

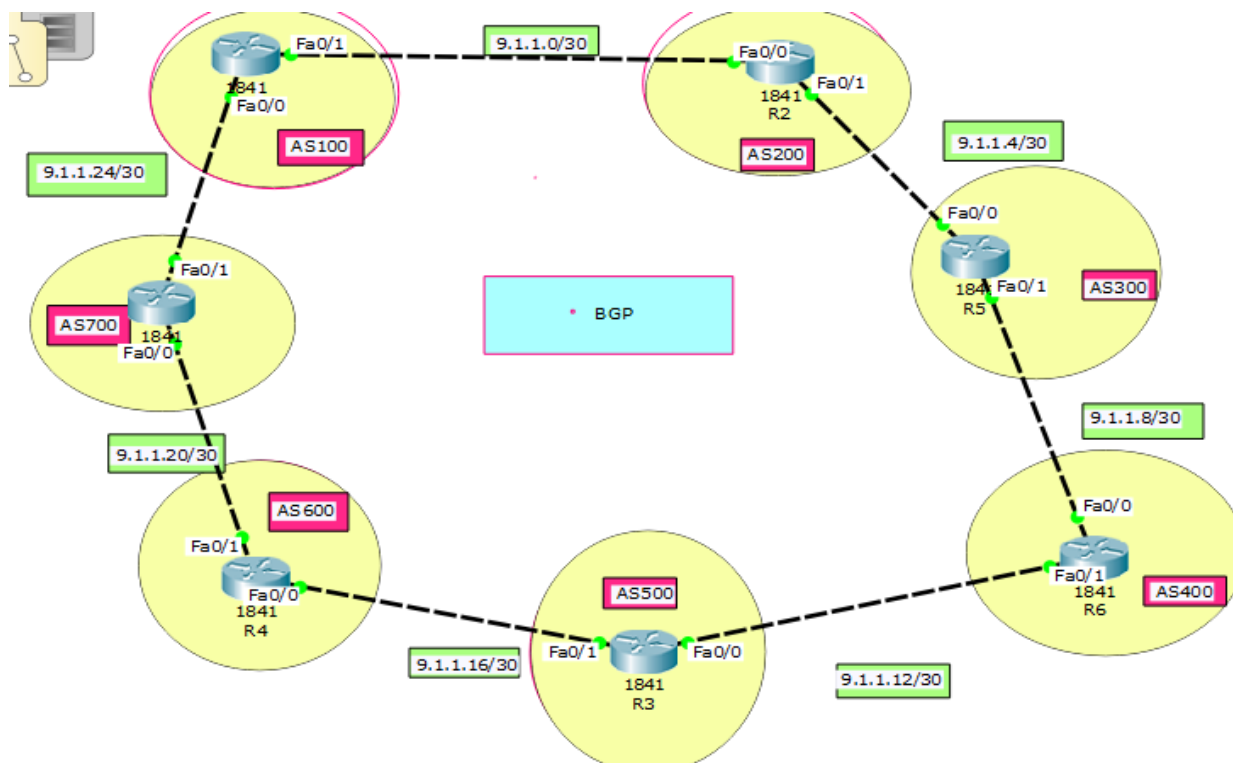
ESERCITAZIONE: il protocollo BGP (Border gateway protocol)

Obiettivi:

- Configurare il routing dinamico con il protocollo BGP di una rete di sette router di confine (*border gateway*) di sette sistemi autonomi.
- Apprendere i comandi specifici di configurazione BGP.
- Saper analizzare la tabella di instradamento creata dal BGP (*show ip route*).
- Saper analizzare la tabella di path creata dal BGP (*show ip bgp*).

FASE I

1. Creare una rete di sette router di confine (*border gateway*) dei sette sistemi autonomi AS100, AS200, AS300, AS400, AS500, AS600, AS700.
2. Fare il piano di indirizzamento IP 9.1.1.0 (router serie 1841).



3. Per configurare il Border Gateway Protocol si utilizzano i comandi specifici:

```
router bgp 100      //100 (o un altro numero) è il numero di AS a cui appartiene il router

neighbor 9.1.1.2 remote-as 200  //indicare la porta (IP address) del ciascun router-neighbor
                                e il numero del sistema autonomo remoto a cui appartiene questo router
.....
network 9.1.1.0 mask 255.255.255.252  //indicare le reti collegate direttamente
.....
```

Nel nostro caso, tutti i router avranno due porte configurate, quindi due vicini (*neighbor*) e, di conseguenza, due reti indicate.

FASE II

4. Sull'esempio di configurazione dei router R1 e R2, configurare i router R5, R6, R3, R4, R0.
5. Fare le prove di ping tra i router che devono andare a buon fine.
6. Dopo aver completato la configurazione di tutti i router, eseguire il comando **show ip route** su ciascun router, incollare gli screenshot su un file .doc, confrontare con le immagini fornite.

Prestare l'attenzione alla corretta configurazione:

- Devono essere indicate 7 subnet, di cui 2 connesse direttamente ("C") e 5 tramite BGP ("B").
- Prestare l'attenzione all'ordine delle sottoreti e ai next hop.

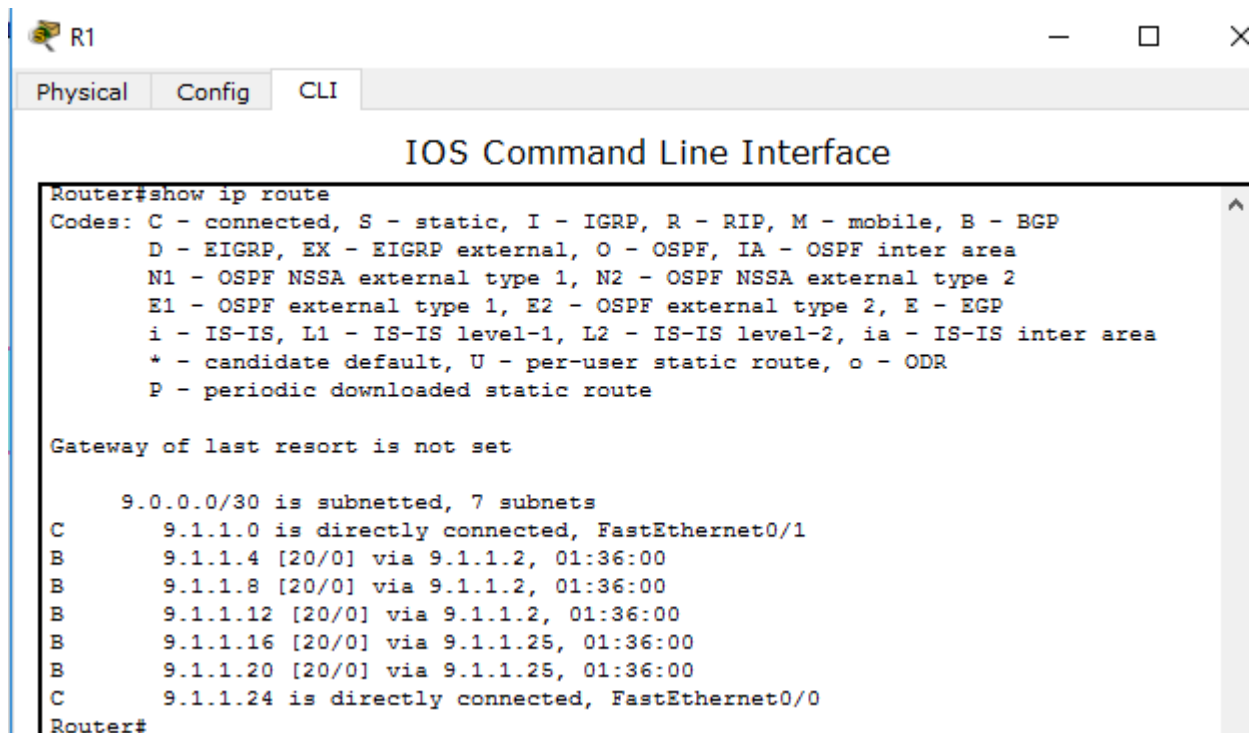
R1

```

interface FastEthernet0/0
ip address 9.1.1.26 255.255.255.252
!
interface FastEthernet0/1
ip address 9.1.1.1 255.255.255.252
!
router bgp 100
neighbor 9.1.1.2 remote-as 200
neighbor 9.1.1.25 remote-as 700
network 9.1.1.0 mask 255.255.255.252
network 9.1.1.24 mask 255.255.255.252

```

Dopo aver completato la configurazione **di tutti i router**, la tabella di instradamento di **R1** sarà:



The screenshot shows the CLI of router R1 with the 'show ip route' command executed. The output displays the routing table, including codes for various route types, a message about the gateway of last resort, and a list of subnets for 9.0.0.0/30. The routes shown are:

- 9.1.1.0 is directly connected, FastEthernet0/1
- 9.1.1.4 [20/0] via 9.1.1.2, 01:36:00
- 9.1.1.8 [20/0] via 9.1.1.2, 01:36:00
- 9.1.1.12 [20/0] via 9.1.1.2, 01:36:00
- 9.1.1.16 [20/0] via 9.1.1.25, 01:36:00
- 9.1.1.20 [20/0] via 9.1.1.25, 01:36:00
- 9.1.1.24 is directly connected, FastEthernet0/0

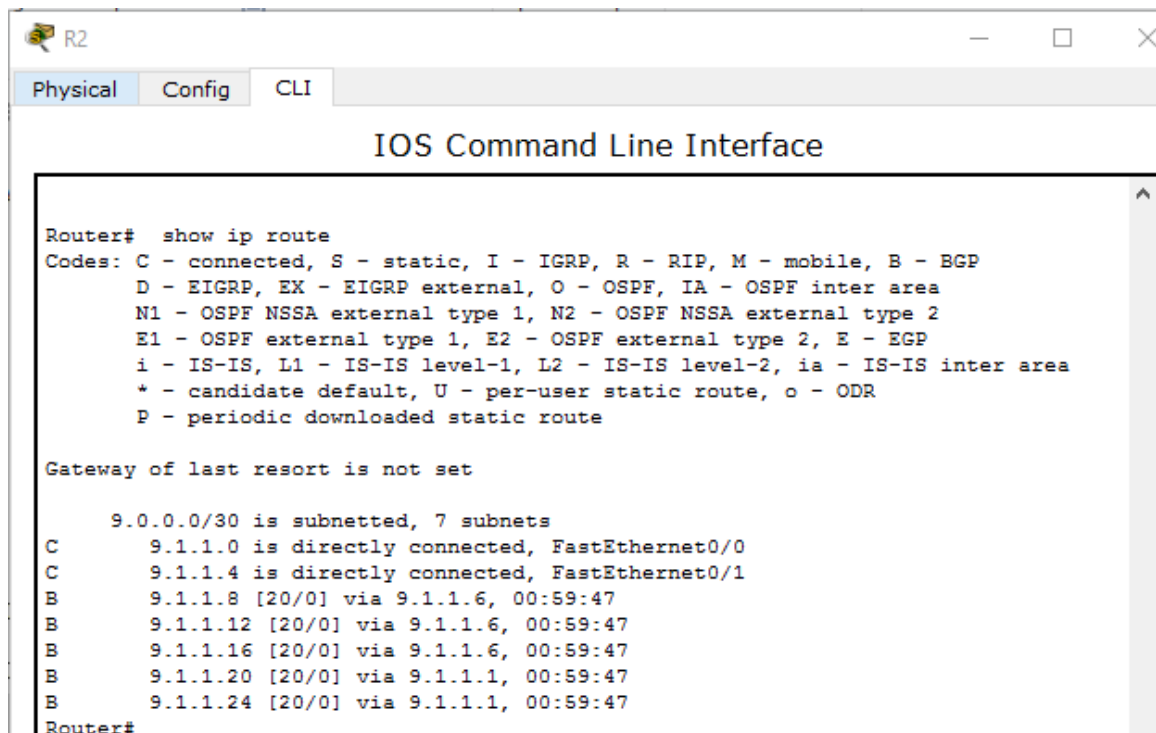
R2

```

interface FastEthernet0/0
ip address 9.1.1.2 255.255.255.252
!
interface FastEthernet0/1
ip address 9.1.1.5 255.255.255.252
!
router bgp 200
neighbor 9.1.1.6 remote-as 300
neighbor 9.1.1.1 remote-as 100
network 9.1.1.0 mask 255.255.255.252
network 9.1.1.12 mask 255.255.255.252

```

Dopo aver completato la configurazione di tutti i router, la tabella di instradamento **R2** sarà:



```

R2
Physical Config CLI
IOS Command Line Interface

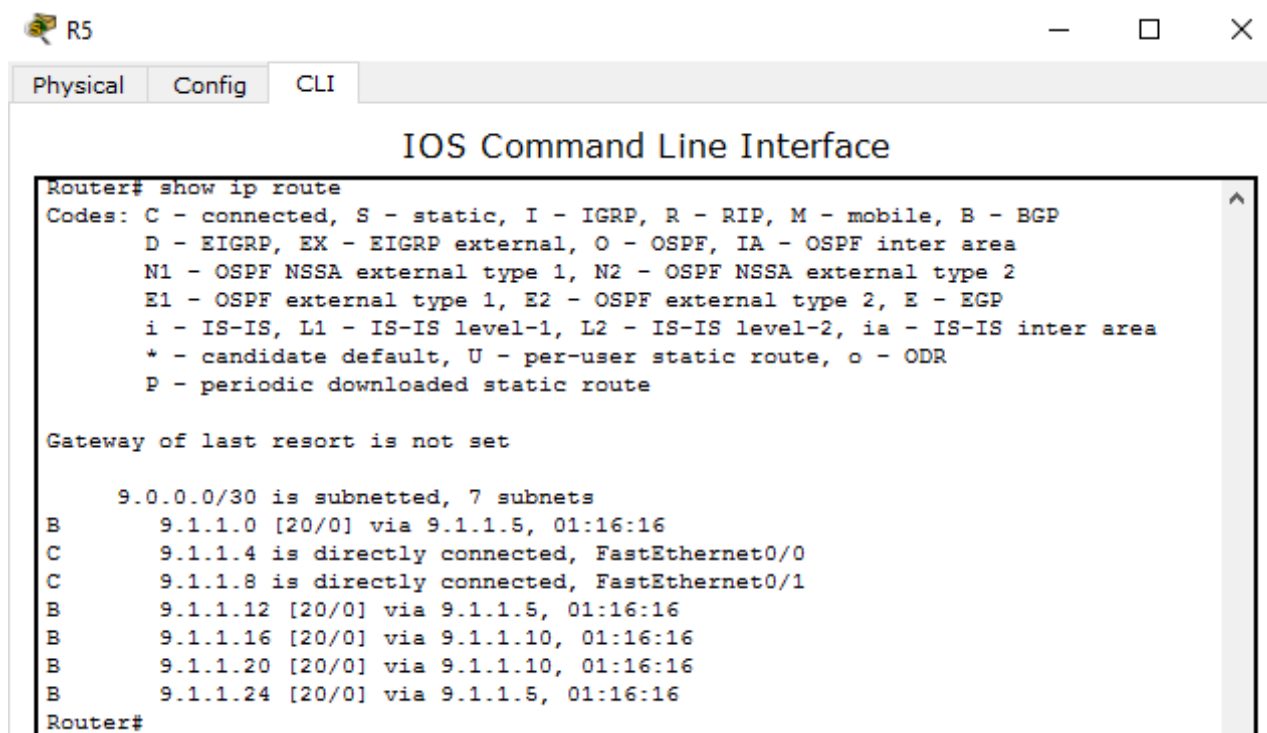
Router# show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP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

Gateway of last resort is not set

    9.0.0.0/30 is subnetted, 7 subnets
C       9.1.1.0 is directly connected, FastEthernet0/0
C       9.1.1.4 is directly connected, FastEthernet0/1
B       9.1.1.8 [20/0] via 9.1.1.6, 00:59:47
B       9.1.1.12 [20/0] via 9.1.1.6, 00:59:47
B       9.1.1.16 [20/0] via 9.1.1.6, 00:59:47
B       9.1.1.20 [20/0] via 9.1.1.1, 00:59:47
B       9.1.1.24 [20/0] via 9.1.1.1, 00:59:47
Router#
  
```

R5

Dopo aver completato la configurazione di tutti i router, la tabella di instradamento **R5** sarà:



```

R5
Physical Config CLI
IOS Command Line Interface

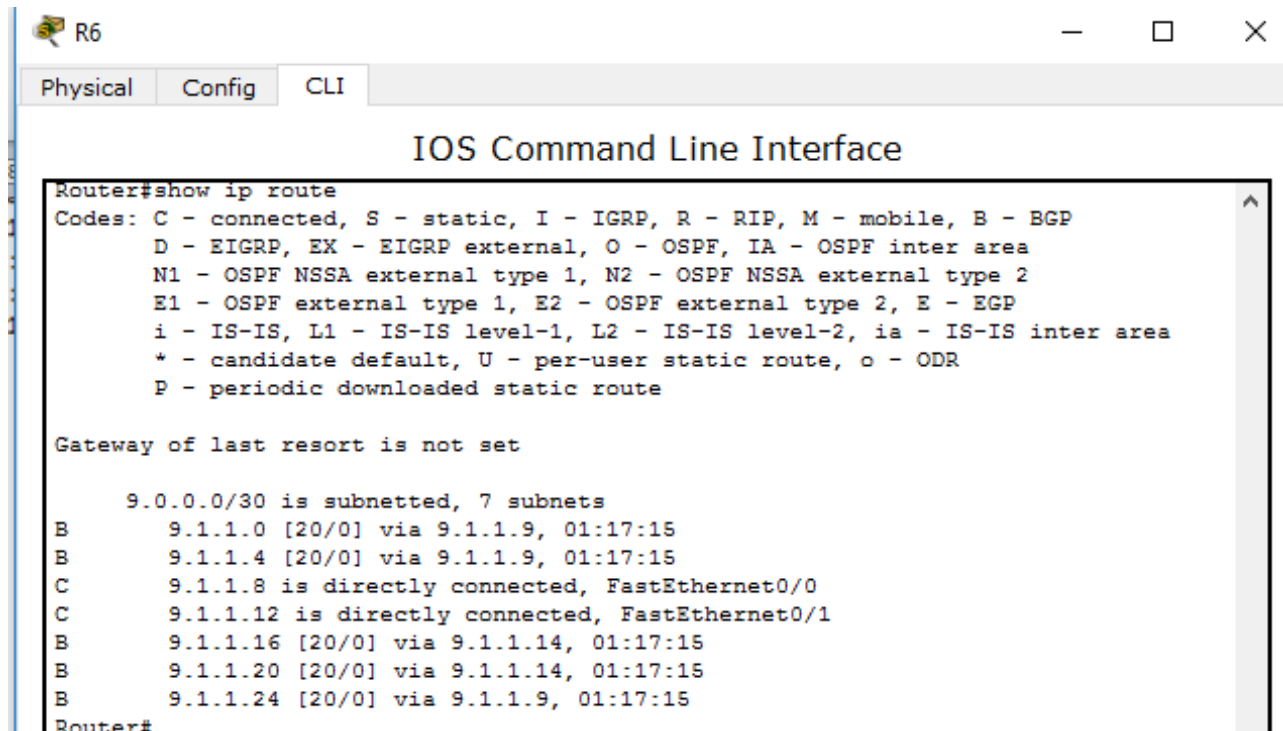
Router# show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP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

Gateway of last resort is not set

    9.0.0.0/30 is subnetted, 7 subnets
B       9.1.1.0 [20/0] via 9.1.1.5, 01:16:16
C       9.1.1.4 is directly connected, FastEthernet0/0
C       9.1.1.8 is directly connected, FastEthernet0/1
B       9.1.1.12 [20/0] via 9.1.1.5, 01:16:16
B       9.1.1.16 [20/0] via 9.1.1.10, 01:16:16
B       9.1.1.20 [20/0] via 9.1.1.10, 01:16:16
B       9.1.1.24 [20/0] via 9.1.1.5, 01:16:16
Router#
  
```

R6

Dopo aver completato la configurazione di tutti i router, la tabella di instradamento **R6** sarà:



```

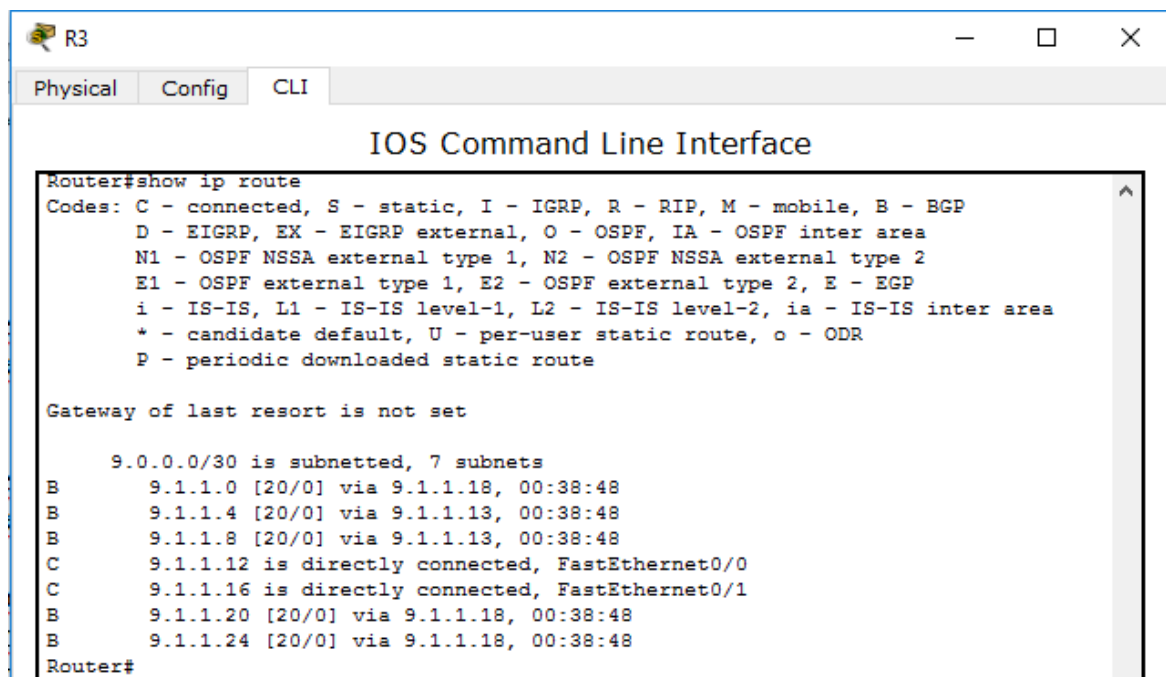
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP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

Gateway of last resort is not set

    9.0.0.0/30 is subnetted, 7 subnets
B       9.1.1.0 [20/0] via 9.1.1.9, 01:17:15
B       9.1.1.4 [20/0] via 9.1.1.9, 01:17:15
C       9.1.1.8 is directly connected, FastEthernet0/0
C       9.1.1.12 is directly connected, FastEthernet0/1
B       9.1.1.16 [20/0] via 9.1.1.14, 01:17:15
B       9.1.1.20 [20/0] via 9.1.1.14, 01:17:15
B       9.1.1.24 [20/0] via 9.1.1.9, 01:17:15
Router#
  
```

R3

Dopo aver completato la configurazione di tutti i router, la tabella di instradamento **R3** sarà:



```

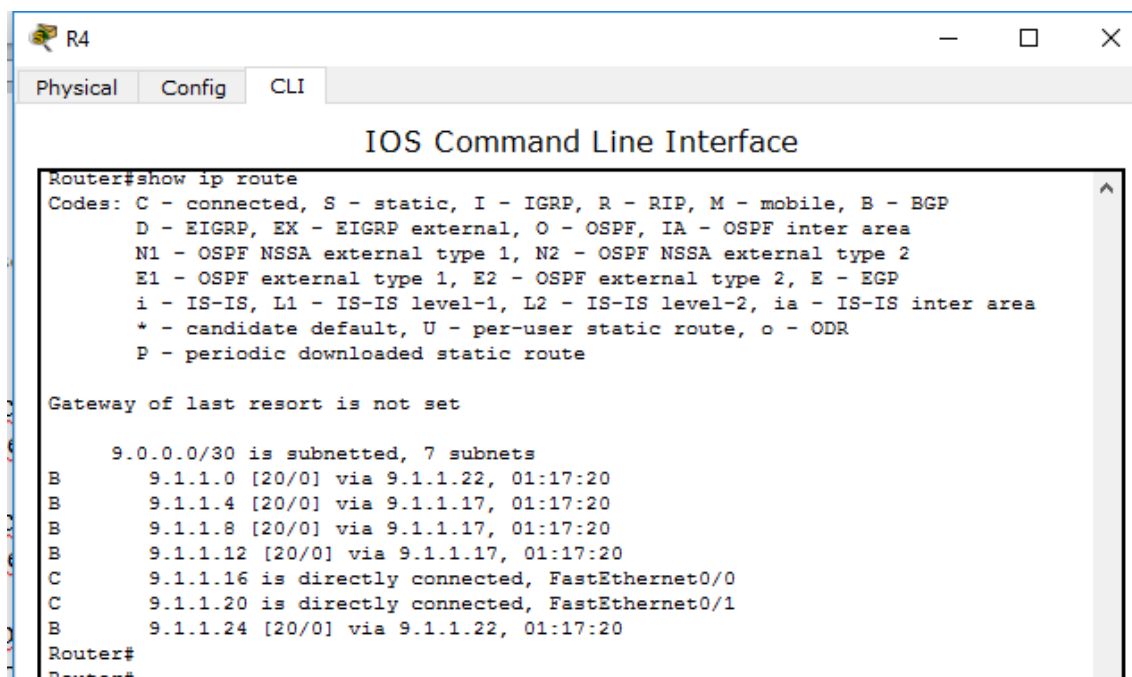
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP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

Gateway of last resort is not set

    9.0.0.0/30 is subnetted, 7 subnets
B       9.1.1.0 [20/0] via 9.1.1.18, 00:38:48
B       9.1.1.4 [20/0] via 9.1.1.13, 00:38:48
B       9.1.1.8 [20/0] via 9.1.1.13, 00:38:48
C       9.1.1.12 is directly connected, FastEthernet0/0
C       9.1.1.16 is directly connected, FastEthernet0/1
B       9.1.1.20 [20/0] via 9.1.1.18, 00:38:48
B       9.1.1.24 [20/0] via 9.1.1.18, 00:38:48
Router#
  
```

R4

Dopo aver completato la configurazione di tutti i router, la tabella di instradamento **R4** sarà:



```

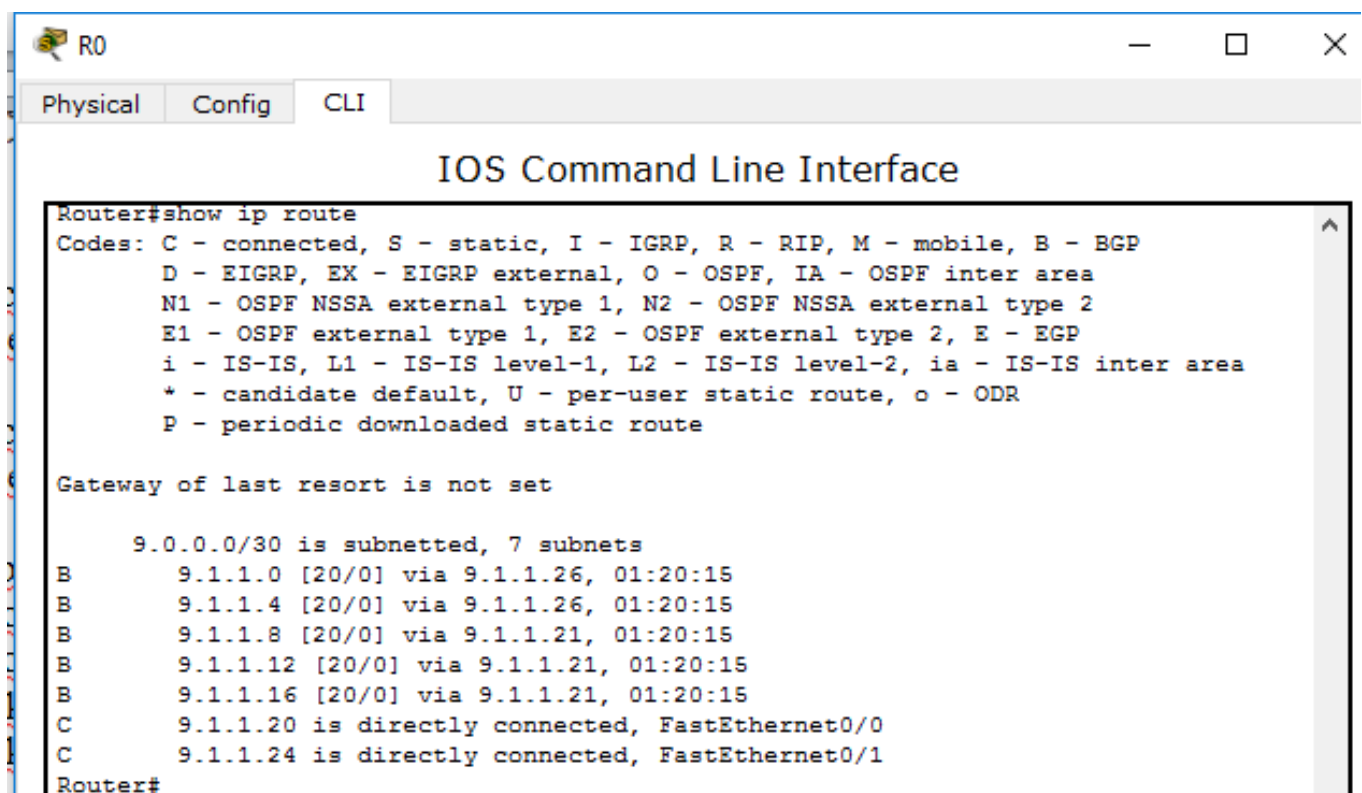
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP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

Gateway of last resort is not set

    9.0.0.0/30 is subnetted, 7 subnets
B       9.1.1.0 [20/0] via 9.1.1.22, 01:17:20
B       9.1.1.4 [20/0] via 9.1.1.17, 01:17:20
B       9.1.1.8 [20/0] via 9.1.1.17, 01:17:20
B       9.1.1.12 [20/0] via 9.1.1.17, 01:17:20
C       9.1.1.16 is directly connected, FastEthernet0/0
C       9.1.1.20 is directly connected, FastEthernet0/1
B       9.1.1.24 [20/0] via 9.1.1.22, 01:17:20
Router#
  
```

R0

Dopo aver completato la configurazione di tutti i router, la tabella di instradamento **R0** sarà:



```

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

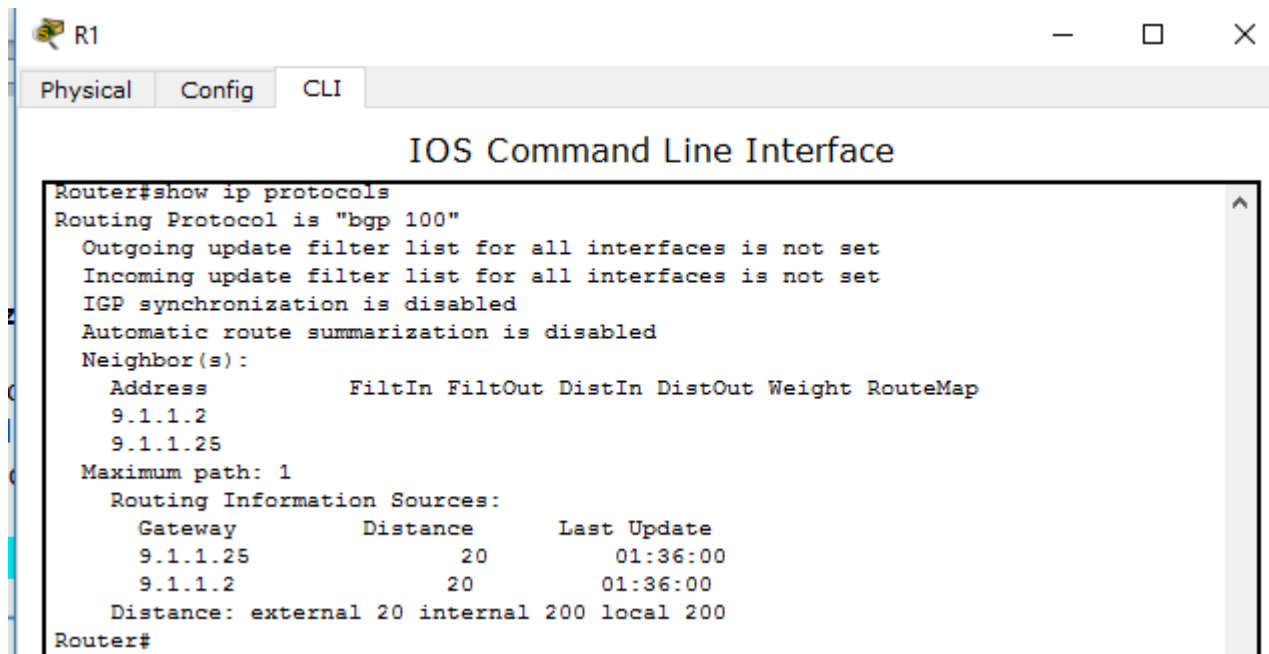
Gateway of last resort is not set

    9.0.0.0/30 is subnetted, 7 subnets
B       9.1.1.0 [20/0] via 9.1.1.26, 01:20:15
B       9.1.1.4 [20/0] via 9.1.1.26, 01:20:15
B       9.1.1.8 [20/0] via 9.1.1.21, 01:20:15
B       9.1.1.12 [20/0] via 9.1.1.21, 01:20:15
B       9.1.1.16 [20/0] via 9.1.1.21, 01:20:15
C       9.1.1.20 is directly connected, FastEthernet0/0
C       9.1.1.24 is directly connected, FastEthernet0/1
Router#
  
```

FASE III**7. Analizziamo le informazioni sui protocolli di instradamento:**

show ip bgp protocols Detailed information on TCP and BGP neighbor connections

Si nota il protocollo BGP per il sistema autonomo 100: "bgp100"



```

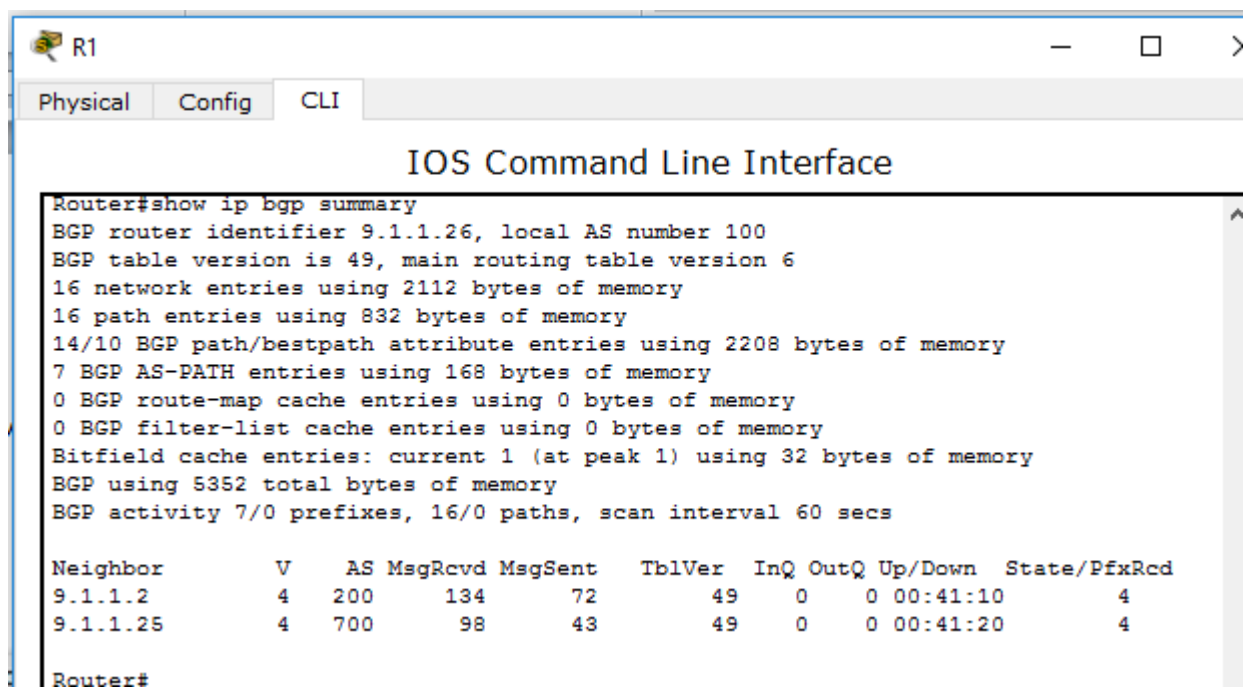
Router#show ip protocols
Routing Protocol is "bgp 100"
  Outgoing update filter list for all interfaces is not set
  Incoming update filter list for all interfaces is not set
  IGP synchronization is disabled
  Automatic route summarization is disabled
  Neighbor(s):
    Address          FiltIn FiltOut DistIn DistOut Weight RouteMap
    9.1.1.2
    9.1.1.25
  Maximum path: 1
  Routing Information Sources:
    Gateway          Distance    Last Update
    9.1.1.25          20          01:36:00
    9.1.1.2           20          01:36:00
  Distance: external 20 internal 200 local 200
Router#
  
```

8. L'analisi del comando *show ip bgp summary*

Il comando **show ip bgp summary** fornisce lo stato di tutti i vicini (Summary of BGP neighbor status)

Si nota che:

- la tabella di path contiene 16 record, cioè, 16 path (vedi lo screenshot del p.9)
- R1 ha due vicini



```

Router#show ip bgp summary
BGP router identifier 9.1.1.26, local AS number 100
BGP table version is 49, main routing table version 6
16 network entries using 2112 bytes of memory
16 path entries using 832 bytes of memory
14/10 BGP path/bestpath attribute entries using 2208 bytes of memory
7 BGP AS-PATH entries using 168 bytes of memory
0 BGP route-map cache entries using 0 bytes of memory
0 BGP filter-list cache entries using 0 bytes of memory
Bitfield cache entries: current 1 (at peak 1) using 32 bytes of memory
BGP using 5352 total bytes of memory
BGP activity 7/0 prefixes, 16/0 paths, scan interval 60 secs

Neighbor      V    AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
9.1.1.2        4    200    134     72      49    0    0 00:41:10        4
9.1.1.25       4    700     98     43      49    0    0 00:41:20        4
Router#
  
```

9. Analizziamo la tabella di path-vector BGP del router R0:

leggiamo che, per esempio, la rete 9.1.1.0 è raggiungibile tramite due next hop:
 uno del R1 e uno del R4, ma quello del R1 (9.1.1.26) è il migliore
 (difatti, questo percorso è più corto di quello comprendente un giro intero in senso antiorario)
show ip bgp //l'asterisco * significa "rotta valida", ">" sta per "rotta migliore"

```

R0
Physical Config CLI
IOS Command Line Interface
Router#
Router#
Router#
Router#
Router#show ip bgp
BGP table version is 34, local router ID is 9.1.1.25
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
*> 9.1.1.0/30      9.1.1.26             0      0         0 100 i
* 9.1.1.0/30      9.1.1.21             0      0         0 600 500 400 300 200 i
*> 9.1.1.4/30      9.1.1.26             0      0         0 100 200 300 i
* 9.1.1.4/30      9.1.1.21             0      0         0 600 500 400 300 i
*> 9.1.1.8/30      9.1.1.21             0      0         0 600 500 400 i
* 9.1.1.8/30      9.1.1.26             0      0         0 100 200 300 400 i
*> 9.1.1.12/30     9.1.1.21             0      0         0 600 500 i
* 9.1.1.12/30     9.1.1.26             0      0         0 100 200 i
*> 9.1.1.16/30     9.1.1.21             0      0         0 600 i
* 9.1.1.16/30     9.1.1.26             0      0         0 100 200 300 400 500 i
*> 9.1.1.20/30     9.1.1.21             0      0         0 600 i
* 9.1.1.20/30     9.1.1.26             0      0         0 100 200 300 400 500 600 i
*> 9.1.1.24/30     9.1.1.26             0      0         0 100 i
* 9.1.1.24/30     9.1.1.21             0      0         0 600 500 400 300 200 100 i
*> 0.0.0.0         0.0.0.0             0      0 32768 i
  
```

Per ogni rete è indicato l'intero percorso (PATH, difatti il protocollo BGP è del tipo PATH-VECTOR),
 per esempio, **dal R0** alla rete 9.1.1.4/30

```

* 9.1.1.4/30      9.1.1.21             0      0         0 600 500 400 300 i
*> 9.1.1.4/30      9.1.1.26             0      0         0 100 200 300 i
  
```

si arriva passando per i sistemi autonomi 600-500-400-300
 o passando per i sistemi autonomi 100-200-300 (path migliore)

Analizzare i percorsi (path) per una rete a scelta e indicare i percorsi, come da esempio :

