一、环境准备
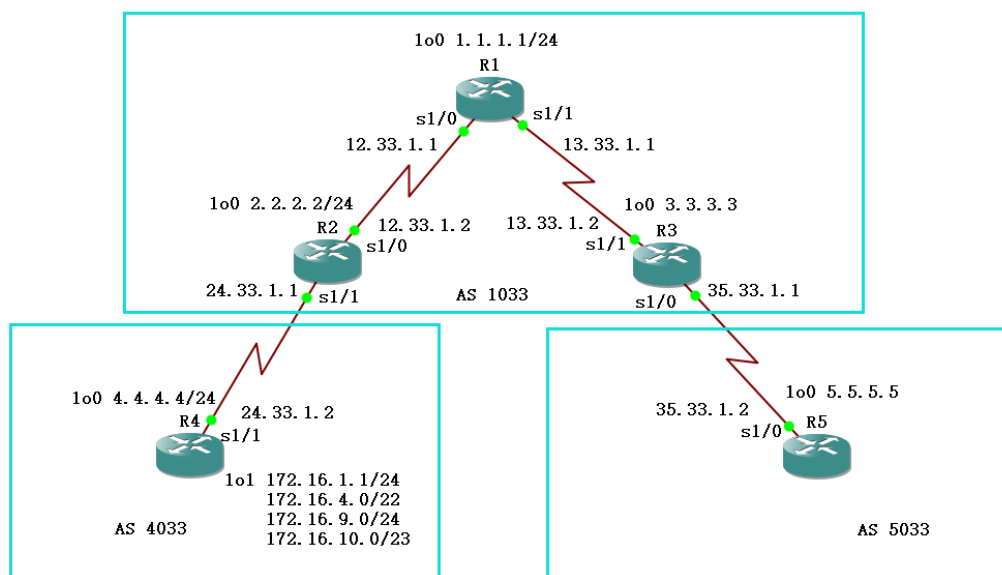
1. 软件：GNS3

2. 路由：c7200

二、实验操作

实验要求：

1、掌握 BGP 的基本配置方法。

2、掌握如何查看 BGP 的各种配置信息。

3、掌握基于回环口的 BGP 的邻居关系建立的配置方法。

4、理解需要使用回环口为目的。

5、理解 BGP 同步功能的作用和配置。

6、掌握使用指向 NULL0 接口的静态路由的汇总配置方法。

7、掌握使用聚合属性的路由汇总配置方法。

8、掌握 BGP 认证配置方法

实验拓扑：

实验过程：

1、根据实验拓扑搭建实验环境

2、根据实验拓扑，配置路由器各接口 IP 地址，使路由器之间直连接口可以通信。

R1 接口信息

```
R1#show ip inter bri
Interface               IP-Address      OK? Method Status                 Protocol
FastEthernet0/0         unassigned      YES unset  administratively down  down
FastEthernet0/1         unassigned      YES unset  administratively down  down
Serial1/0               12.33.1.1       YES manual up                     up
Serial1/1               13.33.1.1       YES manual up                     up
Serial1/2               unassigned      YES unset  administratively down  down
Serial1/3               unassigned      YES unset  administratively down  down
SSLVPN-VIF0             unassigned      NO  unset  up                     up
Loopback0               1.1.1.1         YES manual up                     up
R1#
```

R2 接口信息

```
R2#show ip inter br
Interface               IP-Address      OK? Method Status                 Protocol
FastEthernet0/0         unassigned      YES unset  administratively down  down
FastEthernet0/1         unassigned      YES unset  administratively down  down
Serial1/0               12.33.1.2       YES manual up                     up
Serial1/1               24.33.1.1       YES manual up                     up
Serial1/2               unassigned      YES unset  administratively down  down
Serial1/3               unassigned      YES unset  administratively down  down
SSLVPN-VIF0             unassigned      NO  unset  up                     up
Loopback0               2.2.2.2         YES manual up                     up
R2#
```

R3 接口信息

```
R3#show ip inter br
Interface               IP-Address      OK? Method Status                 Protocol
FastEthernet0/0         unassigned      YES unset  administratively down  down
FastEthernet0/1         unassigned      YES unset  administratively down  down
Serial1/0               35.33.1.1       YES manual up                     up
Serial1/1               13.33.1.2       YES manual up                     up
Serial1/2               unassigned      YES unset  administratively down  down
Serial1/3               unassigned      YES unset  administratively down  down
SSLVPN-VIF0             unassigned      NO  unset  up                     up
Loopback0               3.3.3.3         YES manual up                     up
R3#
```

R4 接口信息

```
R4#show ip inter br
Interface               IP-Address      OK? Method Status                 Protocol
FastEthernet0/0         unassigned      YES unset  administratively down  down
FastEthernet0/1         unassigned      YES unset  administratively down  down
Serial1/0               unassigned      YES unset  administratively down  down
Serial1/1               24.33.1.2       YES manual up                     up
Serial1/2               unassigned      YES unset  administratively down  down
Serial1/3               unassigned      YES unset  administratively down  down
SSLVPN-VIF0             unassigned      NO  unset  up                     up
Loopback0               4.4.4.4         YES manual up                     up
Loopback1               172.16.1.1      YES manual up                     up
R4#
```

R5 接口信息

```
R5#show ip inter brief
Interface              IP-Address      OK? Method Status                 Protocol
FastEthernet0/0        unassigned      YES unset  administratively down down
FastEthernet0/1        unassigned      YES unset  administratively down down
Serial1/0              35.33.1.2       YES manual up                     up
Serial1/1              unassigned      YES unset  administratively down down
Serial1/2              unassigned      YES unset  administratively down down
Serial1/3              unassigned      YES unset  administratively down down
SSLVPN-VIF0            unassigned      NO  unset  up                     up
Loopback0              5.5.5.5         YES manual up                     up
R5#
```

3、在路由器 R2 和 R4 上配置 BGP 邻居关系。参考命令如下：

```
R4(config)#router bgp 4033


R4(config-router)#bgp router-id 4.4.4.4


R4(config-router)#neighbor 24.33.1.1 remote-as 1033
```

参考 R4 的配置配置 R2

问题 1：配置后在 R4 上查看邻居关系，R2 和 R4 之间是否形成邻居关系。

参考命令：show ip bgp summary

R2

```
R2#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 1033
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
24.33.1.2       4         4033       2       2        0    0    0 00:00:36           0
R2#
```
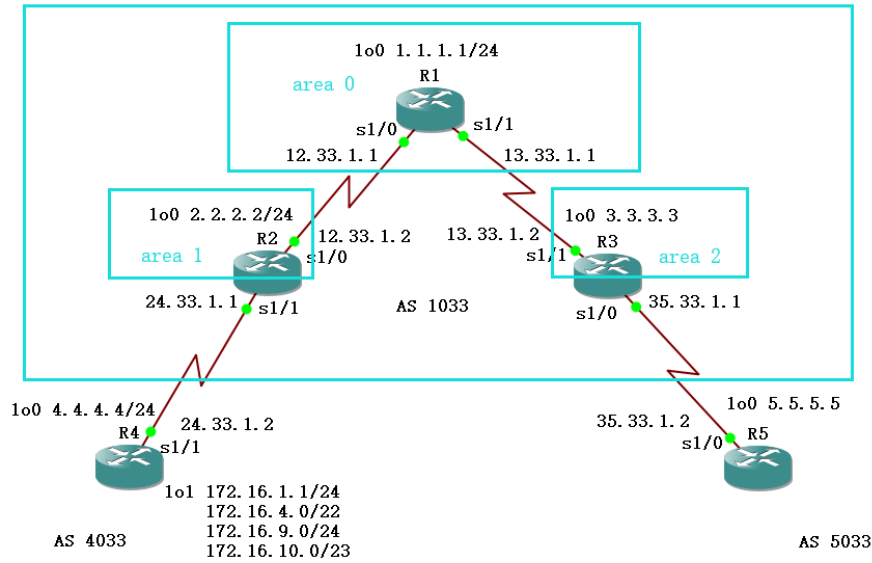
R4

```
R4#show ip bgp summary
BGP router identifier 4.4.4.4, local AS number 4033
BGP table version is 1, main routing table version 1

Neighbor        V           AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
24.33.1.1       4         1033       2       2        0    0    0 00:00:48           0
R4#
```

答：R2 和 R4 之间是形成邻居关系

4、在 R1、R2、R3 之间配置 OSPF 路由选择协议，使各路由器之间可以进行通信。

OSPF 搭建拓扑

R1 上的配置清单：

```
R1(config)#router ospf 33

R1(config-router)#network 1.1.1.0 0.0.0.255 area 0

R1(config-router)#network 12.33.1.0 0.0.0.255 area 0

R1(config-router)#network 13.33.1.0 0.0.0.255 area 0
```

R2 上的配置清单：

```
R2(config)#router ospf 33

R2(config-router)#network 2.2.2.0 0.0.0.255 area 1

R2(config-router)#network 12.33.1.0 0.0.0.255 area 0
```

R3 上的配置清单：

```
R3(config)#router ospf 33

R3(config-router)#network 3.3.3.0 0.0.0.255 area 2
```

```
R3(config-router)#network 13.33.1.0 0.0.0.255 area 0
```

5、在 R2 和 R3 之间使用回环接口配置邻居关系。

```
R2(config)#router bgp 1033


R2(config-router)#bgp router-id 2.2.2.2


R2(config-router)#neighbor 3.3.3.3 remote-as 1033


R2(config-router)#neighbor 3.3.3.3 update-source Loopback0
```

R3 参考 R2 配置进行配置。

R2

```
R2#show ip bgp summary
BGP router identifier 2.2.2.2, local AS number 1033
BGP table version is 1, main routing table version 1

Neighbor        V        AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
3.3.3.3         4      1033       5       5        1    0    0 00:02:11        0
24.33.1.2       4      4033      35      35        1    0    0 00:33:21        0
R2#
```

R3

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 1033
BGP table version is 1, main routing table version 1

Neighbor        V        AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
2.2.2.2         4      1033       4       4        1    0    0 00:01:10        0
R3#
```

6、参考步骤 5 的配置在 R3 和 R5 之间使用回环接口配置邻居关系。

问题 2：步骤 6 配置后，在 R3 和 R5 上查看 BGP 邻居关系，能否形成邻居关系？为什么？

R3

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 1033
BGP table version is 1, main routing table version 1

Neighbor        V         AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
2.2.2.2         4       1033      48      47        1    0    0 00:02:49        0
5.5.5.5         4       5033       0       0        0    0    0 never    Idle
R3#
R3#
```

R5

```
R5#show ip bgp summary
BGP router identifier 5.5.5.5, local AS number 5033
BGP table version is 1, main routing table version 1

Neighbor        V         AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
3.3.3.3         4       1033       0       0        0    0    0 never    Idle
R5#
```

答：在 R3 和 R5 上查看 BGP 邻居关系，发现不能形成邻居关系。因为 R3 没有到达网络 5.5.5.0 的路由、R5 没有到达网络 3.3.3.0 的路由.

7、在 R3 和 R5 上添加静态路由使得回环接口之间进行通信。参考命令：

```
R3(config)#ip route 5.5.5.5 255.255.255.255 s1/0
```

R5 参考 R3 配置

问题 3：步骤 7 配置后，在 R3 和 R5 上查看 BGP 邻居关系，能否形成邻居关系？为什么？

R3

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 1033
BGP table version is 1, main routing table version 1

Neighbor        V         AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
2.2.2.2         4       1033       3       4        1    0    0 00:01:24        0
5.5.5.5         4       5033       0       0        0    0    0 never    Idle
R3#
```

R5

```
R5#show ip bgp summary
BGP router identifier 5.5.5.5, local AS number 5033
BGP table version is 1, main routing table version 1

Neighbor        V         AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
3.3.3.3         4       1033       0       0        0    0    0 never    Idle
R5#
```

答：在 R3 和 R5 上查看 BGP 邻居关系，发现不能形成邻居关系。因为在 ebgp 建立邻居的时候默认 ttl 值为 1，如果不修改 ebgp-multihop 会导致非直连的 ebgp 邻居无法建立邻居关系

8、修改 EBGP 的默认跳数，参考命令：

```
R5(config)#router bgp 5033
```

```
R5(config-router)#neighbor 3.3.3.3 ebgp-multihop 2
```

R3 参考 R5 命令进行配置。

R3 和 R5 的虚拟接口 loopback 0 成功建立邻居关系：

```
R3#show ip bgp summary
BGP router identifier 3.3.3.3, local AS number 1033
BGP table version is 1, main routing table version 1

Neighbor        V          AS MsgRcvd MsgSent   TblVer  InQ OutQ Up/Down  State/PfxRcd
2.2.2.2         4        1033      10      11        1    0    0 00:08:07        0
5.5.5.5         4        5033       3       2        1    0    0 00:00:13        0
R3#lo
R3#
```

9、将 R4 和 R5 上的所有回环接口都宣告进 BGP，参考命令如下：

```
R4(config)#router bgp 4033


R4(config-router)#network 4.4.4.0 mask 255.255.255.0
```

其他回环接口网络地址参考本配置进行配置（此处忽略 R4 上的 loopback1 口）

问题 4：在 R4 上查看路由表，能否看到 BGP 生成的路由？在 R2 上查看路由表，能看到几条 BGP 路由，缺少哪个网络地址的路由？

```
R4#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

     2.0.0.0/24 is subnetted, 1 subnets
B       2.2.2.0 [20/0] via 24.33.1.1, 00:00:12
     4.0.0.0/24 is subnetted, 1 subnets
C       4.4.4.0 is directly connected, Loopback0
     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.1.0 is directly connected, Loopback1
     24.0.0.0/24 is subnetted, 1 subnets
C       24.33.1.0 is directly connected, Serial1/1
R4#
R4#
```

答：在 R4 上查看路由表，能看到 BGP 生成的路由。

```
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

     1.0.0.0/32 is subnetted, 1 subnets
O       1.1.1.1 [110/65] via 12.33.1.1, 01:16:14, Serial1/0
     2.0.0.0/24 is subnetted, 1 subnets
C       2.2.2.0 is directly connected, Loopback0
     3.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
O IA    3.3.3.3/32 [110/129] via 12.33.1.1, 00:45:59, Serial1/0
B       3.3.3.0/24 [200/0] via 3.3.3.3, 00:02:07
     4.0.0.0/24 is subnetted, 1 subnets
B       4.4.4.0 [20/0] via 24.33.1.2, 00:02:08
     24.0.0.0/24 is subnetted, 1 subnets
C       24.33.1.0 is directly connected, Serial1/1
     12.0.0.0/24 is subnetted, 1 subnets
C       12.33.1.0 is directly connected, Serial1/0
     13.0.0.0/24 is subnetted, 1 subnets
O       13.33.1.0 [110/128] via 12.33.1.1, 01:16:15, Serial1/0
R2#
R2#
```

答：在 R2 上查看路由表，能看到 2 条 BGP 路由。缺少到达 5.5.5.0 网络地址的路由。

问题 5：在 R4 上查看 BGP 表，哪些是最优？哪些不是？什么原因造成的？

参考命令：show ip bgp

```
R4#show ip bgp
BGP table version is 4, local router ID is 4.4.4.4
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
*> 2.2.2.0/24       24.33.1.1                0             0 1033 i
*> 3.3.3.0/24       24.33.1.1                0             0 1033 i
*> 4.4.4.0/24       0.0.0.0                  0         32768 i
R4#
```

答：都是最优路由。R4 收到的是 ebgp 生成的路由，在 ibgp 生成路由时才有最佳路由问题.

10、在 R2 和 R3 上关闭 BGP 同步，参考命令如下：

```
R2(config)#router bgp 1033


R2(config-router)#no synchronization
```

R3 参考 R2 的配置进行配置

11、在 R2 和 R3 上配置宣告 IBGP 下一跳为自己，参考命令如下：

```
R2(config)#router bgp 1033
```

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

参考 R2 配置配置 R3

问题 6：此时在 R4 上能否看到 R5 上的路由？

```
R4#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

     2.0.0.0/24 is subnetted, 1 subnets
B       2.2.2.0 [20/0] via 24.33.1.1, 01:12:33
     3.0.0.0/24 is subnetted, 1 subnets
B       3.3.3.0 [20/0] via 24.33.1.1, 01:12:33
     4.0.0.0/24 is subnetted, 1 subnets
C       4.4.4.0 is directly connected, Loopback0
     5.0.0.0/24 is subnetted, 1 subnets
B       5.5.5.0 [20/0] via 24.33.1.1, 00:00:19
     172.16.0.0/24 is subnetted, 1 subnets
C       172.16.1.0 is directly connected, Loopback1
     24.0.0.0/24 is subnetted, 1 subnets
C       24.33.1.0 is directly connected, Serial1/1
R4#
```

答：在 R4 上能看到 R5 上的路由

问题 7：在 R4 上以 4.4.4.4 为源 ping 5.5.5.5，能否 ping 通？为什么？

```
R4#ping 5.5.5.5 source 4.4.4.4

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 4.4.4.4
.....
Success rate is 0 percent (0/5)
R4#
```

答：不能 ping 通。因为 R2 和 R3 需要在 IBGP 中与 R1 建立邻居关系。

12、在 R1 上配置 IBGP，使它和 R2 和 R3 互为邻居，在 R2 和 R3 上添加 R1 为邻居。

R1 配置：

```
R1(config)#router bgp 1033


R1(config-router)#bgp router-id 1.1.1.1


R1(config-router)#neighbor xcu peer-group


R1(config-router)#neighbor xcu remote-as 1033
```

```
R1(config-router)#neighbor xcu update-source lo0


R1(config-router)#neighbor xcu next-hop-self


R1(config-router)#neighbor 2.2.2.2 peer-group xcu


R1(config-router)#neighbor 3.3.3.3 peer-group xcu
```

R2 和 R3 的配置：

```
R(config)#router bgp 1033


R(config-router)#neighbor 1.1.1.1 remote-as 1033


R(config-router)#neighbor 1.1.1.1 next-hop-self
```

问题 8：此时在 R4 上以 4.4.4.4 为源 ping 5.5.5.5，能否 ping 通?

答：能 ping 通。

13、在 R4 上配置 null0 静态路由实现路由汇总，参考命令如下：

```
R4(config)#ip route 172.16.0.0 255.255.240.0 null 0


R4(config)#router bgp 4033


R4(config-router)#network 172.16.0.0 mask 255.255.240.0
```

问题 9：在 R5 上能否看到汇总后的路由，R5 上 172.16 开头的路由有几条?

```
R5#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

     1.0.0.0/24 is subnetted, 1 subnets
B       1.1.1.0 [20/0] via 3.3.3.3, 00:15:49
     35.0.0.0/24 is subnetted, 1 subnets
C       35.33.1.0 is directly connected, Serial1/0
     2.0.0.0/24 is subnetted, 1 subnets
B       2.2.2.0 [20/0] via 3.3.3.3, 01:57:12
     3.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
S       3.3.3.3/32 is directly connected, Serial1/0
B       3.3.3.0/24 [20/0] via 3.3.3.3, 01:57:42
     4.0.0.0/24 is subnetted, 1 subnets
B       4.4.4.0 [20/0] via 3.3.3.3, 00:46:16
     5.0.0.0/24 is subnetted, 1 subnets
C       5.5.5.0 is directly connected, Loopback0
     172.16.0.0/20 is subnetted, 1 subnets
B       172.16.0.0 [20/0] via 3.3.3.3, 00:00:50
R5#
R5#
```

答：在 R5 上能看到汇总后的路由，R5 上 172.16 开头的路由 1 几条。

14、将步骤 13 的配置删除，使用聚合属性配置路由汇总。

```
R4(config)#router bgp 4033


R4(config-router)#aggregate-address 172.16.0.0 255.255.240.0 summary-only


R4(config-router)#network 172.16.1.0 mask 255.255.255.0


R4(config-router)#network 172.16.4.0 mask 255.255.252.0


R4(config-router)#network 172.16.9.0 mask 255.255.255.0


R4(config-router)#network 172.16.10.0 mask 255.255.254.0
```

问题 10：配置后 R5 上关于 172 的路由还有几条？在 R5 中以 5.5.5.5 为
源 ping 172.16.1.1，能否 ping 通？

```
R5#ping 172.16.1.1 source 5.5.5.5

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 172.16.1.1, timeout is 2 seconds:
Packet sent with a source address of 5.5.5.5
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/72/84 ms
R5#
```

答：能 ping 通。

15、在 R4 和 R2 之间配置认证，参考命令如下：

```
R2(config)#router bgp 1033



R2(config-router)#neighbor 24.33.1.2 password 0 ctj
```

配置后在 R2 和 R4 上清除 BGP 表，参考命令 clear ip bgp * soft

问题 11：在 R4 上能否看到 R5 上的路由？

R4 路由表

```
R4#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

     4.0.0.0/24 is subnetted, 1 subnets
C       4.4.4.0 is directly connected, Loopback0
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
B       172.16.0.0/20 [200/0] via 0.0.0.0, 00:12:42, Null0
C       172.16.1.0/24 is directly connected, Loopback1
     24.0.0.0/24 is subnetted, 1 subnets
C       24.33.1.0 is directly connected, Serial1/1
R4#
```

答：不能看到 R5 上的路由。

16、参考步骤 15 配置 R4。

配置之后查看 R4 路由表

```
R4#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

     1.0.0.0/24 is subnetted, 1 subnets
B       1.1.1.0 [20/0] via 24.33.1.1, 00:01:46
     2.0.0.0/24 is subnetted, 1 subnets
B       2.2.2.0 [20/0] via 24.33.1.1, 00:01:16
     3.0.0.0/24 is subnetted, 1 subnets
B       3.3.3.0 [20/0] via 24.33.1.1, 00:01:46
     4.0.0.0/24 is subnetted, 1 subnets
C       4.4.4.0 is directly connected, Loopback0
     5.0.0.0/24 is subnetted, 1 subnets
B       5.5.5.0 [20/0] via 24.33.1.1, 00:01:46
     172.16.0.0/16 is variably subnetted, 2 subnets, 2 masks
B       172.16.0.0/20 [200/0] via 0.0.0.0, 00:01:46, Null0
C       172.16.1.0/24 is directly connected, Loopback1
     24.0.0.0/24 is subnetted, 1 subnets
C       24.33.1.0 is directly connected, Serial1/1
R4#
```