

CE-A-2(config)#ip route 0.0.0.0 0.0.0.0 160.1.22.1
```

```
CE-A-2(config)#end
```

### **Configurazione CE-B-1**

```
CE-B-1#conf t
CE-B-1(config)#int f0/0
CE-B-1(config-if)#ip address 160.2.11.2 255.255.255.252
CE-B-1(config-if)#no shut
CE-B-1(config-if)#exit
CE-B-1(config)#int f0/1
CE-B-1(config-if)#ip address 192.168.0.1 255.255.255.0
CE-B-1(config-if)#no shut
CE-B-1(config-if)#exit

CE-B-1(config)#router bgp 200
CE-B-1(config-router)#no bgp default ipv4-unicast
CE-B-1(config-router)#neighbor 160.2.11.1 remote-as 3269
CE-B-1(config-router)#neighbor 160.2.11.1 update-source f0/0

CE-B-1(config-router)#address-family ipv4
CE-B-1(config-router-af)#neighbor 160.2.11.1 activate
CE-B-1(config-router-af)#network 192.168.0.0
CE-B-1(config-router-af)#end
```

### **Configurazione CE-B-2**

```
CE-B-2#conf t
CE-B-2(config)#int f0/0
CE-B-2(config-if)#ip address 160.2.22.2 255.255.255.252
CE-B-2(config-if)#no shut
CE-B-2(config-if)#exit
CE-B-2(config)#int f0/1
CE-B-2(config-if)#ip address 192.168.2.1 255.255.255.0
CE-B-2(config-if)#no shut
CE-B-2(config-if)#exit

CE-B-2(config)#router bgp 200
CE-B-2(config-router)#neighbor 160.2.22.1 remote-as 3269
CE-B-2(config-router)#neighbor 160.2.22.1 update-source f0/0
CE-B-2(config-router)#end
```

### **Configurazione LSR-3**

```
LSR-3#conf t
LSR-3(config)#int loopback 0
LSR-3(config-if)#ip address 3.3.3.3 255.255.255.255
LSR-3(config-if)#exit
LSR-3(config)#int f1/0
LSR-3(config-if)#10.0.13.2 255.255.255.252
LSR-3(config-if)#no shut
LSR-3(config-if)#mpls ip
```

```
LSR-3(config-if)#exit
LSR-3(config)#int f2/0
LSR-3(config-if)#ip address 10.0.32.1 255.255.255.252
LSR-3(config-if)#no shut
LSR-3(config-if)#mpls ip
LSR-3(config-if)#exit
```

```
LSR-3(config)#router ospf 1
LSR-3(config-router)#router-id 3.3.3.3
LSR-3(config-router)#network 3.3.3.3 0.0.0.0 area 0
LSR-3(config-router)#network 10.0.13.2 0.0.0.0 area 0
LSR-3(config-router)#network 10.0.32.1 0.0.0.0 area 0
```

```
LSR-3(config)#router bgp 3269
LSR-3(config-router)#no bgp default ipv4-unicast
LSR-3(config-router)#neighbor 1.1.1.1 remote-as 3269
LSR-3(config-router)#neighbor 1.1.1.1 update-source loopback0
LSR-3(config-router)#neighbor 2.2.2.2 remote-as 3269
LSR-3(config-router)#neighbor 2.2.2.2 update-source loopback0
```

## Configurazione VPN-A

### Configurazione PE-1

```
PE-1#conf t
PE-1(config)#ip vrf vpnA
PE-1(config-vrf)#rd 100:0
PE-1(config-vrf)#route-target export 100:1
PE-1(config-vrf)#route-target import 100:2
PE-1(config-vrf)#exit

PE-1(config)#int loopback 0
PE-1(config-if)#ip address 1.1.1.1 255.255.255.255
PE-1(config-if)#exit
PE-1(config)#int f0/0
PE-1(config-if)#ip vrf forwarding vpnA
PE-1(config-if)#ip address 160.1.11.1 255.255.255.252
PE-1(config-if)#no shut
PE-1(config-if)#exit
PE-1(config)#int f0/1
PE-1(config-if)#ip address 160.2.11.1 255.255.255.252
PE-1(config-if)#no shut
PE-1(config-if)#exit
PE-1(config)#int f1/0
PE-1(config-if)#ip address 10.0.13.1 255.255.255.252
PE-1(config-if)#mpls ip
PE-1(config-if)#no shut
PE-1(config-if)#exit

PE-1(config)#router ospf 1
PE-1(config-router)#router-id 1.1.1.1
PE-1(config-router)#network 1.1.1.1 0.0.0.0 area 0
PE-1(config-router)#network 10.0.13.1 0.0.0.0 area 0
```

```

PE-1(config-router)#exit

PE-1(config)#router bgp 3269
PE-1(config-router)#no bgp default ipv4-unicast
PE-1(config-router)#neighbor 2.2.2.2 remote-as 3269
PE-1(config-router)#neighbor 2.2.2.2 update-source loopback 0
PE-1(config-router)#neighbor 3.3.3.3 remote-as 3269
PE-1(config-router)#neighbor 3.3.3.3 update-source loopback 0
PE-1(config-router)#exit

PE-1(config-router)#address-family vpnv4
PE-1(config-router-af)#neighbor 2.2.2.2 activate
PE-1(config-router-af)#neighbor 2.2.2.2 send-community extended
PE-1(config-router-af)#neighbor 2.2.2.2 next-hop-self
PE-1(config-router-af)#exit

PE-1(config-router)#address-family ipv4 vrf vpnA
PE-1(config-router-af)#network 192.168.0.0
PE-1(config-router-af)#exit
PE-1(config-router)#exit

PE-1(config)#ip route vrf vpnA 192.168.0.0 255.255.255.0 160.1.11.2
PE-1(config)#end

```

## Configurazione PE-2

```

PE-2#conf t
PE-2(config)#ip vrf vpnA
PE-2(config-vrf)#rd 100:0
PE-2(config-vrf)#route-target export 100:2
PE-2(config-vrf)#route-target import 100:1
PE-2(config-vrf)#exit

PE-2(config)#int loopback 0
PE-2(config-if)#ip address 2.2.2.2 255.255.255.255
PE-2(config-if)#exit
PE-2(config)#int f0/0
PE-2(config-if)#ip vrf forwarding vpnA
PE-2(config-if)#ip address 160.1.22.1 255.255.255.252
PE-2(config-if)#no shut
PE-2(config-if)#exit
PE-2(config)#int f0/1
PE-2(config-if)#ip address 160.2.22.1 255.255.255.252
PE-2(config-if)#no shut
PE-2(config-if)#exit
PE-2(config)#int f1/0
PE-2(config-if)#ip address 10.0.32.2 255.255.255.252
PE-2(config-if)#mpls ip
PE-2(config-if)#no shut
PE-2(config-if)#exit

PE-2(config)#router ospf 1

```

```

PE-2(config-router)#router-id 2.2.2.2
PE-2(config-router)#network 2.2.2.2 0.0.0.0 area 0
PE-2(config-router)#network 10.0.32.2 0.0.0.0 area 0
PE-2(config-router)#exit

PE-2(config)#router bgp 3269
PE-2(config-router)#no bgp default ipv4-unicast
PE-2(config-router)#neighbor 1.1.1.1 remote-as 3269
PE-2(config-router)#neighbor 1.1.1.1 update-source loopback 0
PE-2(config-router)#neighbor 3.3.3.3 remote-as 3269
PE-2(config-router)#neighbor 3.3.3.3 update-source loopback 0
PE-2(config-router)#exit

PE-2(config-router)#address-family vpnv4
PE-2(config-router-af)#neighbor 1.1.1.1 activate
PE-2(config-router-af)#neighbor 1.1.1.1 send-community extended
PE-2(config-router-af)#neighbor 1.1.1.1 next-hop-self
PE-2(config-router-af)#exit

PE-2(config-router)#address-family ipv4 vrf vpnA
PE-2(config-router-af)#network 192.168.1.0
PE-2(config-router-af)#exit
PE-2(config-router)#exit

PE-2(config)#ip route vrf vpnA 192.168.1.0 255.255.255.0 160.1.22.2
PE-2(config)#end

```

```

LSR-3(config)#do show mpls int
Interface          IP          Tunnel  Operational
FastEthernet1/0    Yes (ldp)   No      Yes
FastEthernet2/0    Yes (ldp)   No      Yes
LSR-3(config)#

```

## ***Configuriamo la VPN-B***

### **Configurazione PE-1**

```

PE-1#conf t
PE-1(config)#ip vrf vpnB
PE-1(config-vrf)#rd 200:0
PE-1(config-vrf)#route-target export 200:1
PE-1(config-vrf)#route-target import 200:2
PE-1(config-vrf)#exit

PE-1(config)#int f0/1
PE-1(config-if)#ip vrf forwarding vpnB
PE-1(config-if)#exit

PE-1(config)#do show ip vrf

```

```
PE-1(config)#do show ip vrf
Name           Default RD      Interfaces
vpnA           100:0           Fa0/0
vpnB           200:0           Fa0/1
```

```
PE-1(config)#router bgp 3269
PE-1(config-router)#neighbor 160.2.11.2 remote-as 200
PE-1(config-router)#neighbor 160.2.11.2 update-source f0/1
```

```
PE-1(config-router)#address-family ipv4 vrf vpnB
PE-1(config-router-af)#neighbor 160.2.11.2 remote-as 200
PE-1(config-router-af)#neighbor 160.2.11.2 activate
PE-1(config-router-af)#neighbor 160.2.11.2 as-override
PE-1(config-router-af)#end
```

## Configurazione PE-2

```
PE-2#conf t
PE-2(config)#ip vrf vpnB
PE-2(config-vrf)#rd 200:0
PE-2(config-vrf)#route-target export 200:2
PE-2(config-vrf)#route-target import 200:1
PE-2(config-vrf)#exit
```

```
PE-2(config)#int f0/1
PE-2(config-if)#ip vrf forwarding vpnB
PE-2(config-if)#exit
```

```
PE-2(config)#router bgp 3269
PE-2(config-router)#neighbor 160.2.22.2 remote-as 200
PE-2(config-router)#neighbor 160.2.22.2 update-source f0/1
```

```
PE-2(config-router)#address-family ipv4 vrf vpnB
PE-2(config-router-af)#neighbor 160.2.22.2 remote-as 200
PE-2(config-router-af)#neighbor 160.2.22.2 activate
PE-2(config-router-af)#neighbor 160.2.22.2 as-override
PE-2(config-router-af)#end
```

## Configurazione degli Host

### Host1

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.0.1
root@box:~#
```

### Host2

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.2/24 dev eth1
```



```
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.0.1
root@box:~#
```

**Host3**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.1.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.1.1
root@box:~#
```

**Host4**

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.2.2/24 dev eth1
root@box:~# ip r d default
root@box:~# ip r a default via 192.168.2.1
root@box:~#
```

Host1 pinga verso se stesso ( 192.168.0.2 appartiene anche ad Host2 ma sono di VPN differenti) e verso Host3 ma non verso Host2 e Host4

Verso se stesso

```
host1
root@box:~# traceroute 192.168.0.2
traceroute to 192.168.0.2 (192.168.0.2), 30 hops max, 38 byte packets
 1 192.168.0.2 (192.168.0.2) 0.012 ms 0.005 ms 0.002 ms
root@box:~#
```

Verso host3

```
host1
root@box:~# ping 192.168.1.2
PING 192.168.1.2 (192.168.1.2): 56 data bytes
64 bytes from 192.168.1.2: seq=2 ttl=59 time=99.404 ms
64 bytes from 192.168.1.2: seq=3 ttl=59 time=96.906 ms
64 bytes from 192.168.1.2: seq=4 ttl=59 time=94.111 ms
```

Verso host4

```
host1
root@box:~# ping 192.168.2.2
PING 192.168.2.2 (192.168.2.2): 56 data bytes
--- 192.168.2.2 ping statistics ---
12 packets transmitted, 0 packets received, 100% packet loss
root@box:~#
```

```

PE-1
PE-1#show ip vrf
  Name          Default RD      Interfaces
  ----          -
  vpnA          100:0          Fa0/0
  vpnB          200:0          Fa0/1
PE-1#

```

```

PE-1
PE-1#show ip vrf interfaces
Interface      IP-Address      VRF      Protocol
----
Fa0/0         160.1.11.1     vpnA     up
Fa0/1         160.2.11.1     vpnB     up
PE-1#

```

```

PE-1
PE-1#show ip route vrf vpnA

Routing Table: vpnA
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

  160.1.0.0/30 is subnetted, 1 subnets
C       160.1.11.0 is directly connected, FastEthernet0/0
S       192.168.0.0/24 [1/0] via 160.1.11.2
B       192.168.1.0/24 [200/0] via 2.2.2.2, 00:15:42
PE-1#

```

```

PE-1
PE-1#show ip bgp vpnv4 all
BGP table version is 8, local router ID is 1.1.1.1
Status codes: s suppressed, d damped, h history, * valid, > best, i - internal,
              r RIB-failure, S Stale
Origin codes: i - IGP, e - EGP, ? - incomplete

   Network          Next Hop          Metric LocPrf  Weight Path
Route Distinguisher: 100:0 (default for vrf vpnA)
*> 192.168.0.0      160.1.11.2        0           32768 i
*>i192.168.1.0     2.2.2.2           0          100      0 i
Route Distinguisher: 200:0 (default for vrf vpnB)
*> 192.168.0.0     160.2.11.2        0           0 200 i
*>i192.168.2.0     2.2.2.2           0          100      0 200 i
PE-1#

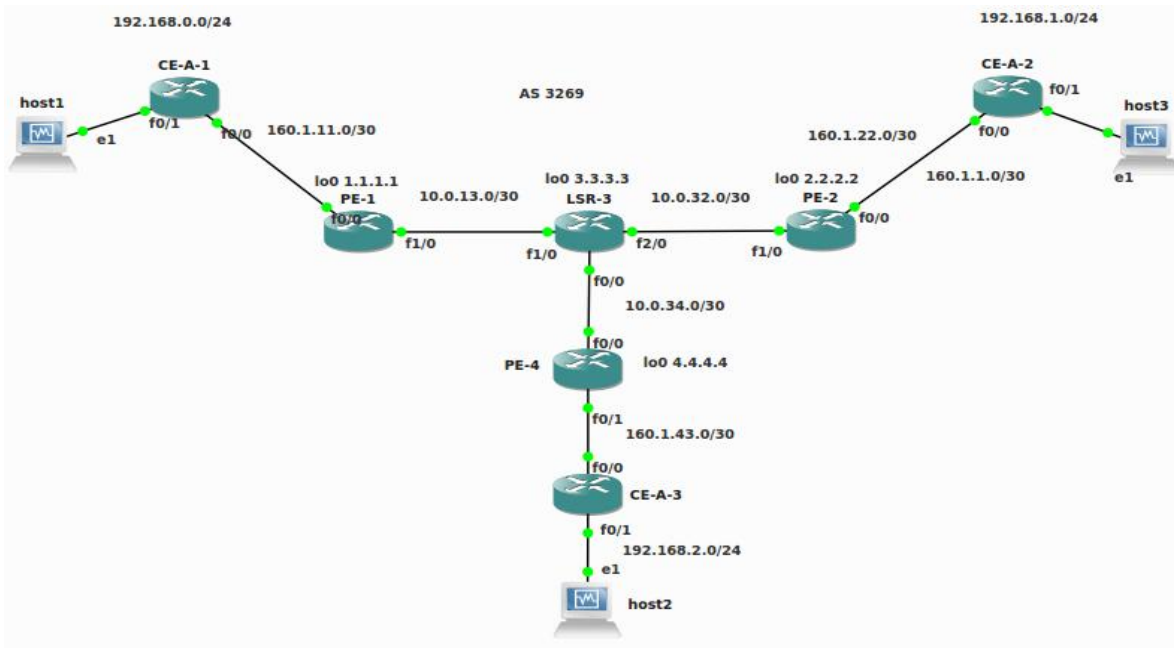
```

```

PE-1
PE-1#show ip bgp vpnv4 all tags
  Network          Next Hop          In tag/Out tag
Route Distinguisher: 100:0 (vpnA)
  192.168.0.0      160.1.11.2        19/notag
  192.168.1.0      2.2.2.2           notag/19
Route Distinguisher: 200:0 (vpnB)
  192.168.0.0     160.2.11.2        20/notag
  192.168.2.0     2.2.2.2           notag/20
PE-1#

```

## VPN MPLS – Hub & Spoke



### Configurazione Router CE-A-1

```
CE-A-1#conf t
```

```
CE-A-1(config)#int f0/0
CE-A-1(config-if)#ip address 160.1.11.2 255.255.255.252
CE-A-1(config-if)#no shut
CE-A-1(config-if)#exit
```

```
CE-A-1(config)#int f0/1
CE-A-1(config-if)#ip address 192.168.0.1 255.255.255.0
CE-A-1(config-if)#no shut
CE-A-1(config-if)#exit
```

```
CE-A-1(config)#router bgp 100
CE-A-1(config-router)#network 192.168.0.0
CE-A-1(config-router)#neighbor 160.1.11.1 remote-as 3269
CE-A-1(config-router)#neighbor 160.1.11.1 update-source f0/0
CE-A-1(config-router)#end
```

### Configurazione Router CE-A-2

```
CE-A-2#conf t
```

```
CE-A-2(config)#int f0/0
CE-A-2(config-if)#ip address 160.1.22.2 255.255.255.252
CE-A-2(config-if)#no shut
CE-A-2(config-if)#exit
```

```
CE-A-2(config)#int f0/1
CE-A-2(config-if)#ip address 192.168.1.1 255.255.255.0
CE-A-2(config-if)#no shut
```

```
CE-A-2(config-if)#exit
```

```
CE-A-2(config)#router bgp 100
CE-A-2(config-router)#network 192.168.1.0
CE-A-2(config-router)#neighbor 160.1.22.1 remote-as 3269
CE-A-2(config-router)#neighbor 160.1.22.1 update-source f0/0
CE-A-2(config-router)#end
```

### **Configurazione Router CE-A-3**

```
CE-A-3#conf t
```

```
CE-A-3(config)#int f0/0
CE-A-3(config-if)#ip address 160.1.43.2 255.255.255.252
CE-A-3(config-if)#no shut
CE-A-3(config-if)#exit
```

```
CE-A-3(config)#int f0/1
CE-A-3(config-if)#ip address 192.168.2.1 255.255.255.0
CE-A-3(config-if)#no shut
CE-A-3(config-if)#exit
```

```
CE-A-3(config)#router bgp 100
CE-A-3(config-router)#neighbor 160.1.43.1 remote-as 3269
CE-A-3(config-router)#neighbor 160.1.43.1 update-source f0/0
CE-A-3(config-router)#network 192.168.2.0
CE-A-3(config-router)#end
```

### **Configurazione Router LSR-3**

```
LSR-3#conf t
```

```
LSR-3(config)#int loopback 0
LSR-3(config-if)#ip address 3.3.3.3 255.255.255.255
LSR-3(config-if)#exit
```

```
LSR-3(config)#int f0/0
LSR-3(config-if)#ip address 10.0.34.1 255.255.255.252
LSR-3(config-if)#mpls ip
LSR-3(config-if)#no shut
LSR-3(config-if)#exit
```

```
LSR-3(config)#int f1/0
LSR-3(config-if)#ip address 10.0.13.2 255.255.255.252
LSR-3(config-if)#mpls ip
LSR-3(config-if)#no shut
LSR-3(config-if)#exit
```

```
LSR-3(config)#int f2/0
LSR-3(config-if)#ip address 10.0.32.1 255.255.255.252
LSR-3(config-if)#mpls ip
LSR-3(config-if)#no shut
LSR-3(config-if)#exit
```

```
LSR-3(config)#router ospf 1
LSR-3(config-router)#network 3.3.3.3 0.0.0.0 area 0
LSR-3(config-router)#network 10.0.13.2 0.0.0.0 area 0
LSR-3(config-router)#network 10.0.32.1 0.0.0.0 area 0
LSR-3(config-router)#network 10.0.34.1 0.0.0.0 area 0
LSR-3(config-router)#exit
```

```
LSR-3(config)#router bgp 3269
LSR-3(config-router)#no bgp default ipv4-unicast
LSR-3(config-router)#neighbor 1.1.1.1 remote-as 3269
LSR-3(config-router)#neighbor 1.1.1.1 update-source loopback 0
LSR-3(config-router)#neighbor 2.2.2.2 remote-as 3269
LSR-3(config-router)#neighbor 2.2.2.2 update-source loopback 0
LSR-3(config-router)#neighbor 4.4.4.4 remote-as 3269
LSR-3(config-router)#neighbor 4.4.4.4 update-source loopback 0
LSR-3(config-router)#end
```

### Configurazione Router PE-1

```
PE-1#conf t
PE-1(config)#ip vrf vpnA
PE-1(config-vrf)#rd 100:0
PE-1(config-vrf)#route-target export 100:1
PE-1(config-vrf)#route-target import 100:2
PE-1(config-vrf)#route-target import 100:4
PE-1(config-vrf)#exit
```

```
PE-1(config)#int loopback 0
PE-1(config-if)#ip address 1.1.1.1 255.255.255.255
PE-1(config-if)#exit
```

```
PE-1(config)#int f0/0
PE-1(config-if)#ip vrf forwarding vpnA
PE-1(config-if)#ip address 160.1.11.1 255.255.255.252
PE-1(config-if)#no shut
PE-1(config-if)#exit
```

```
PE-1(config)#int f1/0
PE-1(config-if)#ip address 10.0.13.1 255.255.255.252
PE-1(config-if)#mpls ip
PE-1(config-if)#no shut
PE-1(config-if)#exit
```

```
PE-1(config)#router ospf 1
PE-1(config-router)#router-id 1.1.1.1
PE-1(config-router)#network 1.1.1.1 0.0.0.0 area 0
PE-1(config-router)#network 10.0.13.1 0.0.0.0 area 0
PE-1(config-router)#exit
```

```
PE-1(config)#router bgp 3269
PE-1(config-router)#no bgp default ipv4-unicast
```

```

PE-1(config-router)#neighbor 2.2.2.2 remote-as 3269
PE-1(config-router)#neighbor 2.2.2.2 update-source loopback 0
PE-1(config-router)#neighbor 3.3.3.3 remote-as 3269
PE-1(config-router)#neighbor 3.3.3.3 update-source loopback 0
PE-1(config-router)#neighbor 4.4.4.4 remote-as 3269
PE-1(config-router)#neighbor 4.4.4.4 update-source loopback 0
PE-1(config-router)#neighbor 160.1.11.2 remote-as 100
PE-1(config-router)#neighbor 160.1.11.2 update-source f0/0
PE-1(config-router)#exit

```

```

PE-1(config)#router bgp 3269
PE-1(config-router)#address-family vpnv4
PE-1(config-router-af)#neighbor 2.2.2.2 activate
PE-1(config-router-af)#neighbor 2.2.2.2 send-community extended
PE-1(config-router-af)#neighbor 2.2.2.2 next-hop-self
PE-1(config-router-af)#neighbor 4.4.4.4 activate
PE-1(config-router-af)#neighbor 4.4.4.4 send-community extended
PE-1(config-router-af)#neighbor 4.4.4.4 next-hop-self
PE-1(config-router-af)#exit
PE-1(config-router)#exit

```

```

PE-1(config)#router bgp 3269
PE-1(config-router)#address-family ipv4 vrf vpnA
PE-1(config-router-af)#neighbor 160.1.11.2 remote-as 100
PE-1(config-router-af)#neighbor 160.1.11.2 activate
PE-1(config-router-af)#neighbor 160.1.11.2 as-override
PE-1(config-router-af)#network 0.0.0.0
PE-1(config-router-af)#exit
PE-1(config-router)#exit

```

```

PE-1(config)#ip route vrf vpnA 0.0.0.0 0.0.0.0 null 0
PE-1(config)#end

```

## Configurazione Router PE-2

```
PE-2#conf t
```

```

PE-2(config)#ip vrf vpnA
PE-2(config-vrf)#rd 100:0
PE-2(config-vrf)#route-target export 100:2
PE-2(config-vrf)#route-target import 100:1
PE-2(config-vrf)#exit

```

```

PE-2(config)#int loopback 0
PE-2(config-if)#ip address 2.2.2.2 255.255.255.255
PE-2(config-if)#exit

```

```

PE-2(config)#int f0/0
PE-2(config-if)#ip vrf forwarding vpnA
PE-2(config-if)#ip address 160.1.22.1 255.255.255.252
PE-2(config-if)#no shut
PE-2(config-if)#exit

```

```
PE-2(config)#int f1/0
PE-2(config-if)#ip address 10.0.32.2 255.255.255.252
PE-2(config-if)#mpls ip
PE-2(config-if)#no shut
PE-2(config-if)#exit
```

```
PE-2(config)#router ospf 1
PE-2(config-router)#network 2.2.2.2 0.0.0.0 area 0
PE-2(config-router)#network 10.0.32.2 0.0.0.0 area 0
PE-2(config-router)#exit
```

```
PE-2(config)#router bgp 3269
PE-2(config-router)#no bgp default ipv4-unicast
PE-2(config-router)#neighbor 1.1.1.1 remote-as 3269
PE-2(config-router)#neighbor 1.1.1.1 update-source loopback 0
PE-2(config-router)#neighbor 3.3.3.3 remote-as 3269
PE-2(config-router)#neighbor 3.3.3.3 update-source loopback 0
PE-2(config-router)#neighbor 4.4.4.4 remote-as 3269
PE-2(config-router)#neighbor 4.4.4.4 update-source loopback 0
PE-2(config-router)#neighbor 160.1.22.2 remote-as 100
PE-2(config-router)#neighbor 160.1.22.2 update-source f0/1
PE-2(config-router)#exit
```

```
PE-2(config)#router bgp 3269
PE-2(config-router)#address-family vpnv4
PE-2(config-router-af)#neighbor 1.1.1.1 activate
PE-2(config-router-af)#neighbor 1.1.1.1 send-community extended
PE-2(config-router-af)#neighbor 1.1.1.1 next-hop-self
PE-2(config-router-af)#neighbor 4.4.4.4 activate
PE-2(config-router-af)#neighbor 4.4.4.4 send-community extended
PE-2(config-router-af)#neighbor 4.4.4.4 next-hop-self
PE-2(config-router-af)#exit
PE-2(config-router)#exit
```

```
PE-2(config)#router bgp 3269
PE-2(config-router)#address-family ipv4 vrf vpnA
PE-2(config-router-af)#neighbor 160.1.22.2 remote-as 100
PE-2(config-router-af)#neighbor 160.1.22.2 activate
PE-2(config-router-af)#neighbor 160.1.22.2 as-override
PE-2(config-router-af)#end
```

#### **Configurazione Router PE-4**

```
PE-4#conf t
```

```
PE-4(config)#ip vrf vpnA
PE-4(config-vrf)#rd 100:0
PE-4(config-vrf)#route-target export 100:2
PE-4(config-vrf)#route-target import 100:1
PE-4(config-vrf)#exit
```

```
PE-4(config)#int loopback 0
PE-4(config-if)#ip address 4.4.4.4 255.255.255.255
PE-4(config-if)#exit
```

```
PE-4(config)#int f0/0
PE-4(config-if)#ip address 10.0.34.2 255.255.255.252
PE-4(config-if)#mpls ip
PE-4(config-if)#no shut
PE-4(config-if)#exit
```

```
PE-4(config)#int f0/1
PE-4(config-if)#ip vrf forwarding vpnA
PE-4(config-if)#ip address 160.1.43.1 255.255.255.252
PE-4(config-if)#no shut
PE-4(config-if)#exit
```

```
PE-4(config)#router ospf 1
PE-4(config-router)#router-id 4.4.4.4
PE-4(config-router)#network 4.4.4.4 0.0.0.0 area 0
PE-4(config-router)#network 10.0.34.2 0.0.0.0 area 0
PE-4(config-router)#exit
```

```
PE-4(config)#router bgp 3269
PE-4(config-router)#no bgp default ipv4-unicast
PE-4(config-router)#neighbor 1.1.1.1 remote-as 3269
PE-4(config-router)#neighbor 1.1.1.1 update-source loopback 0
PE-4(config-router)#neighbor 2.2.2.2 remote-as 3269
PE-4(config-router)#neighbor 2.2.2.2 update-source loopback 0
PE-4(config-router)#neighbor 3.3.3.3 remote-as 3269
PE-4(config-router)#neighbor 3.3.3.3 update-source loopback 0
PE-4(config-router)#neighbor 160.1.43.2 remote-as 100
PE-4(config-router)#neighbor 160.1.43.2 update-source f0/1
PE-4(config-router)#exit
```

```
PE-4(config)#router bgp 3269
PE-4(config-router)#address-family vpnv4
PE-4(config-router-af)#neighbor 1.1.1.1 activate
PE-4(config-router-af)#neighbor 1.1.1.1 send-community extended
PE-4(config-router-af)#neighbor 1.1.1.1 next-hop-self
PE-4(config-router-af)#neighbor 2.2.2.2 activate
PE-4(config-router-af)#neighbor 2.2.2.2 send-community extended
PE-4(config-router-af)#neighbor 2.2.2.2 next-hop-self
PE-4(config-router-af)#exit
PE-4(config-router)#exit
```

```
PE-4(config)#router bgp 3269
PE-4(config-router)#address-family ipv4 vrf vpnA
PE-4(config-router-af)#neighbor 160.1.43.2 remote-as 100
PE-4(config-router-af)#neighbor 160.1.43.2 activate
PE-4(config-router-af)#neighbor 160.1.43.2 as-override
PE-4(config-router-af)#end
```



## CONFIGURAZIONE – VPN

**aprire il terminale della macchina reale e digitare:**

```
paolo@paolo-Aspire-5750G:~$ sudo apt-get install openvpn
```

```
paolo@paolo-Aspire-5750G:~$ sudo apt-get install easy-rsa
```

```
paolo@paolo-Aspire-5750G:~$ cd /usr/share/easy-rsa/
```

```
paolo@paolo-Aspire-5750G:/usr/share$ cd easy-rsa/
```

```
paolo@paolo-Aspire-5750G:/usr/share/easy-rsa$ ls
```

```
paolo@paolo-Aspire-5750G:/usr/share/easy-rsa$ ls
build-ca          build-key-pkcs12 inherit-inter    pkitool
build-dh          build-key-server list-crl         revoke-full
build-inter       build-req        openssl-0.9.6.cnf sign-req
build-key         build-req-pass   openssl-0.9.8.cnf vars
build-key-pass    clean-all       openssl-1.0.0.cnf whichopensslcnf
paolo@paolo-Aspire-5750G:/usr/share/easy-rsa$
```

```
paolo@paolo-Aspire-5750G:/usr/share/easy-rsa$ sudo su
```

```
root@paolo-Aspire-5750G:/usr/share/easy-rsa# ./clean all
```

```
root@paolo-Aspire-5750G:/usr/share/easy-rsa# ls
```

```
root@paolo-Aspire-5750G:/usr/share/easy-rsa# ls
build-ca          build-key-server list-crl         sign-req
build-dh          build-req        openssl-0.9.6.cnf vars
build-inter       build-req-pass   openssl-0.9.8.cnf whichopensslcnf
build-key         clean-all       openssl-1.0.0.cnf
build-key-pass    inherit-inter    pkitool
build-key-pkcs12 keys             revoke-full
```

```
root@paolo-Aspire-5750G:/usr/share/easy-rsa# ./build-ca
```

```
root@paolo-Aspire-5750G:/usr/share/easy-rsa# ./build-ca
Generating a 2048 bit RSA private key
.....+++
.....+++
writing new private key to 'ca.key'
-----
You are about to be asked to enter information that will be incorporated
into your certificate request.
What you are about to enter is what is called a Distinguished Name or a DN.
There are quite a few fields but you can leave some blank
For some fields there will be a default value,
If you enter '.', the field will be left blank.
-----
Country Name (2 letter code) [US]:
State or Province Name (full name) [CA]:
Locality Name (eg, city) [SanFrancisco]:
Organization Name (eg, company) [Fort-Funston]:
Organizational Unit Name (eg, section) [MyOrganizationalUnit]:
Common Name (eg, your name or your server's hostname) [Fort-Funston CA]:
Name [EasyRSA]:
Email Address [me@myhost.mydomain]:
root@paolo-Aspire-5750G:/usr/share/easy-rsa#
```

```
root@paolo-Aspire-5750G:/usr/share/easy-rsa# cd keys/
```

```
root@paolo-Aspire-5750G:/usr/share/easy-rsa/keys# ls
```

```
root@paolo-Aspire-5750G:/usr/share/easy-rsa/keys# ls
ca.crt ca.key index.txt serial
```

```
root@paolo-Aspire-5750G:/usr/share/easy-rsa/keys# cd..
```

```
root@paolo-Aspire-5750G:/usr/share/easy-rsa# ./build-key-server server
```



```

paolo@paolo-Aspire-5750G:~/openvpn-ex1$ ls
keys
paolo@paolo-Aspire-5750G:~/openvpn-ex1$ mkdir config-files
paolo@paolo-Aspire-5750G:~/openvpn-ex1$ cd ..
paolo@paolo-Aspire-5750G:~/openvpn-ex1$ cd /usr/share/doc
paolo@paolo-Aspire-5750G:/usr/share/doc$ cd openvpn/
paolo@paolo-Aspire-5750G:/usr/share/doc/openvpn$ ls

```

```

paolo@paolo-Aspire-5750G:/usr/share/doc/openvpn$ ls
AUTHORS          examples          README.auth-pam
changelog.Debian.gz  management-notes.txt.gz  README.Debian.gz
COPYING.gz        NEWS.Debian.gz    README.down-root
copyright         PORTS             README.IPv6
COPYRIGHT.GPL.gz  README           README.polarssl

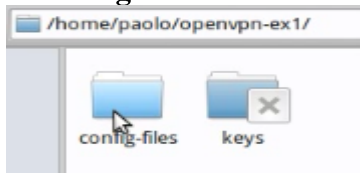
```

```

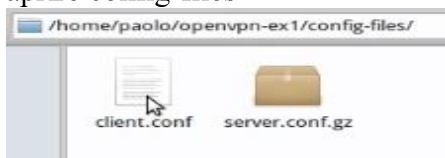
paolo@paolo-Aspire-5750G:/usr/share/doc/openvpn$ cd examples/
paolo@paolo-Aspire-5750G:/usr/share/doc/openvpn/examples$ cd sample-config-files/
paolo@paolo-Aspire-5750G:/usr/share/doc/openvpn/examples/sample-config-files$ cp client.conf
~/openvpn-ex1/config-files/
paolo@paolo-Aspire-5750G:/usr/share/doc/openvpn/examples/sample-config-files$ cp
server.conf.gz ~/openvpn-ex1/config-files/
paolo@paolo-Aspire-5750G:/usr/share/doc/openvpn/examples/sample-config-files$ cd
/usr/share/doc/easy-rsa/

```

### tramite gestore file andate nella vostra home e aprite openvpn-ex1



aprire config-files



aprire client.conf

salva con nome e rinominare con client1.conf

```

# You can have multiple remote entries
# to load balance between the servers.
remote my-server-1 1194
;remote my-server-2 1194

```

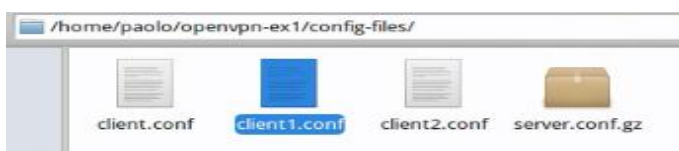
sostituire my-server-1 con 160.0.0.1

```

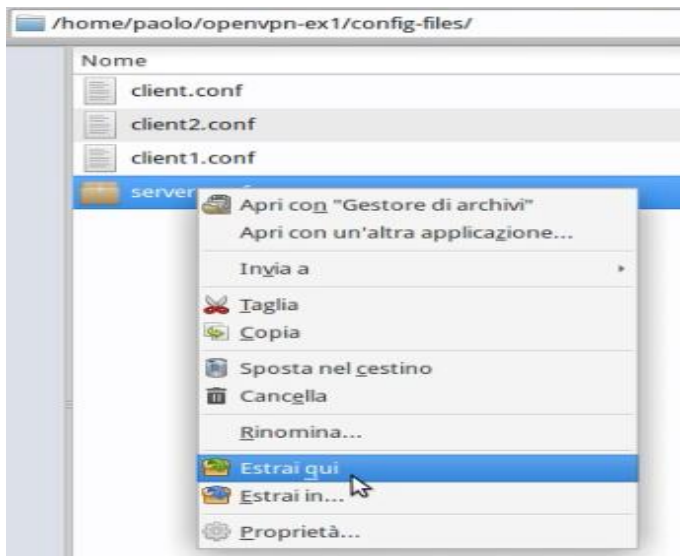
# You can have multiple remote entries
# to load balance between the servers.
remote 160.0.0.1 1194
;remote my-server-2 1194

```

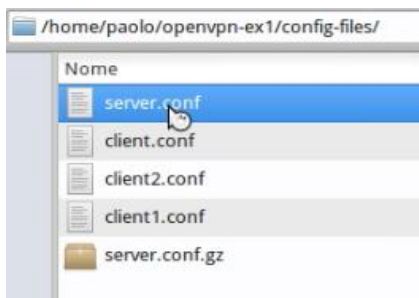
salviamo e successivamente salviamo con nome e rinominiamo client2.conf  
alla fine dovranno risultare queste cartelle.



andare su /home/paolo/openvpn-ex1/config-files



scompattare server.conf



aprire server.conf

```
server.conf - Mousepad
File Modifica Visualizza Testo Documento Navigazione Aiuto
# address pool (10.0.0.0/255.255.255.0)
# back to the OpenVPN server.
;push "route 192.168.10.0 255.255.255.0"
;push "route 192.168.20.0 255.255.255.0"
```

trovare la riga con la scritta 'push' e aggiungere:

```
;push "route 192.168.10.0 255.255.255.0"
;push "route 192.168.20.0 255.255.255.0"
push "route 192.168.0.0 255.255.255.0"
push "route 192.168.1.0 255.255.255.0"
```

trovare la seguente riga:

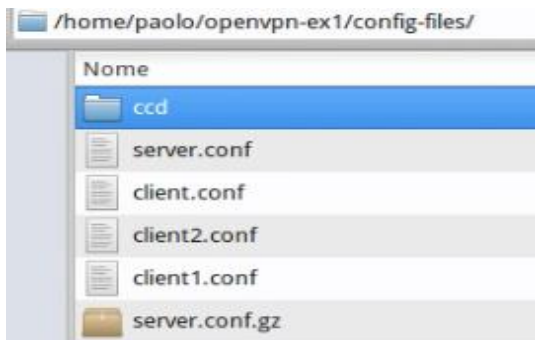
```
;client-config-dir ccd
;route 192.168.40.128 255.255.255.248
```

e sostituirla con

```
client-config-dir ccd
route 192.168.1.0 255.255.255.0
```

andare su /home/paolo/openvpn-ex1/config-files

creare una nuova cartella chiamandola 'ccd'

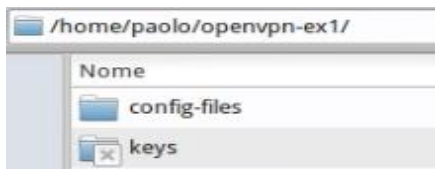


aprire ccd e creare il file client1

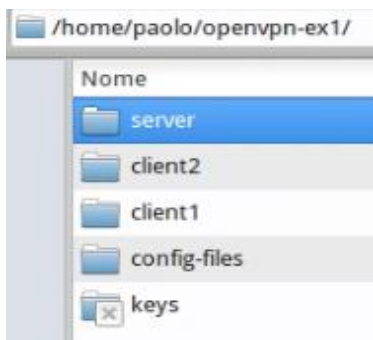
all'interno di client1 andiamo a scrivere:

```
iroute 192.168.1.0 255.255.255.0
```

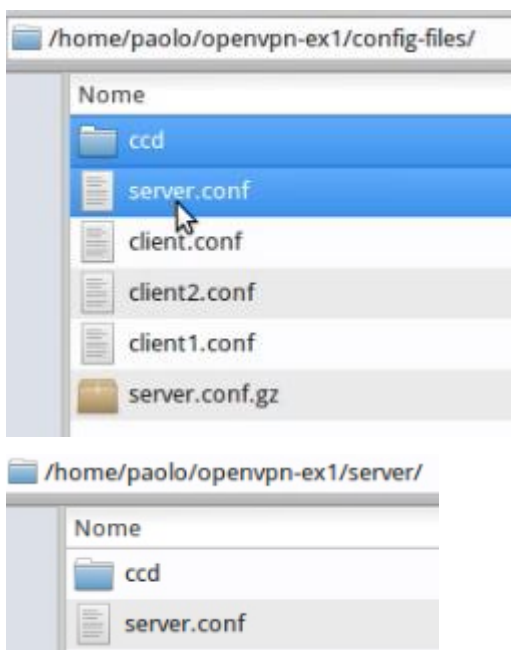
andare su /home/paolo/openvpn-ex1/



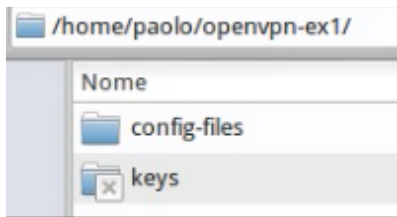
e creare le seguenti cartelle: client1, client2, server



dalla cartella config-files spostare nella cartella server : 'ccd' e 'server.conf'



Rendere accessibile la cartella keys presente in openvpn-ex1

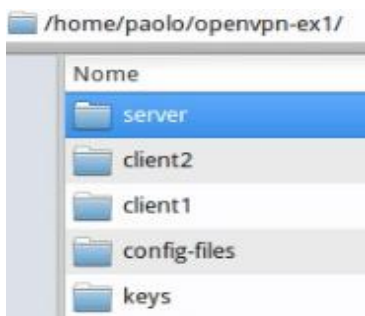


aprire il terminale e digitare il percorso dove è presente openvpn-ex1  
nel mio caso:

```
paolo@paolo-Aspire-5750G:~$ sudo su
```

```
root@paolo-Aspire-5750G:/home/paolo# cd openvpn-ex1/keys
```

```
root@paolo-Aspire-5750G:/home/paolo/openvpn-ex1/keys# chown -R paolo:paolo keys
```

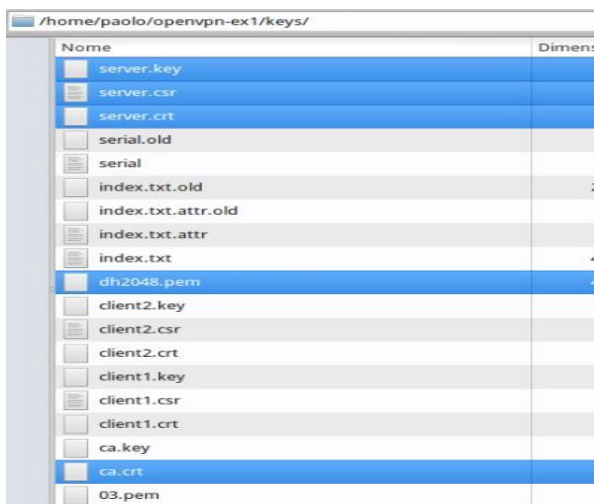


possiamo notare che la cartella keys non ha più la 'x'

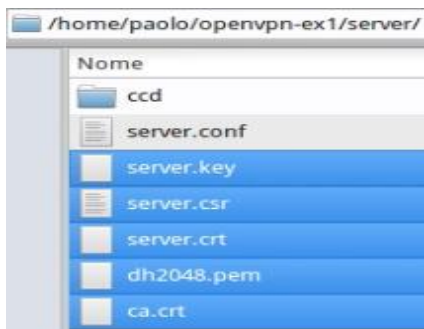
### Configurazione Server

aprire la cartella keys e selezionare i seguenti file:

server.key server.csr server.crt dh2048.pem ca.crt



e copiarli nella cartella server



aprire server.conf e cercare:

```
# 2048 bit keys.  
dh dh1024.pem
```

sostituire << dh dh1024.pem>> con il nome del file presente nella cartella server

```
# 2048 bit keys.  
dh dh2048.pem
```

trovare anche:

```
# server's tun/tap interface  
;client-to-client  
# Uncomment this directive
```

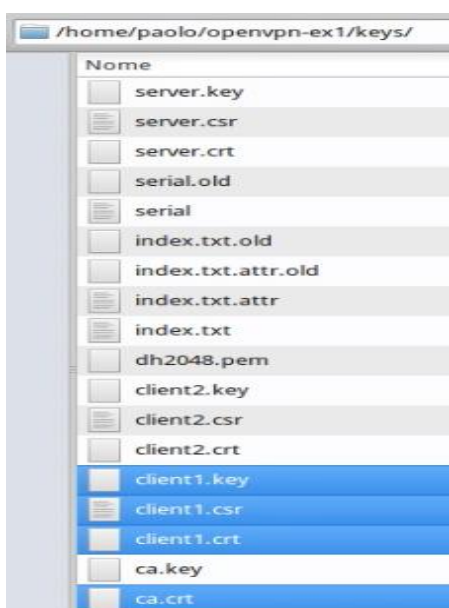
sostituire con:

```
# server's tun/tap interface  
|client-to-client  
# Uncomment this directive
```

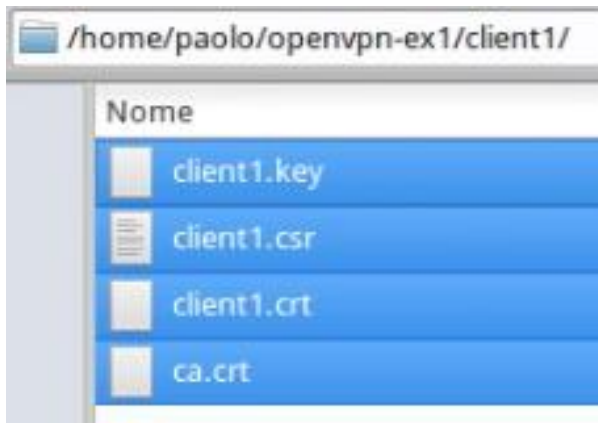
### Configurazione Client1

tornare nella cartella keys e copiare:

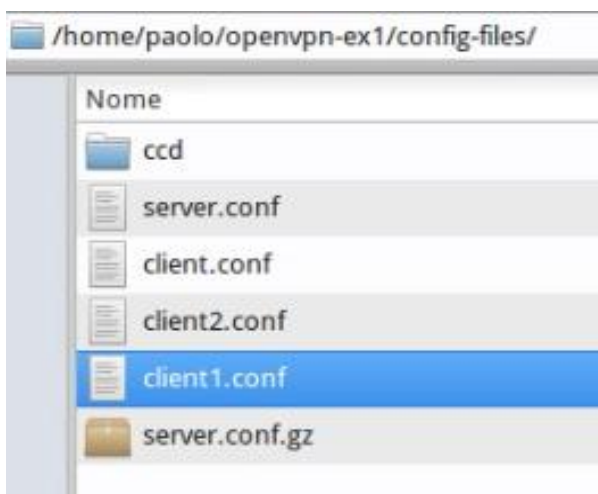
client1.key client1.csr client1.crt ca.crt



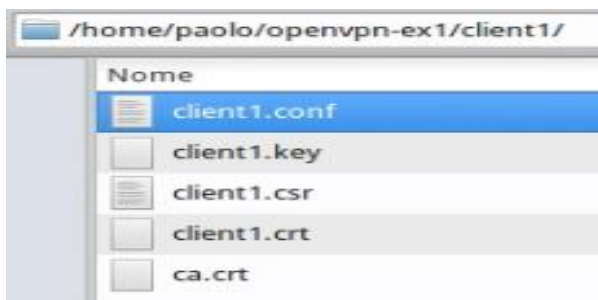
e copiarli all'interno della cartella client1



andare all'interno della cartella config-files e copiare il file client1.conf



copiare il file client1.conf all'interno della cartella client1



aprire client1.conf e sostituire:

```
ca ca.crt
cert client.crt
key client.key
```

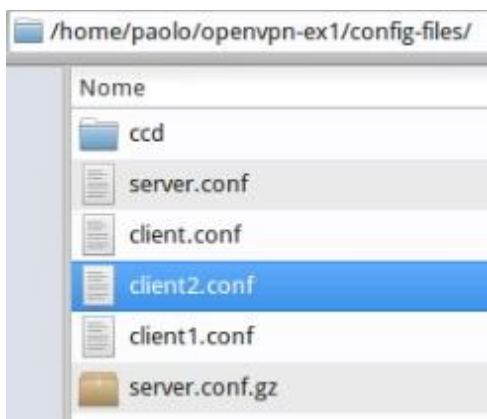
con:

```
ca ca.crt
cert client1.crt
key client1.key
```

### Configurazione Client2



andare all'interno della cartella config-files e copiare il file client2.conf

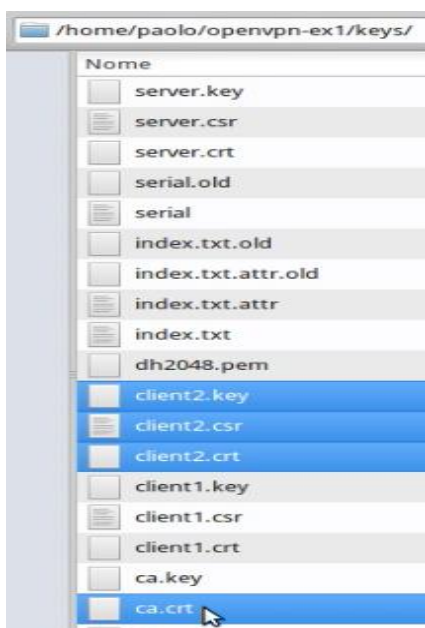


copiare il file client2.conf all'interno della cartella client2

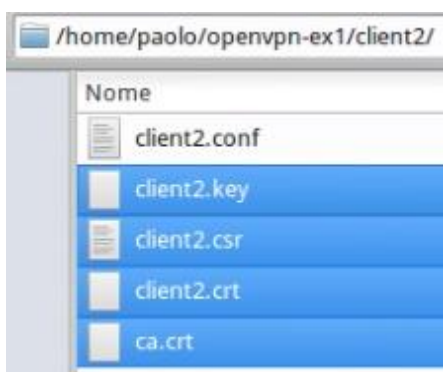


tornare nella cartella keys e copiare:

client2.key client2.csr client2.crt ca.crt



copiare il tutto all'interno della cartella client2



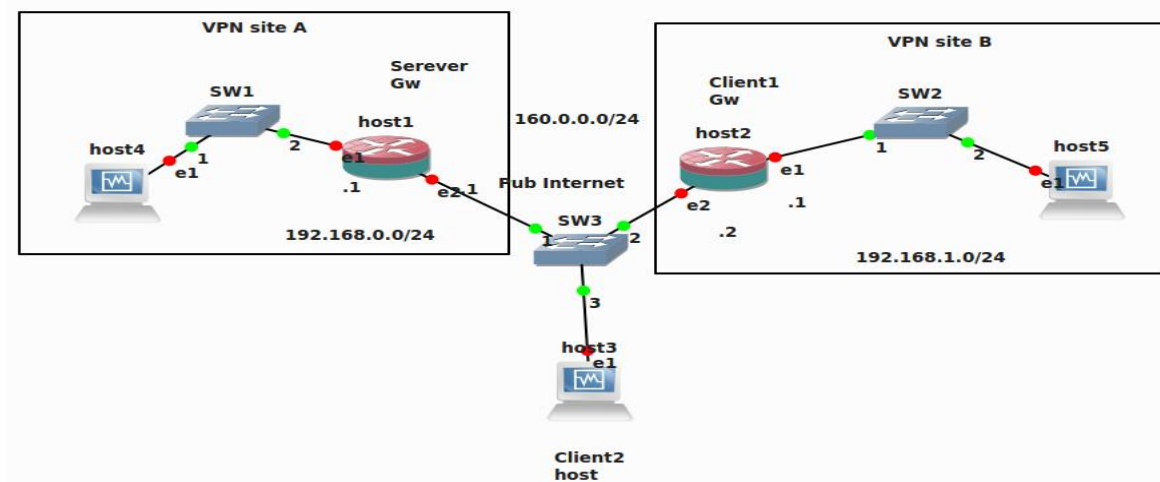
aprire client2.conf e sostituire

```
ca ca.crt  
cert client.crt  
key client.key
```

con:

```
ca ca.crt  
cert client2.crt  
key client2.key
```

## VPN



assicurarsi di avere installato sul proprio pc 'openssh-server' altrimenti da terminale date il seguente comando:

```
paolo@paolo-Aspire-5750G:~$ sudo apt-get install openssh-server
```

### configurazione Host1

box login: tc

```
tc@box:~$ ip a s
```

```
tc@box:~$ ip a s
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 16436 qdisc noqueue state
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
    inet6 ::1/128 scope host
        valid_lft forever preferred_lft forever
2: dummy0: <BROADCAST,NOARP> mtu 1500 qdisc noop state DOWN
    link/ether 56:29:29:fe:4a:54 brd ff:ff:ff:ff:ff:ff
3: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc p
    link/ether 08:00:27:6f:78:b2 brd ff:ff:ff:ff:ff:ff
    inet 10.0.2.15/24 brd 10.0.2.255 scope global eth0
    inet6 fe80::a00:27ff:fe6f:78b2/64 scope link
        valid_lft forever preferred_lft forever
4: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc p
    link/ether 08:00:27:0e:92:b0 brd ff:ff:ff:ff:ff:ff
    inet6 fe80::a00:27ff:fe0e:92b0/64 scope link
        valid_lft forever preferred_lft forever
5: eth2: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc p
```

```
tc@box:~$ route -n
```

```
tc@box:~$ route -n
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
0.0.0.0 10.0.2.2 0.0.0.0 UG 0 0 0 eth0
10.0.2.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0
127.0.0.1 0.0.0.0 255.255.255.255 UH 0 0 0 lo
tc@box:~$
```

```
tc@box:~$ scp -r paolo@10.0.2.2:/home/paolo/opencvn-ex1/server ./
```

```
tc@box:~$ scp -r paolo@10.0.2.2:/home/paolo/opencvn-ex1/server ./
paolo@10.0.2.2's password:
dh2048.pem 100% 424 0.4KB/s 00:00
server.csr 100% 1098 1.1KB/s 00:00
server.conf 100% 10KB 10.1KB/s 00:00
client1 100% 32 0.0KB/s 00:00
server.key 100% 1704 1.7KB/s 00:00
server.crt 100% 5728 5.6KB/s 00:00
ca.crt 100% 1818 1.8KB/s 00:00
tc@box:~$
```

```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.1/24 dev eth1
root@box:~# ip a a 160.0.0.1/24 dev eth2
root@box:~# echo 1 > /proc/sys/net/ipv4/ip_forward
root@box:~# exit
tc@box:~$ screen
tc@box:~$ cd server/
tc@box:~/server$ sudo openvpn server.conf
```

```
tc@box:~/server$ sudo openvpn server.conf
Fri Jan 23 23:16:35 2015 OpenVPN 2.2.2 i686-pc-linux-gnu [SSL] [LZO2] [EPOLL] [PKCS11] [eurephia] built on Mar  9 20
12
Fri Jan 23 23:16:35 2015 NOTE: OpenVPN 2.1 requires '--script-security 2' or higher to call user-defined scripts or
executables
Fri Jan 23 23:16:35 2015 Diffie-Hellman initialized with 2048 bit key
Fri Jan 23 23:16:35 2015 TLS-Auth MTU parms [ L:1542 D:138 EF:38 EB:0 ET:0 EL:0 ]
Fri Jan 23 23:16:35 2015 Socket Buff
ers: R=[112640->131072] S=[112640->131072]
Fri Jan 23 23:16:35 2015 ROUTE default_gateway=10.0.2.2
Fri Jan 23 23:16:35 2015 TUN/TAP device tun0 opened
Fri Jan 23 23:16:35 2015 TUN/TAP TX queue length set to 100
Fri Jan 23 23:16:35 2015 /usr/local/sbin/ip link set dev tun0 up mtu 1500
Fri Jan 23 23:16:35 2015 /usr/local/sbin/ip addr add dev tun0 local 10.8.0.1 peer 10.8.0.2
Fri Jan 23 23:16:35 2015 /usr/local/sbin/ip route add 192.168.1.0/24 via 10.8.0.2
Fri Jan 23 23:16:35 2015 /usr/local/
sbin/ip route add 10.8.0.0/24 via 10.8.0.2
Fri Jan 23 23:16:35 2015 Data Channel MTU parms [ L:1542 D:1450 EF:42 EB:135 ET:0 EL:0 AF:3/1 ]
Fri Jan 23 23:16:35 2015 UDPv4 link local (bound): [undef]:1194
Fri Jan 23 23:16:35 2015 UDPv4 link remote: [undef]
Fri Jan 23 23:16:35 2015 MULTI: multi_init called, r=256 v=256
Fri Jan 23 23:16:35 2015 IFCONFIG POOL: base=10.8.0.4 size=62
Fri Jan 23 23:16:35 2015 IFCONFIG POOL LIST
Fri Jan 23 23:16:35 2015 Initialization Sequence Completed
```

//e lasciare così in maniera tale che il server sia acceso//  
muoversi tra le bash di screen tramite Ctrl+A N o Ctrl+A C  
tc@box:~\$ route -n

```
tc@box:~$ route -n
Kernel IP routing table
Destination Gateway Genmask Flags Metric Ref Use Iface
0.0.0.0 10.0.2.2 0.0.0.0 UG 0 0 0 eth0
10.0.2.0 0.0.0.0 255.255.255.0 U 0 0 0 eth0
10.8.0.0 10.8.0.2 255.255.255.0 UG 0 0 0 tun0
10.8.0.2 0.0.0.0 255.255.255.255 UH 0 0 0 tun0
127.0.0.1 0.0.0.0 255.255.255.255 UH 0 0 0 lo
160.0.0.0 0.0.0.0 255.255.255.0 U 0 0 0 eth2
192.168.0.0 0.0.0.0 255.255.255.0 U 0 0 0 eth1
192.168.1.0 10.8.0.2 255.255.255.0 UG 0 0 0 tun0
```

tc@box:~\$ ping -I 192.168.0.1 192.168.1.1

```
tc@box:~$ ping -I 192.168.0.1 192.168.1.1
PING 192.168.1.1 (192.168.1.1) from 192.168.0.1: 56 data bytes

--- 192.168.1.1 ping statistics ---
3 packets transmitted, 0 packets received, 100% packet loss
```

tc@box:~\$ cd server  
tc@box:~/server\$ ls

```
tc@box:~/server$ ls
ca.crt          ipp.txt        server.crt
cd/            openvpn-status.log  server.csr
dh2048.pem     server.conf    server.key
```

tc@box:~/server\$ sudo cat openvpn-status.log

```
tc@box:~/server$ sudo cat openvpn-status.log
OpenVPN CLIENT LIST
Updated,Fri Jan 23 23:34:23 2015
Common Name,Real Address,Bytes Received,Bytes Sent,Connected Since
ROUTING TABLE
Virtual Address,Common Name,Real Address,Last Ref
GLOBAL STATS
Max broadcast/mcast queue length,0
END
tc@box:~/server$
```

## configurazione Host 2

box login: tc

tc@box:~\$ scp -r paolo@10.0.2.2:/home/paolo/openvpn-ex1/client1 ./

```
tc@box:~$ scp -r paolo@10.0.2.2:/home/paolo/openvpn-ex1/client1 ./
The authenticity of host '10.0.2.2 (10.0.2.2)' can't be established.
ECDSA key fingerprint is c7:51:2a:bf:b5:b9:4a:84:12:90:dd:10:4b:b2:67:aa.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '10.0.2.2' (ECDSA) to the list of known hosts.
paolo@10.0.2.2's password:
client1.csr                                100% 1102      1.1KB/s   00:00
client1.conf                               100% 3427      3.4KB/s   00:00
client1.crt                                100% 5612      5.5KB/s   00:00
client1.key                                 100% 1708      1.7KB/s   00:00
ca.crt                                      100% 1818      1.8KB/s   00:00
tc@box:~$ █
```

tc@box:~\$ sudo su

root@box:~# ip a a 192.168.1.1/24 dev eth1

root@box:~# ip a a 160.0.0.2/24 dev eth2

root@box:~# ping 160.0.0.1

root@box:~# echo 1 > /proc/sys/net/ipv4/ip\_forward

root@box:~# exit

tc@box:~\$ screen

tc@box:~\$ cd client1

tc@box:~/client1\$ openvpn client1.conf

*//con openvpn client1.conf non abilitato//*

tc@box:~\$ route -n

```
tc@box:~$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         10.0.2.2       0.0.0.0        UG    0      0      0 eth0
10.0.2.0        0.0.0.0        255.255.255.0  U     0      0      0 eth0
127.0.0.1      0.0.0.0        255.255.255.255 UH    0      0      0 lo
160.0.0.0      0.0.0.0        255.255.255.0  U     0      0      0 eth2
192.168.1.0    0.0.0.0        255.255.255.0  U     0      0      0 eth1
```

*//con openvpn client1.conf abilitato//*

tc@box:~\$ route -n

```
tc@box:~$ route -n
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         10.0.2.2       0.0.0.0        UG    0      0      0 eth0
10.0.2.0        0.0.0.0        255.255.255.0  U     0      0      0 eth0
10.8.0.0        10.8.0.5       255.255.255.0  UG    0      0      0 tun0
10.8.0.5        0.0.0.0        255.255.255.255 UH    0      0      0 tun0
127.0.0.1      0.0.0.0        255.255.255.255 UH    0      0      0 lo
160.0.0.0      0.0.0.0        255.255.255.0  U     0      0      0 eth2
192.168.0.0    10.8.0.5       255.255.255.0  UG    0      0      0 tun0
192.168.1.0    0.0.0.0        255.255.255.0  U     0      0      0 eth1
tc@box:~$ █
```

su Host 1 *con client1.conf attivo*, ridigitiamo:

tc@box:~/server\$ sudo cat openvpn-status.log

```
tc@box:~/server$ sudo cat openvpn-status.log
OpenVPN CLIENT LIST
Updated,Fri Jan 23 23:56:48 2015
Common Name,Real Address,Bytes Received,Bytes Sent,Connected Since
client1,160.0.0.2:39408,6723,8481,Fri Jan 23 23:53:43 2015
ROUTING TABLE
Virtual Address,Common Name,Real Address,Last Ref
192.168.1.0/24,client1,160.0.0.2:39408,Fri Jan 23 23:53:44 2015
10.8.0.6,client1,160.0.0.2:39408,Fri Jan 23 23:53:44 2015
GLOBAL STATS
Max bcst/mcast queue length,0
END
tc@box:~/server$ █
```

**configurazione Host 4**

```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.2/24 dev eth1
root@box:~# ip r a 192.168.0.0/16 via 192.168.0.1
root@box:~# ping 192.168.1.2
root@box:~# ip r a 10.8.0.0/24 via 192.168.0.1
```

**configurazione Host 5**

```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.1.2/24 dev eth1
root@box:~# ip r a 192.168.0.0/16 via 192.168.1.1
root@box:~# ip r a 10.8.0.0/24 via 192.168.1.1
```

**configurazione Host 3**

```
tc@box:~$ sudo su
root@box:~# ip a a 160.0.0.3/24 dev eth1
root@box:~# exit
tc@box:~$ scp -r paolo@10.0.2.2:/home/paolo/openvpn-ex1/client2 ./
```

```
tc@box:~$ scp -r paolo@10.0.2.2:/home/paolo/openvpn-ex1/client2 ./
The authenticity of host '10.0.2.2 (10.0.2.2)' can't be established.
ECDSA key fingerprint is c7:51:2a:bf:b5:b9:4a:84:12:90:dd:10:4b:b2:67:aa.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '10.0.2.2' (ECDSA) to the list of known hosts.
paolo@10.0.2.2's password:
client2.csr                100% 1102      1.1KB/s   00:00
client2.crt                100% 5612      5.5KB/s   00:00
client2.key                100% 1704      1.7KB/s   00:00
client2.conf               100% 3427      3.4KB/s   00:00
ca.crt                     100% 1818      1.8KB/s   00:00
tc@box:~$
```

```
tc@box:~$ screen
tc@box:~$ cd client2/
tc@box:~/client2$ sudo openvpn client2.conf
```

//digitare Ctrl+a c per creare una nuova bash screen//

```
tc@box:~$ ip r s
```

```
tc@box:~$ ip r s
default via 10.0.2.2 dev eth0
10.0.2.0/24 dev eth0 proto kernel scope link src 10.0.2.15
10.8.0.0/24 via 10.8.0.9 dev tun0
10.8.0.9 dev tun0 proto kernel scope link src 10.8.0.10
127.0.0.1 dev lo scope link
160.0.0.0/24 dev eth1 proto kernel scope link src 160.0.0.3
192.168.0.0/24 via 10.8.0.9 dev tun0
192.168.1.0/24 via 10.8.0.9 dev tun0
tc@box:~$
```

```
tc@box:~$ ifconfig tun0
```

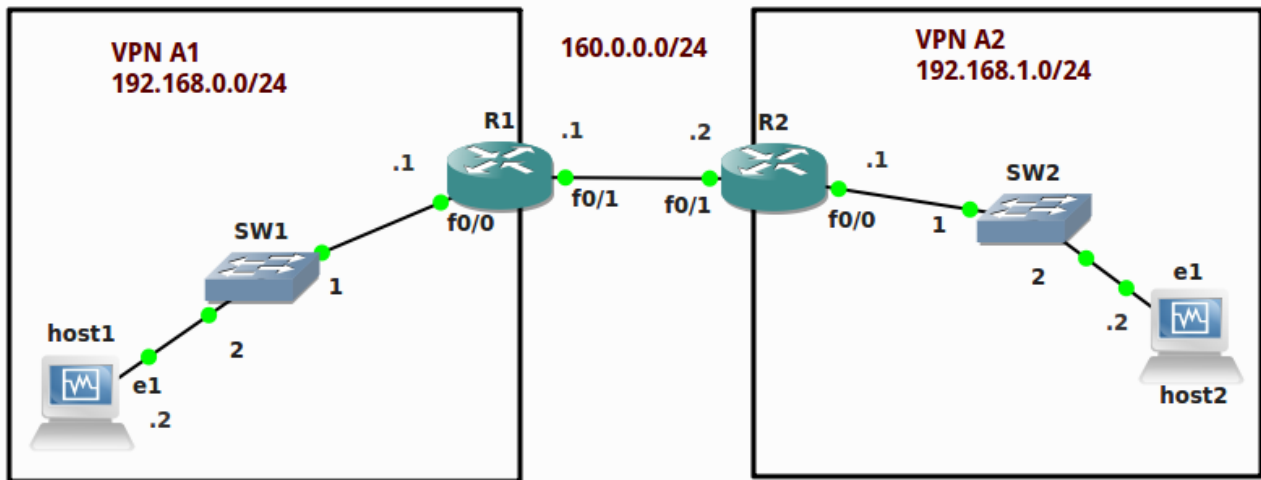
```
tc@box:~$ ifconfig tun0
tun0    Link encap:UNSPEC  HWaddr 00-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00
-00

    inet addr:10.8.0.10 P-t-P:10.8.0.9 Mask:255.255.255.255
UP POINTOPOINT RUNNING NOARP MULTICAST MTU:1500 Metric:1
RX packets:0 errors:0 dropped:0 overruns:0 frame:0
TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
collisions:0 txqueuelen:100
RX bytes:0 (0.0 B) TX bytes:0 (0.0 B)
```

```
tc@box:~$ ping 192.168.0.2
```

```
tc@box:~$ ping 192.168.1.2
```

## IPSec



### Configurazione Router R1

```
R1#conf t
```

```
R1(config)#crypto ipsec transform-set mts esp-aes
```

```
R1(cfg-crypto-trans)#mode transport
```

```
R1(cfg-crypto-trans)#exit
```

```
R1(config)#crypto map mcmmap 1 ipsec-manual
```

```
R1(config-crypto-map)#set peer 160.0.0.2
```

// utilizzare il terminale per creare la chiave cifrata //

```

Terminale - paolo@paolo-Aspire-5750G: ~
File Modifica Visualizza Terminale Schede Aiuto
paolo@paolo-Aspire-5750G:~$ dd if=/dev/random count=16 bs=1 | xxd -ps
16+0 record dentro
16+0 record fuori
16 byte (16 B) copiati, 0,000181752 s, 88,0 kB/s
6e073a921ccfc34278f2869cb15e9ca9
paolo@paolo-Aspire-5750G:~$

```

```
R1(config-crypto-map)#set session-key inbound esp 1000 cipher
```

```
6e073a921ccfc34278f2869cb15e9ca9
```

```
R1(config-crypto-map)#set session-key outbound esp 1001 cipher
```

```
6e073a921ccfc34278f2869cb15e9ca9
```

```
R1(config-crypto-map)#set transform-set mts
```

```
R1(config-crypto-map)#match address 100
```

```
R1(config-crypto-map)#exit
```

```
R1(config)#int tunnel 12
```

```
R1(config-if)#ip address 10.0.12.1 255.255.255.0
```

```
R1(config-if)#ip ospf network point-to-point
```

```
R1(config-if)#tunnel source 160.0.0.1
```

```
R1(config-if)#tunnel destination 160.0.0.2
```

```
R1(config-if)#exit
```

```
R1(config)#int f0/0
```

```
R1(config-if)#ip address 192.168.0.1 255.255.255.0
```

```
R1(config-if)#no shut
```

```
R1(config-if)#exit
```

```
R1(config)#int f0/1
```

```
R1(config-if)#ip address 160.0.0.1 255.255.255.0
```

```
R1(config-if)#no shut
```

```
R1(config-if)#crypto map mcmmap
```

```
R1(config-if)#exit
```

```
R1(config)#router ospf 1
```

```
R1(config-router)#router-id 1.1.1.1
```

```
R1(config-router)#network 10.0.12.1 0.0.0.0 area 1
```

```
R1(config-router)#network 192.168.0.0 0.0.0.255 area 1
```

```
R1(config-router)#exit
```

```
R1(config)#access-list 100 permit ip host 160.0.0.1 host 160.0.0.2
```

```
R1(config)#access-list 100 permit ip host 160.0.0.2 host 160.0.0.1
```

```
R1#ping 192.168.1.1 source 192.168.0.1
```

```
R1#ping 192.168.1.1 source 192.168.0.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 192.168.1.1, timeout is 2 seconds:
Packet sent with a source address of 192.168.0.1
!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 16/20/24 ms
R1#
```

```
R1#show interface tunnel 12
```

```
R1#show interface tunnel 12
Tunnel12 is up, line protocol is up
  Hardware is Tunnel
  Internet address is 10.0.12.1/24
  MTU 1514 bytes, BW 9 Kbit/sec, DLY 500000 usec,
    reliability 255/255, txload 1/255, rxload 1/255
  Encapsulation TUNNEL, loopback not set
  Keepalive not set
  Tunnel source 160.0.0.1, destination 160.0.0.2
  Tunnel protocol/transport GRE/IP
  Key disabled, sequencing disabled
  Checksumming of packets disabled
  Tunnel TTL 255
```

```
R1#show ip route
```

```
R1#show ip route
Codes: 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
       i - IS-IS, su - IS-IS summary, 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

 160.0.0.0/24 is subnetted, 1 subnets
C       160.0.0.0 is directly connected, FastEthernet0/1
 10.0.0.0/24 is subnetted, 1 subnets
C       10.0.12.0 is directly connected, Tunnel12
C       192.168.0.0/24 is directly connected, FastEthernet0/0
O       192.168.1.0/24 [110/11121] via 10.0.12.2, 00:45:00, Tunnel12
R1#
```



R1#show crypto engine connections active

```
R1#show crypto engine connections active
```

ID	Interface	IP-Address	State	Algorithm	Encrypt	Decrypt
2001	FastEthernet0/1	160.0.0.1	set	3DES	0	578
2002	FastEthernet0/1	160.0.0.1	set	3DES	845	0

## Configurazione Router R2

R2#conf t

R2(config)#crypto ipsec transform-set mts esp-aes

R2(cfg-crypto-trans)#mode transport

R2(cfg-crypto-trans)#exit

R2(config)#crypto map mcmmap 1 ipsec-manual

R2(config-crypto-map)#set peer 160.0.0.1

R2(config-crypto-map)#set session-key inbound esp 1001 ci

R2(config-crypto-map)#set session-key inbound esp 1001 cipher  
6e073a921ccfc34278f2869cb15e9ca9

R2(config-crypto-map)#set session-key outbound esp 1000 cipher  
6e073a921ccfc34278f2869cb15e9ca9

R2(config-crypto-map)#set transform-set mts

R2(config-crypto-map)#match address 100

R2(config-crypto-map)#exit

R2(config)#int tunnel 21

R2(config-if)#ip address 10.0.12.2 255.255.255.0

R2(config-if)#tunnel source 160.0.0.2

R2(config-if)#tunnel destination 160.0.0.1

R2(config-if)#exit

R2(config)#int f0/0

R2(config-if)#ip address 192.168.1.1 255.255.255.0

R2(config-if)#no shut

R2(config-if)#exit

R2(config)#int f0/1

R2(config-if)#ip address 160.0.0.2 255.255.255.0

R2(config-if)#no shut

R2(config-if)#crypto map mcmmap

R2(config-if)#exit

R2(config)#router ospf 1

R2(config-router)#router-id 2.2.2.2

R2(config-router)#network 10.0.12.2 0.0.0.0 area 1

R2(config-router)#network 192.168.1.0 0.0.0.255 area 1

R2(config-router)#exit

R2(config)#access-list 100 permit ip host 160.0.0.2 host 160.0.0.1

R2(config)#access-list 100 permit ip host 160.0.0.1 host 160.0.0.2

```
R2(config)#end
```

### Configurazione Host1

```
box login: tc
tc@box:~$ sudo su
root@box:~# ip a a 192.168.0.2/24 dev eth1
root@box:~# ip r a 192.168.0.0/16 via 192.168.0.1
root@box:~# ping 192.168.1.2
```

### Configurazione Host2

```
tc@box:~$ sudo su
root@box:~# ip a a 192.168.1.2/24 dev eth1
root@box:~# ip r a 192.168.0.0/16 via 192.168.1.1
```

//per provare IPsec facciamo un ping da uno dei due Host ed effettuiamo una cattura del traffico tra R1 e R2, con Wireshark osserveremo pacchetti incapsulati ESP come da teoria//

```
host2
root@box:~# ping 192.168.0.2
PING 192.168.0.2 (192.168.0.2): 56 data bytes
64 bytes from 192.168.0.2: seq=1 ttl=62 time=34.181 ms
64 bytes from 192.168.0.2: seq=2 ttl=62 time=39.365 ms
64 bytes from 192.168.0.2: seq=3 ttl=62 time=39.001 ms
64 bytes from 192.168.0.2: seq=4 ttl=62 time=36.315 ms
64 bytes from 192.168.0.2: seq=5 ttl=62 time=33.314 ms
64 bytes from 192.168.0.2: seq=6 ttl=62 time=42.099 ms
64 bytes from 192.168.0.2: seq=7 ttl=62 time=40.047 ms
64 bytes from 192.168.0.2: seq=8 ttl=62 time=39.010 ms
```

No.	Time	Source	Destination	Protocol	Length	Info
7	12.408842000	160.0.0.1	160.0.0.2	ESP	154	ESP (SPI=0x000003e9)
8	14.526982000	160.0.0.2	160.0.0.1	ESP	154	ESP (SPI=0x000003e8)
9	19.998303000	c4:00:1d:82:00:01	c4:00:1d:82:00:01	LOOP	60	Reply
10	21.351040000	c4:01:1d:82:00:01	c4:01:1d:82:00:01	LOOP	60	Reply
11	22.431178000	160.0.0.1	160.0.0.2	ESP	154	ESP (SPI=0x000003e9)
12	24.418514000	160.0.0.2	160.0.0.1	ESP	154	ESP (SPI=0x000003e8)
13	24.529647000	160.0.0.2	160.0.0.1	ESP	154	ESP (SPI=0x000003e8)
14	25.397764000	160.0.0.2	160.0.0.1	ESP	154	ESP (SPI=0x000003e8)
15	25.417947000	160.0.0.1	160.0.0.2	ESP	154	ESP (SPI=0x000003e9)
16	26.405841000	160.0.0.2	160.0.0.1	ESP	154	ESP (SPI=0x000003e8)
17	26.425989000	160.0.0.1	160.0.0.2	ESP	154	ESP (SPI=0x000003e9)
18	27.407707000	160.0.0.2	160.0.0.1	ESP	154	ESP (SPI=0x000003e8)
19	27.428009000	160.0.0.1	160.0.0.2	ESP	154	ESP (SPI=0x000003e9)
20	28.407434000	160.0.0.2	160.0.0.1	ESP	154	ESP (SPI=0x000003e8)
21	28.427693000	160.0.0.1	160.0.0.2	ESP	154	ESP (SPI=0x000003e9)
22	29.406096000	160.0.0.2	160.0.0.1	ESP	154	ESP (SPI=0x000003e8)
23	29.426428000	160.0.0.1	160.0.0.2	ESP	154	ESP (SPI=0x000003e9)
24	30.012028000	c4:00:1d:82:00:01	c4:00:1d:82:00:01	LOOP	60	Reply
25	30.415473000	160.0.0.2	160.0.0.1	ESP	154	ESP (SPI=0x000003e8)
26	30.435756000	160.0.0.1	160.0.0.2	ESP	154	ESP (SPI=0x000003e9)

▶ Frame 1: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface 0  
 ▶ Ethernet II, Src: c4:00:1d:82:00:01 (c4:00:1d:82:00:01), Dst: c4:00:1d:82:00:01 (c4:00:1d:82:00:01)  
 ▶ Configuration Test Protocol (loopback)  
 ▶ Data (40 bytes)

## PROMEMORIA

- `conf t` (abbreviazione di: config terminal) → serve per entrare nella modalità di configurazione del router CISCO;
- `end` (o `CTRL+C`) → serve per uscire dalla modalità di configurazione;
- per lanciare i comandi di troubleshooting:
  - nella modalità di configur terminal anteporre il “do” (ad es.: `do show ip route`);
  - fuori dalla modalità configur terminal non bisogna mettere il “do” (ad es.: `show ip route`);
- se non dovessimo ricordare come completare il comando utilizzare l’help tramite il punto interrogativo “?” per chiudere velocemente la lista che si aprirà digitare un qualunque tasto

```

R1#show ip route ?
hostname or A.B.C.D  Network to display information about or hostname
bgp                 Border Gateway Protocol (BGP)
connected          Connected
dhcp               Show routes added by DHCP Server or Relay
eigrp              Enhanced Interior Gateway Routing Protocol (EIGRP)
isis               ISD IS-IS
list               IP Access list
mobile             Mobile routes
ospf               Open Shortest Path First (OSPF)

```

- per terminare un `ping` premere “`CTRL+C`”
- per terminare il `traceroute` premere “`CRT+6`”
- per salvare la configurazione del terminale: uscire dalla modalità configur terminal, digitare “`copy running-configuration startup-configuration`”, premere invio per due volte e salvare il progetto su GNS3
- per completare automaticamente una parola utilizzare il tasto TAB (le doppie frecce accanto alla lettera Q)
- per vedere la configurazione del terminale possiamo:
  - digitare “`show running-config`” oppure “`do show running-config`”
  - oppure tasto destro sull’icona del terminale e selezionare “`startup-config`”
- per cambiare il nome del dispositivo, tasto destro e selezionare “`change the hostname`”
- per aggiungere nuove interfacce sul dispositivo, tasto destro, configure e slot
- se dovessimo cambiare più nomi o aggiungere più interfacce su più dispositivi:
  - selezionare tramite il mouse, o tramite riquadro (come facevamo sul desktop di windows XP), i dispositivi e ripetere i penultimi due punti
- per tutti i comandi si può utilizzare l’abbreviazione (ad es. `show running-config` → `show run` )
- Comandi SCREEN:

Ctrl+a n	ci muoviamo tra gli screen
Ctrl+a p	
Ctrl+a c	creiamo un nuovo screen
Ctrl+a “	fa vedere le schermate aperte
Ctrl+a S	creo il multiscreen
Ctrl+a tab	ci muoviamo tra le diverse schermate
Exit	chiudiamo una bash
Ctrl+a Q	elimina gli split ma lascia solo la sessione da cui si lancia il comando

Per tutto il resto c’è [GOOGLE](#) !!!

## CONFIGURAZIONE GNS3 & VIRTUALBOX

L'installazione semplice è quella tramite "Ubuntu Software Center" anche se utilizza una versione vecchiotta di GNS3.

Da "Ubuntu Software Center" installare "GNS3" e "VirtualBox".

### Aprire GNS3:

- selezionare:
  - edit
  - IOS images and
  - image file...caricare il file.image nel nostro caso c3745
  - apri
  - save (compare una riga nel menu image)
  - base confing: selezionare baseconfinf.txt (in modo da visualizzare tutto il percorso)
  - auto calculatation
  - save
  - test setting
  - close
  
- selezionare:
  - l'icona di virtual box (Show VirtualBox Manager)
  - file
  - importa applicazione virtuale
  - selezioniamo l'applicazione (base.ova)
  - avanti
  - inizializza nuovamente l'indirizzo MAC di tutte le schede di rete
  - importa
  - avremo la nostra prima macchina virtuale chiamata "base"
  - diamo avvia (la freccia verde che punta a destra)
  - inserendo "tc" effettuiamo il login alla macchina virtuale
  - per spengere la macchina andiamo su "base" tasto destro, chiudi, spegni, spegni
  - sempre tasto destro su base, clona
  - host1, inizializza, avanti, clone completo, clona
  - ripetere per il numero di host da realizzare
  - chiudi
  
- edit
  - preference
  - virtual box
  - test setting
  
- virtualbox guest

- refresh vm list
- vm list:host1
- identifier name: host1
- spuntare tutte le voci tranne "show advanced options"
- save
- ripetere per tutti gli host cambiando il nome
- chiudere
  
- edit
  - preferences
  - terminal settings (se utilizzate ubuntu lasciare gnome terminal) (con altre versioni xterm) selezionare Use apply
  - yes
  - ok

Verificare il corretto funzionamento:

- mettere due host
- collegarli
- selezionare play
- tasto dx sui due host
- selezionare console
- si dovrebbero aprire i terminali

