Guia de Exercícios Práticos para Protocolo BGP

Contents

1 IBGP e EBGP

1.1 OBJETIVOS DE APRENDIZAGEM

Os objetivos deste laboratório são para aprender e entender como realizar as seguintes operações:

- Configure única área Border Gateway Protocol (BGP)
- Configure múltiplas área BGP.
- Veja a lista de vizinho e banco de dados BGP.
- Configure as fontes de atualizações BGP.
- Configure múltiplos BGP externos (EBGP).
- Observe a mudança de próximos saltos nas rotas de BGP interno

(IBGP) e rotas EBGP.

- Configure os próximos saltos para rotas IBGP.
- Configure o comando **network** no BGP.

1.2 Topologia

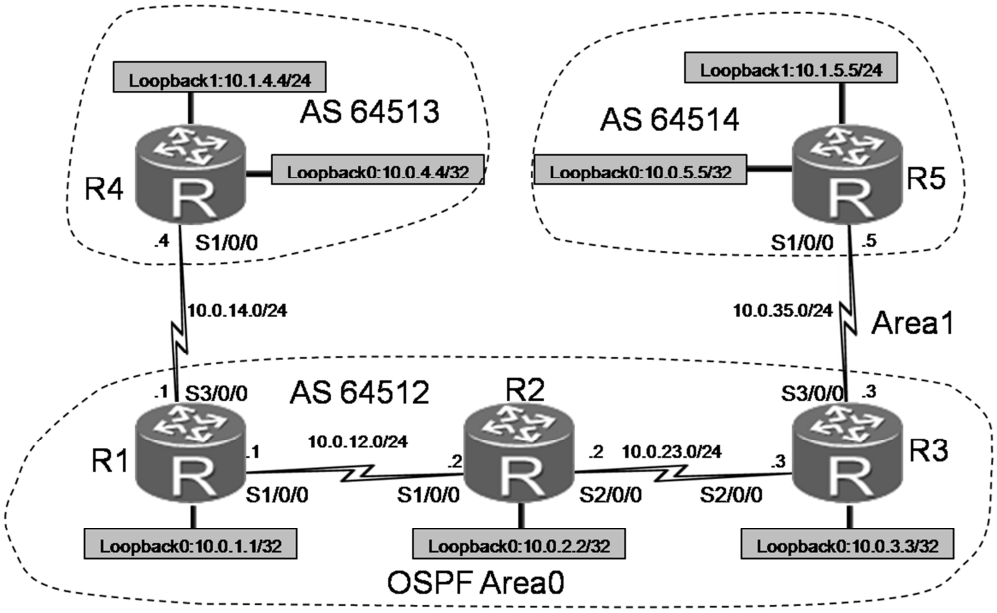

Figura 3-1 IBGP e EBGP

1.3 Cenário

Suponha que você é um administrador de rede de uma empresa que utiliza BGP para a sua rede. A rede de serviço da empresa é composta por vários sistemas autônomos (ASs). Diferentes ramos utilizam diferentes AS IDs. A tarefa é completar a construção da rede. Na sede, Open Shortest Path First (OSPF) é usado como o Interior Gateway Protocol (IGP). Os escritórios usam AS IDs de BGP privado. Após a construção da rede, observar a transmissão de informações de roteamento BGP.

1.4 Tarefas

Step 1 Realizar configurações básicas e endereçamento IP.

Configurar endereços IP e máscaras de sub-rede para todos os roteadores. As máscaras de sub-rede da interfaces Loopback 1 de R4 e R5 contêm 24 dígitos binários para simular a rede do usuário.

```
<R1>system-view
```

```
Enter system view, return user view with Ctrl+Z.
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]ip address 10.0.12.1 24
[R1-Serial1/0/0]interface Serial 3/0/0
[R1-Serial3/0/0]ip address 10.0.14.1 24
[R1-Serial3/0/0]interface LoopBack 0
[R1-LoopBack0]ip address 10.0.1.1 32

<R2>system-view
Enter system view, return user view with Ctrl+Z.
[R2]interface Serial 1/0/0
[R2-Serial1/0/0]ip address 10.0.12.2 24
[R2-Serial1/0/0]interface Serial 2/0/0
[R2-Serial2/0/0]ip address 10.0.23.2 24
[R2-Serial2/0/0]interface LoopBack 0
[R2-LoopBack0]ip address 10.0.2.2 32

<R3>system-view
Enter system view, return user view with Ctrl+Z.
[R3]interface Serial 2/0/0
[R3-Serial2/0/0]ip address 10.0.23.3 24
[R3-Serial2/0/0]interface Serial 3/0/0
[R3-Serial3/0/0]ip address 10.0.35.3 24
[R3-Serial3/0/0]interface LoopBack 0
[R3-LoopBack0]ip address 10.0.3.3 32

<R4>system-view
Enter system view, return user view with Ctrl+Z.
[R4]interface Serial 1/0/0
[R4-Serial1/0/0]ip address 10.0.14.4 24
[R4-Serial1/0/0]interface LoopBack 0
[R4-LoopBack0]ip address 10.0.4.4 32

<R5>system-view
Enter system view, return user view with Ctrl+Z.
[R5]interface Serial 1/0/0
[R5-Serial1/0/0]ip address 10.0.35.5 24
[R5-Serial1/0/0]interface LoopBack 0
[R5-LoopBack0]ip address 10.0.5.5 32
```

Teste a conectividade de links diretos.

```
<R1>ping -c 1 10.0.12.2
  PING 10.0.12.2: 56  data bytes, press CTRL_C to break
```

```
    Reply from 10.0.12.2: bytes=56 Sequence=1 ttl=255 time=34 ms

  --- 10.0.12.2 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 34/34/34 ms

<R1>ping -c 1 10.0.14.4
  PING 10.0.14.4: 56  data bytes, press CTRL_C to break
    Reply from 10.0.14.4: bytes=56 Sequence=1 ttl=255 time=40 ms

  --- 10.0.14.4 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 40/40/40 ms

<R3>ping -c 1  10.0.23.2
  PING 10.0.23.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.23.2: bytes=56 Sequence=1 ttl=255 time=33 ms

  --- 10.0.23.2 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 33/33/33 ms

<R3>ping -c 1 10.0.35.5
  PING 10.0.35.5: 56  data bytes, press CTRL_C to break
    Reply from 10.0.35.5: bytes=56 Sequence=1 ttl=255 time=35 ms

  --- 10.0.35.5 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
round-trip min/avg/max = 35/35/35 ms
```

A informação anterior mostra que os links diretos são acessíveis.

Step 2 **Configure única área IGP.**

Configure o AS 64512 para usar o OSPF como IGP para anunciar os segmentos de rede onde as interfaces de loopback 0 residem para OSPF. Activar OSPF no segmento de rede em que a interface S1/0/0 R1 reside.

```
[R1]router id 10.0.1.1
[R1]ospf 1
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 10.0.12.1 0.0.0.0
[R1-ospf-1-area-0.0.0.0]network 10.0.1.1 0.0.0.0
```

Ativar OSPF no segmento de rede onde as interfaces S1/0/0 e S2/0/0 de R2 residem.

```
[R2]router id 10.0.2.2
[R2]ospf 1
[R2-ospf-1]area 0
[R2-ospf-1-area-0.0.0.0]network 10.0.12.2 0.0.0.0
[R2-ospf-1-area-0.0.0.0]network 10.0.23.2  0.0.0.0
[R2-ospf-1-area-0.0.0.0]network 10.0.2.2 0.0.0.0
```

Ativar OSPF no segmento de rede em que a interface de S2/0/0 de R3 reside.

```
[R3]router id 10.0.3.3
[R3]ospf 1
[R3-ospf-1]area 0
[R3-ospf-1-area-0.0.0.0]network 10.0.23.3 0.0.0.0
[R3-ospf-1-area-0.0.0.0]network 10.0.3.3 0.0.0.0
```

Note que a máscara coringa 0.0.0.0 é usada quando você utiliza o comando **network**.

Verifique se as relações de vizinhança OSPF são estabelecidas.

```
[R2]display ospf peer

       OSPF Process 1 with Router ID 10.0.2.2
             Neighbors

 Area 0.0.0.0 interface 10.0.12.2(Serial1/0/0)'s neighbors
 Router ID: 10.0.1.1        Address: 10.0.12.1
   State: Full  Mode:Nbr is  Slave  Priority: 1
   DR: None   BDR: None   MTU: 0
```

```
  Dead timer due in 31  sec
  Retrans timer interval: 4
  Neighbor is up for 00:00:29
  Authentication Sequence: [ 0 ]

            Neighbors

 Area 0.0.0.0 interface 10.0.23.2(Serial2/0/0)'s neighbors
 Router ID: 10.0.3.3        Address: 10.0.23.3
  State: Full  Mode:Nbr is  Master  Priority: 1
  DR: None   BDR: None   MTU: 0
  Dead timer due in 34  sec
  Retrans timer interval: 4
  Neighbor is up for 00:00:06
  Authentication Sequence: [ 0 ]
```

Veja a tabela de roteamento de cada roteador. Verifique se um roteador aprende a rota para o segmento de rede onde a interface Loopback 0 do roteador peer reside.

```
[R1]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
        Destinations : 15      Routes : 15

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

       10.0.1.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
       10.0.2.2/32  OSPF    10   1562        D   10.0.12.2       Serial1/0/0
       10.0.3.3/32  OSPF    10   3124        D   10.0.12.2       Serial1/0/0
      10.0.12.0/24  Direct  0    0           D   10.0.12.1       Serial1/0/0
      10.0.12.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.12.2/32  Direct  0    0           D   10.0.12.2       Serial1/0/0
    10.0.12.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.14.0/24  Direct  0    0           D   10.0.14.1       Serial3/0/0
      10.0.14.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.14.4/32  Direct  0    0           D   10.0.14.4       Serial3/0/0
    10.0.14.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.23.0/24  OSPF    10   3124        D   10.0.12.2       Serial1/0/0
      127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
```

```
[R2]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 15        Routes : 15

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

10.0.1.1/32     OSPF    10   1562        D   10.0.12.1       Serial1/0/0
10.0.2.2/32     Direct  0    0           D   127.0.0.1       InLoopBack0
10.0.3.3/32     OSPF    10   1562        D   10.0.23.3       Serial2/0/0
10.0.12.0/24    Direct  0    0           D   10.0.12.2       Serial1/0/0
10.0.12.1/32    Direct  0    0           D   10.0.12.1       Serial1/0/0
10.0.12.2/32    Direct  0    0           D   127.0.0.1       InLoopBack0
10.0.12.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
10.0.23.0/24    Direct  0    0           D   10.0.23.2       Serial2/0/0
10.0.23.2/32    Direct  0    0           D   127.0.0.1       InLoopBack0
10.0.23.3/32    Direct  0    0           D   10.0.23.3       Serial2/0/0
10.0.23.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
127.0.0.0/8     Direct  0    0           D   127.0.0.1       InLoopBack0
127.0.0.1/32    Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0

[R3]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 16        Routes : 16

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.1.1/32   OSPF    10   3124        D   10.0.23.2       Serial2/0/0
      10.0.2.2/32   OSPF    10   1562        D   10.0.23.2       Serial2/0/0
      10.0.3.3/32   Direct  0    0           D   127.0.0.1       InLoopBack0
     10.0.12.0/24   OSPF    10   3124        D   10.0.23.2       Serial2/0/0
     10.0.23.0/24   Direct  0    0           D   10.0.23.3       Serial2/0/0
     10.0.23.2/32   Direct  0    0           D   10.0.23.2       Serial2/0/0
     10.0.23.3/32   Direct  0    0           D   127.0.0.1       InLoopBack0
   10.0.23.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
     10.0.35.0/24   Direct  0    0           D   10.0.35.3       Serial3/0/0
     10.0.35.3/32   Direct  0    0           D   127.0.0.1       InLoopBack0
```

```
     10.0.35.5/32   Direct  0    0          D   10.0.35.5       Serial3/0/0
    10.0.35.255/32  Direct  0    0          D   127.0.0.1       InLoopBack0
     127.0.0.0/8    Direct  0    0          D   127.0.0.1       InLoopBack0
     127.0.0.1/32   Direct  0    0          D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0          D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0          D   127.0.0.1       InLoopBack0
```

A informação anterior mostra que cada um de R1, R2 e R3 pode aprender as rotas para os segmentos de rede onde as interfaces loopback 0 dos outros dois roteadores residem.

Step 3 **Estabelecer IBGP peers.**

Configure interconexão full-mesh IBGP em R1, R2 e R3. Use as interfaces de loopback 0 como fontes de atualização.

```
[R1]bgp 64512
[R1-bgp]peer 10.0.2.2 as-number 64512
[R1-bgp]peer 10.0.2.2 connect-interface LoopBack 0
[R1-bgp]peer 10.0.3.3 as-number 64512
[R1-bgp]peer 10.0.3.3 connect-interface LoopBack 0

[R2]bgp 64512
[R2-bgp]peer 10.0.1.1 as-number 64512
[R2-bgp]peer 10.0.1.1 connect-interface loopback 0
[R2-bgp]peer 10.0.3.3 as-number 64512
[R2-bgp]peer 10.0.3.3 connect-interface LoopBack 0

[R3]bgp 64512
[R3-bgp]peer 10.0.1.1 as-number 64512
[R3-bgp]peer 10.0.1.1 connect-interface loopback 0
[R3-bgp]peer 10.0.2.2 as-number 64512
[R3-bgp]peer 10.0.2.2 connect-interface LoopBack 0
```

Execute o comando **display tcp status** para visualizar o status de portas Transmission Control Protocol (TCP).

```
[R2]display tcp status
TCPCB    Tid/Soid Local Add:port      Foreign Add:por   VPNID  State
194a3c7c  8  /2     0.0.0.0:22          0.0.0.0:0       23553   Listening
194a3b18  8  /1     0.0.0.0:23          0.0.0.0:0       23553   Listening
194a3850  106/1     0.0.0.0:80          0.0.0.0:0           0   Listening
19ec2bb8  234/2     0.0.0.0:179         10.0.1.1:0          0   Listening
```

```
19ec2360  234/5     0.0.0.0:179         10.0.3.3:0          0   Listening
194a3de0  8  /3     0.0.0.0:830         0.0.0.0:0       23553   Listening
194a39b4  6  /1     0.0.0.0:7547        0.0.0.0:0           0   Listening
19ec3410  234/11    10.0.2.2:179        10.0.3.3:49663      0   Established
19ec2a54  234/4     10.0.2.2:50151      10.0.1.1:179        0   Established
```

O valor **Local Add** é 10.0.2.2, que é o endereço IP da interface Loopback 0 de R2 , e o número da porta é 179, que é o número da porta TCP do BGP. O estado das conexões TCP entre 10.0.2.2 e 10.0.3.3, e entre 10.0.2.2 e 10.0.1.1 está estabelecido. Isto indica que as conexões TCP são estabelecidas entre R1 e R2, e de entre R2 e R3.

Execute o comando **display bgp peer** para ver as relações de vizinhança BGP nos roteadores.

```
[R1]display bgp peer

 BGP local router ID : 10.0.1.1
 Local AS number : 64512
 Total number of peers : 2              Peers in established state : 2

  Peer          V         AS  MsgRcvd  MsgSent  OutQ  Up/Down     State  PrefRcv

  10.0.2.2      4      64512      273      277     0 02:15:53 Established      0
  10.0.3.3      4      64512      276      276     0 02:15:53 Established      0


[R2]display bgp peer

 BGP local router ID : 10.0.2.2
 Local AS number : 64512
 Total number of peers : 2              Peers in established state : 2

  Peer          V         AS  MsgRcvd  MsgSent  OutQ  Up/Down   State    PrefRcv

  10.0.1.1      4      64512       38       38     0 00:18:02 Established      0
  10.0.3.3      4      64512     1000     1000     0 16:38:38 Established      0

[R3]display bgp peer

 BGP local router ID : 10.0.3.3
 Local AS number : 64512
 Total number of peers : 2              Peers in established state : 2
```

```
 Peer            V         AS  MsgRcvd  MsgSent  OutQ  Up/Down       State  PrefRcv

 10.0.1.1        4      64512       39       39     0 00:18:35 Established        0
 10.0.2.2        4      64512     1001     1001     0 16:39:11 Established        0
```

A informação anterior mostra que as relações de vizinhança BGP são estabelecidas entre os três roteadores.

Em R1, executar o comando **timer** para mudar o tempo de keepalive do BGP para 30 segundos, e o tempo de espera para 90 segundos. Execute o comando **display bgp peer verbose** para ver o intervalo de negociação, após negociado o intervalo o relacionamento de peer é estabelecido entre R1 e R2.

```
[R1-bgp] timer keepalive 30 hold 90
```

Note que os vizinhos BGP de R1 será reiniciado se o tempo de keepalive e tempo de espera são alterados.

```
[R2]display bgp peer verbose

  BGP Peer is 10.0.1.1,  remote AS 64512
  Type: IBGP link
  BGP version 4, Remote router ID 10.0.1.1
  Update-group ID: 1
  BGP current state: Established, Up for 00h07m19s
  BGP current event: KATimerExpired
  BGP last state: OpenConfirm
  BGP Peer Up count: 2
  Received total routes: 0
  Received active routes total: 0
  Advertised total routes: 0
  Port:  Local - 50117    Remote - 179
  Configured: Connect-retry Time: 32 sec
  Configured: Active Hold Time: 180 sec   Keepalive Time:60 sec
  Received  : Active Hold Time: 90 sec
  Negotiated: Active Hold Time: 90 sec    Keepalive Time:30 sec
  Peer optional capabilities:
  Peer supports bgp multi-protocol extension
  Peer supports bgp route refresh capability
  Peer supports bgp 4-byte-as capability
  Address family IPv4 Unicast: advertised and received
Received: Total 16 messages
          Update messages              0
```

```
              Open messages                1
              KeepAlive messages           15
              Notification messages        0
              Refresh messages             0
Sent: Total 16 messages
              Update messages              0
              Open messages                1
              KeepAlive messages           15
              Notification messages        0
              Refresh messages             0
Authentication type configured: None
Last keepalive received: 2011/12/07 08:33:52
Minimum route advertisement interval is 15 seconds
Optional capabilities:
Route refresh capability has been enabled
4-byte-as capability has been enabled
Connect-interface has been configured
Peer Preferred Value: 0
Routing policy configured:
No routing policy is configured

      BGP Peer is 10.0.3.3,  remote AS 64512
      Type: IBGP link
      BGP version 4, Remote router ID 10.0.3.3
      Update-group ID: 1
      BGP current state: Established, Up for 16h28m14s
      BGP current event: RecvKeepalive
      BGP last state: OpenConfirm
      BGP Peer Up count: 1
      Received total routes: 0
      Received active routes total: 0
      Advertised total routes: 0
      Port:  Local - 179     Remote - 49663
      Configured: Connect-retry Time: 32 sec
      Configured: Active Hold Time: 180 sec   Keepalive Time:60 sec
      Received  : Active Hold Time: 180 sec
      Negotiated: Active Hold Time: 180 sec   Keepalive Time:60 sec
      Peer optional capabilities:
      Peer supports bgp multi-protocol extension
      Peer supports bgp route refresh capability
      Peer supports bgp 4-byte-as capability
      Address family IPv4 Unicast: advertised and received
Received: Total 990 messages
```

```
                Update messages              0
                Open messages                1
                KeepAlive messages           989
                Notification messages        0
                Refresh messages             0
Sent: Total 990 messages
                Update messages              0
                Open messages                1
                KeepAlive messages           989
                Notification messages        0
                Refresh messages             0
Authentication type configured: None
Last keepalive received: 2011/12/07 08:34:17
Minimum route advertisement interval is 15 seconds
Optional capabilities:
Route refresh capability has been enabled
4-byte-as capability has been enabled
Connect-interface has been configured
Peer Preferred Value: 0
Routing policy configured:
No routing policy is configured
```

No R2, **Active Hold Time** está definido para **180** segundos e o **Keepalive Time** para **60** segundos por padrão.

Após o keepalive time e o hold time serem alterados para o R1, o valor do **Active Hold Time** nos pacotes recebidos pelo R2 é de **90 segundos**. Durante a negociação, os menores valores tem efeito. Portanto, o valor de negociação do **Active Hold Time** é de **90 segundos**, é do do **Keepalive Time** é de **30 segundos**. Os valores padrão dos dois parâmetros são mantidos para R3.

O mesmo que no R3, **Active Hold Time** é alterado para **180 segundos** e o **Keepalive Time** para **60 segundos** por padrão no R2.

Step 4 **Configure EBGP peers.**

Configure BGP no R4 e configure o AS ID local para 64513. Estabeleça uma relação de pares entre o R4 e o R1. Quando estabelecer a relação de pares, defina o endereço IP para a interface Loopback 0 como a fonte de atualização e ajuste **ebgp-max-hop** para 2. Adicione uma rota estática com uma máscara de sub-rede de 32 bits para o endereço IP do par da interface Loopback 0 para que a relação entre pares possa ser

estabelecida com sucesso.

```
[R1]ip route-static 10.0.4.4 32 10.0.14.4
[R4]ip route-static 10.0.1.1 32 10.0.14.1

[R1]bgp 64512
[R1-bgp]peer 10.0.4.4 as-number 64513
[R1-bgp]peer 10.0.4.4 ebgp-max-hop 2
[R1-bgp]peer 10.0.4.4 connect-interface LoopBack0

[R4]bgp 64513
[R4-bgp]peer 10.0.1.1 as-number 64512
[R4-bgp]peer 10.0.1.1 ebgp-max-hop 2
[R4-bgp]peer 10.0.1.1 connect-interface LoopBack0
```

Execute o comando **display bgp peer** para ver a relação de pares.

```
[R4]display bgp peer

 BGP local router ID : 10.0.4.4
 Local AS number : 64513
 Total number of peers : 1              Peers in established state : 1

Peer        V       AS  MsgRcvd   MsgSent    OutQ    Up/Down  State PrefRcv

10.0.1.1     4      64512      4        5     0 00:01:18    Established      0
```

No R4, execute o comando **debugging ip packet verbose** para ver o time to live (TTL) dos pacotes keepalive.

```
<R4>debugging ip packet verbose
Dec  7 2011 09:09:07.240.2+00:00 R4 IP/7/debug_case:
Delivering, interface = S1/0/0, version = 4, headlen = 20, tos = 192,
pktlen = 40, pktid = 11346, offset = 0, ttl = 2, protocol = 6,
checksum = 29370, s = 10.0.1.1, d = 10.0.4.4
prompt: Packet is before IP_Reass before really deliver to up.

45 c0 00 28 2c 52 00 00 02 06 72 ba 0a 00 01 01
0a 00 04 04 c7 cd 00 b3 91 99 51 7b 2b aa b0 8f
50 10 40 00 cf 00 00 00

Dec  7 2011 09:11:07.640.3+00:00 R4 IP/7/debug_case:
Delivering, interface = S1/0/0, version = 4, headlen = 20, tos = 192,
pktlen = 40, pktid = 11383, offset = 0, ttl = 2, protocol = 6,
```

```
checksum = 29333, s = 10.0.1.1, d = 10.0.4.4
prompt: IP packet is delivering up!
```

O TTL dos pacotes recebidos é 2.

Estabeleça uma relação de pares EBGP entre o R3 e o R5 usando a interface física deles.

```
[R3]bgp 64512
[R3-bgp]peer 10.0.35.5 as-number 64514

[R5]bgp 64514
[R5-bgp]peer 10.0.35.3 as-number 64512
[R5-bgp]display bgp peer

 BGP local router ID : 10.1.5.5
   Local AS number : 64514
   Total number of peers : 1              Peers in established state : 1

   Peer       V     AS    MsgRcvd  MsgSent   OutQ  Up/Down   State    PrefRcv

   10.0.35.3    4    64512      2      2       0 00:00:57   Established      0
```

Step 5 **Anuncie informações de roteamento usando o comando network.**

Defina o endereço IP para 10.1.4.4/24 para a interface Loopback 1 do R4. Execute o comando de rede para anunciar este segmento de rede para BGP.

```
[R4]interface LoopBack 1
[R4-LoopBack1]ip address 10.1.4.4 24
[R4-LoopBack1]bgp 64513
[R4-bgp]network 10.1.4.4 24
```

Verifique se a rota 10.1.4.4/24 existe nas tabelas de roteamento globais de R1 e R3.

Veja a tabela de roteamento BGP de R3 para encontrar o próximo salto desta rota.

```
[R1]display ip routing-table
Route Flags: R - relay, D - download to fib
```

```
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 18        Routes : 18

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.1.1/32   Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.2.2/32   OSPF    10   1562        D   10.0.12.2       Serial1/0/0
      10.0.3.3/32   OSPF    10   3124        D   10.0.12.2       Serial1/0/0
      10.0.4.4/32   Static  60   0           RD  10.0.14.4       Serial3/0/0
     10.0.12.0/24   Direct  0    0           D   10.0.12.1       Serial1/0/0
     10.0.12.1/32   Direct  0    0           D   127.0.0.1       InLoopBack0
     10.0.12.2/32   Direct  0    0           D   10.0.12.2       Serial1/0/0
   10.0.12.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
     10.0.14.0/24   Direct  0    0           D   10.0.14.1       Serial3/0/0
     10.0.14.1/32   Direct  0    0           D   127.0.0.1       InLoopBack0
     10.0.14.4/32   Direct  0    0           D   10.0.14.4       Serial3/0/0
   10.0.14.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
     10.0.23.0/24   OSPF    10   3124        D   10.0.12.2       Serial1/0/0
      10.1.4.0/24   EBGP    255  0           RD  10.0.4.4        Serial3/0/0
     127.0.0.0/8    Direct  0    0           D   127.0.0.1       InLoopBack0
     127.0.0.1/32   Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/3   Direct  0    0           D   127.0.0.1       InLoopBack0
```

R1 aprende a rota EBGP 10.1.4.0/24.

Verifique se a tabela de roteamento do R3 possui a rota 10.1.4.0/24.

```
[R3]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 16        Routes : 16

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

      10.0.1.1/32   OSPF    10   3124        D   10.0.23.2       Serial2/0/0
      10.0.2.2/32   OSPF    10   1562        D   10.0.23.2       Serial2/0/0
      10.0.3.3/32   Direct  0    0           D   127.0.0.1       InLoopBack0
     10.0.12.0/24   OSPF    10   3124        D   10.0.23.2       Serial2/0/0
     10.0.23.0/24   Direct  0    0           D   10.0.23.3       Serial2/0/0
     10.0.23.2/32   Direct  0    0           D   10.0.23.2       Serial2/0/0
     10.0.23.3/32   Direct  0    0           D   127.0.0.1       InLoopBack0
```

```
    10.0.23.255/32  Direct  0    0          D   127.0.0.1       InLoopBack0
      10.0.35.0/24  Direct  0    0          D   10.0.35.3       Serial3/0/0
      10.0.35.3/32  Direct  0    0          D   127.0.0.1       InLoopBack0
      10.0.35.5/32  Direct  0    0          D   10.0.35.5       Serial3/0/0
    10.0.35.255/32  Direct  0    0          D   127.0.0.1       InLoopBack0
      127.0.0.0/8   Direct  0    0          D   127.0.0.1       InLoopBack0
      127.0.0.1/32  Direct  0    0          D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0          D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0          D   127.0.0.1       InLoopBack0
```

A tabela de roteamento do R3 não possui a rota 10.1.4.0/24.

Veja a tabela de roteamento BGP do R3.

```
[R3]display bgp routing-table

 BGP Local router ID is 10.0.3.3
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete


 Total Number of Routes: 1
      Network            NextHop        MED        LocPrf    PrefVal Path/Ogn

   i  10.1.4.0/24        10.0.4.4       0          100       0       64513i
```

A rota 10.1.4.0/24 é encontrada na tabela de roteamento BGP do R3, porém não tem um asterisco (*).Isto indica que esta rota não é a melhor e, portanto, não será utilizada. Isso ocorre porque o próximo salto desta rota é 10.0.4.4, porém o R3 não possui uma rota para 10.0.4.4. De acordo com o BGP, a rota não é usada se o próximo salto é inalcançável.

Configure o **next-hop-local** no R1 e depois veja a tabela de roteamento do R3.

```
[R1]bgp 64512
[R1-bgp]peer 10.0.3.3  next-hop-local
[R1-bgp]peer 10.0.2.2  next-hop-local
[R1-bgp]quit
[R3]display bgp routing-table

 BGP Local router ID is 10.0.3.3
 Status codes: * - valid, > - best, d - damped,
```

```
            h - history,  i - internal, s - suppressed, S - Stale
            Origin : i - IGP, e - EGP, ? - incomplete


 Total Number of Routes: 1
      Network          NextHop       MED        LocPrf    PrefVal Path/Ogn

 *>i  10.1.4.0/24       10.0.1.1       0          100        0      64513i
```

O próximo salto da rota BGP 10.1.4.0/24 é 10.0.1.1 e esta rota possui um asterisco (*) e um sinal de maior (>). Isto indica que a rota é a correta e a melhor.

Veja a tabela de roteamento do R3.

```
[R3]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 17      Routes : 17

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

       10.0.1.1/32   OSPF    10   3124        D   10.0.23.2       Serial2/0/0
       10.0.2.2/32   OSPF    10   1562        D   10.0.23.2       Serial2/0/0
       10.0.3.3/32   Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.12.0/24   OSPF    10   3124        D   10.0.23.2       Serial2/0/0
      10.0.23.0/24   Direct  0    0           D   10.0.23.3       Serial2/0/0
      10.0.23.2/32   Direct  0    0           D   10.0.23.2       Serial2/0/0
      10.0.23.3/32   Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.23.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.35.0/24   Direct  0    0           D   10.0.35.3       Serial3/0/0
      10.0.35.3/32   Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.35.5/32   Direct  0    0           D   10.0.35.5       Serial3/0/0
    10.0.35.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
       10.1.4.0/24   IBGP    255  0          RD   10.0.1.1        Serial2/0/0
      127.0.0.0/8    Direct  0    0           D   127.0.0.1       InLoopBack0
      127.0.0.1/32   Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32   Direct  0    0           D   127.0.0.1       InLoopBack0
```

A rota 10.1.4.0/24 é encontrada.

Defina o endereço IP para 10.1.5.5/24 para a interface Loopback 1 do

R5. Anuncie esta rota para BGP e configure o **next-hop-local** no R3.

```
[R5]interface LoopBack 1
[R5-LoopBack1]ip address 10.1.5.5 24
[R5-LoopBack1]quit

[R5]bgp 64514
[R5-bgp]network 10.1.5.0 24

[R3]bgp 64512
[R3-bgp]peer 10.0.1.1 next-hop-local
[R3-bgp]peer 10.0.2.2 next-hop-local
```

Verifique se R4 aprendeu a rota para o segmento de rede onde a interface Loopback 1 do R5 reside. Analise a saída do comando **display bgp routing-table**.

```
[R4]display bgp routing-table

 BGP Local router ID is 10.0.4.4
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete


 Total Number of Routes: 2
      Network            NextHop        MED        LocPrf    PrefVal Path/Ogn

 *>   10.1.4.0/24        0.0.0.0         0                    0      i
 *>   10.1.5.0/24        10.0.1.1                             0      64512 64514i
```

No R5, execute um ping na interface Loopback 1 do R4 a partir da interface Loopback 1 do R5.

```
[R5]ping -c 1 -a  10.1.5.5 10.1.4.4
  PING 10.1.4.4: 56  data bytes, press CTRL_C to break
    Reply from 10.1.4.4: bytes=56 Sequence=1 ttl=252 time=125 ms

  --- 10.1.4.4 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 125/125/125 ms
```

Exercícios Adicionais: Analisar e Verificar

Descobrir quando interfaces físicas devem ser usadas para estabelecer relações de vizinhança EBGP.

Descobrir por que o TTL dos pacotes enviados para EBGP vizinhos é 1.

Descobrir o valor padrão do **hop-count** no comando **peer *group_name* ebgp-max-hop *[hop-count]***.

1.5 Configurações Finais

```
[R1]display current-configuration
[V200R001C00SPC200]
#
 sysname R1
#
 router id 10.0.1.1
#
interface Serial1/0/0
 link-protocol ppp
 ip address 10.0.12.1 255.255.255.0
#
interface Serial3/0/0
 link-protocol ppp
 ip address 10.0.14.1 255.255.255.0
#
interface LoopBack0
 ip address 10.0.1.1 255.255.255.255
#
bgp 64512
 timer keepalive 30 hold 90
 peer 10.0.2.2 as-number 64512
 peer 10.0.2.2 connect-interface LoopBack0
 peer 10.0.3.3 as-number 64512
 peer 10.0.3.3 connect-interface LoopBack0
 peer 10.0.4.4 as-number 64513
 peer 10.0.4.4 ebgp-max-hop 2
 peer 10.0.4.4 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
```

```
  peer 10.0.2.2 enable
  peer 10.0.2.2 next-hop-local
  peer 10.0.3.3 enable
  peer 10.0.3.3 next-hop-local
  peer 10.0.4.4 enable
#
ospf 1
 area 0.0.0.0
  network 10.0.12.0 0.0.0.255
  network 10.0.1.1 0.0.0.0
#
 ip route-static 10.0.4.4 255.255.255.255 10.0.14.4
return
```

[R2]display current-configuration

```
[V200R001C00SPC200]
#
 sysname R2
#
 router id 10.0.2.2
#
interface Serial1/0/0
 link-protocol ppp
 ip address 10.0.12.2 255.255.255.0
#
interface Serial2/0/0
 link-protocol ppp
 ip address 10.0.23.2 255.255.255.0
#
interface LoopBack0
 ip address 10.0.2.2 255.255.255.255
#
bgp 64512
 peer 10.0.1.1 as-number 64512
 peer 10.0.1.1 connect-interface LoopBack0
 peer 10.0.3.3 as-number 64512
 peer 10.0.3.3 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  peer 10.0.1.1 enable
  peer 10.0.3.3 enable
#
```

```
ospf 1
 area 0.0.0.0
  network 10.0.12.0 0.0.0.255
  network 10.0.23.0 0.0.0.255
  network 10.0.2.2 0.0.0.0
return
```

[R3]display current-configuration

```
[V200R001C00SPC200]
#
 sysname R3
#
 router id 10.0.3.3
#
interface Serial2/0/0
 link-protocol ppp
 ip address 10.0.23.3 255.255.255.0
#
interface Serial3/0/0
 link-protocol ppp
 ip address 10.0.35.3 255.255.255.0
#
interface LoopBack0
 ip address 10.0.3.3 255.255.255.255
#
bgp 64512
 peer 10.0.1.1 as-number 64512
 peer 10.0.1.1 connect-interface LoopBack0
 peer 10.0.2.2 as-number 64512
 peer 10.0.2.2 connect-interface LoopBack0
 peer 10.0.35.5 as-number 64514
 #
 ipv4-family unicast
  undo synchronization
  peer 10.0.1.1 enable
  peer 10.0.1.1 next-hop-local
  peer 10.0.2.2 enable
  peer 10.0.2.2 next-hop-local
  peer 10.0.35.5 enable
#
ospf 1
 area 0.0.0.0
  network 10.0.23.0 0.0.0.255
```

```
 network 10.0.3.3 0.0.0.0
return
```

[R4]display current-configuration

```
[V200R001C00SPC200]
#
 sysname R4
#
interface Serial1/0/0
 link-protocol ppp
 ip address 10.0.14.4 255.255.255.0
#
interface LoopBack0
 ip address 10.0.4.4 255.255.255.255
#
interface LoopBack1
 ip address 10.1.4.4 255.255.255.0
#
bgp 64513
 peer 10.0.1.1 as-number 64512
 peer 10.0.1.1 ebgp-max-hop 2
 peer 10.0.1.1 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  network 10.0.4.0 255.255.255.0
  network 10.1.4.0 255.255.255.0
  peer 10.0.1.1 enable
#
 ip route-static 10.0.1.1 255.255.255.255 10.0.14.1
return
```

[R5]display current-configuration

```
[V200R001C00SPC200]
#
 sysname R5
#
interface Serial1/0/0
 link-protocol ppp
 ip address 10.0.35.5 255.255.255.0
#
interface LoopBack0
 ip address 10.0.5.5 255.255.255.255
```

```
#
interface LoopBack1
 ip address 10.1.5.5 255.255.255.0
#
bgp 64514
 peer 10.0.35.3 as-number 64512
 #
 ipv4-family unicast
  undo synchronization
  network 10.1.5.0 255.255.255.0
  peer 10.0.35.3 enable
return
```

2 Atributos BGP e Seleção de Caminho

2.1 Objetivos de Aprendizagem

Os objetivos deste laboratório são aprender e compreender:

- Método usado para mudar a seleção de caminho pela configuração do atributo **AS-PATH**
- Método usado para mudar a seleção de caminho pela configuração do atributo **Origin**
- Método usado para mudar a seleção de caminho pela configuração do atributo **Local-Pref**
- Método usado para mudar a seleção de caminho pela configuração do atributo **MED**

2.2 Topologia

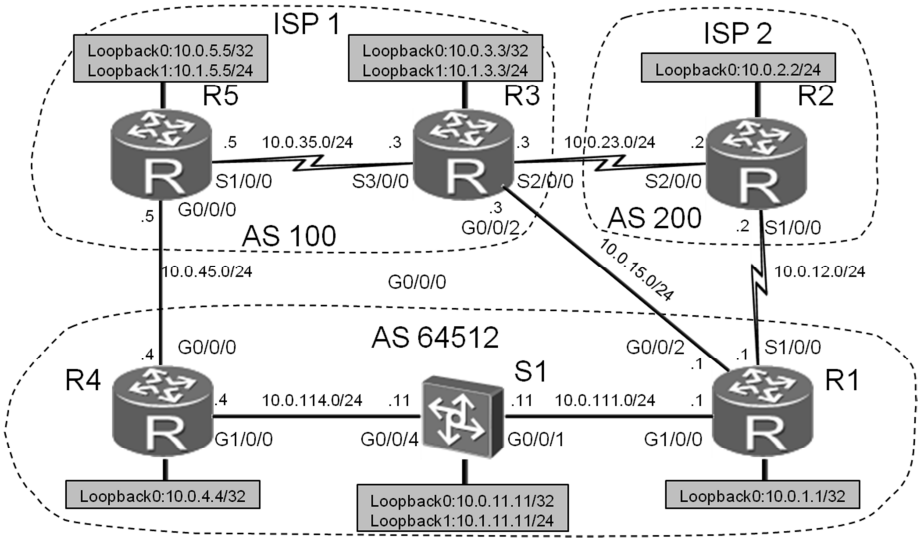

Figure 3-3 BGP attributes and path selection

2.3 Cenário

Suponha que você é um engenheiro de rede de uma empresa. A rede da empresa utiliza BGP para acessar dois prestadores de serviços. A empresa utiliza o privado AS 64512. O número de AS para ISP1 é 100, e 200 para ISP2. A empresa oferece dois links de acesso a ISP1 e aluga uma linha de acesso a ISP2. Alguns assinantes de Internet se queixam de que a velocidade da rede da empresa é muito lento. Portanto, você deve modificar atributos BGP para ajustar as direções de rota.

2.4 Tarefas

Step 1 Configure os endereços IP.

Configurar endereços IP e máscaras para as interfaces físicas e interfaces loopback de todos os roteadores. As interfaces de Loopback0 usam máscaras de 32 bits.

```
<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R1
[R1]interface Serial 1/0/0
[R1-Serial1/0/0]ip address 10.0.12.1 255.255.255.0
[R1-Serial1/0/0]interface GigabitEthernet 0/0/2
[R1-GigabitEthernet0/0/2]ip address 10.0.15.1 255.255.255.0
[R1-GigabitEthernet0/0/2]interface GigabitEthernet 0/0/1
[R1-GigabitEthernet0/0/1]ip address 10.0.111.1 255.255.255.0
[R1-GigabitEthernet0/0/1]interface LoopBack 0
[R1-LoopBack0]ip address 10.0.1.1 255.255.255.255

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R2
[R2]interface Serial 1/0/0
[R2-Serial1/0/0]ip address 10.0.12.2 255.255.255.0
[R2-Serial1/0/0]int Serial 2/0/0
[R2-Serial2/0/0]ip address 10.0.23.2 255.255.255.0
[R2-Serial2/0/0]interface LoopBack 0
[R2-LoopBack0]ip address 10.0.2.2 255.255.255.0

<Huawei>system-view
```

```
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R3
[R3]interface GigabitEthernet 0/0/2
[R3-GigabitEthernet0/0/2]ip address 10.0.15.3 255.255.255.0
[R3-GigabitEthernet0/0/2]interface Serial 2/0/0
[R3-Serial2/0/0]ip address 10.0.23.3 255.255.255.0
[R3-Serial2/0/0]interface Serial 3/0/0
[R3-Serial3/0/0]ip address 10.0.35.3 255.255.255.0
[R3-Serial3/0/0]interface loopback 0
[R3-LoopBack0]ip address 10.0.3.3 255.255.255.255

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R4
[R4]interface GigabitEthernet 0/0/1
[R4-GigabitEthernet0/0/1]ip address 10.0.114.4 255.255.255.0
[R4-GigabitEthernet0/0/1]interface GigabitEthernet 0/0/0
[R4-GigabitEthernet0/0/0]ip address 10.0.45.4 255.255.255.0
[R4-GigabitEthernet0/0/0]interface loopback 0
[R4-LoopBack0]ip address 10.0.4.4 255.255.255.255

<Huawei>system-view
Enter system view, return user view with Ctrl+Z.
[Huawei]sysname R5
[R5]interface Serial 1/0/0
[R5-Serial1/0/0]ip address 10.0.35.5 255.255.255.0
[R5-Serial1/0/0]interface GigabitEthernet 0/0/0
[R5-GigabitEthernet0/0/0]ip address 10.0.45.5 255.255.255.0
[R5-GigabitEthernet0/0/0]interface loopback 0
[R5-LoopBack0]ip address 10.0.5.5 255.255.255.255
```

Depois de configurar os endereços IP e máscaras, testar a conectividade de links diretos.

```
<R1>ping -c 1 10.0.12.2
  PING 10.0.12.2: 56  data bytes, press CTRL_C to break
    Reply from 10.0.12.2: bytes=56 Sequence=1 ttl=255 time=29 ms

  --- 10.0.12.2 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 29/29/29 ms
```

```
[R1]ping -c 1 10.0.15.3
  PING 10.0.15.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.15.3: bytes=56 Sequence=1 ttl=255 time=59 ms

  --- 10.0.15.3 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 59/59/59 ms

<R2>ping -c 1 10.0.23.3
  PING 10.0.23.3: 56  data bytes, press CTRL_C to break
    Reply from 10.0.23.3: bytes=56 Sequence=1 ttl=255 time=32 ms

  --- 10.0.23.3 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 32/32/32 ms

[R3]ping -c 1 10.0.35.5
  PING 10.0.35.5: 56  data bytes, press CTRL_C to break
    Reply from 10.0.35.5: bytes=56 Sequence=1 ttl=255 time=36 ms

  --- 10.0.35.5 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
    round-trip min/avg/max = 36/36/36 ms

<R4>ping -c 1 10.0.45.5
  PING 10.0.45.5: 56  data bytes, press CTRL_C to break
    Reply from 10.0.45.5: bytes=56 Sequence=1 ttl=255 time=11 ms

  --- 10.0.45.5 ping statistics ---
    1 packet(s) transmitted
    1 packet(s) received
    0.00% packet loss
round-trip min/avg/max = 11/11/11 ms
```

Step 2 **Configure IGP e BGP.**

Configure AS 64512 para usar OSPF como o IGP e adicionar todos os dispositivos no AS 64512 para a área 0.

Ativar OSPF sobre os segmentos de rede, tanto em G0/0/1 e na Loopback0 de R1.

```
[R1]ospf
[R1-ospf-1]area 0
[R1-ospf-1-area-0.0.0.0]network 10.0.111.1 0.0.0.0
[R1-ospf-1-area-0.0.0.0]network 10.0.1.1 0.0.0.0
```

Criar a VLAN 111 em S1 e configurar um endereço de IP Vlanif para interconexão com R1.

Criar a VLAN 114 em S1 e configurar um endereço de IP Vlanif para interconexão com R4.

Defina o modo de trabalho das interfaces interligadas para Access e habilite OSPF sobre Vlanif 111 e Vlanif 114 do S1 e da interface Loopback0.

```
[S1]vlan 111
[S1-vlan111]vlan 114
[S1]interface vlan 111
[S1-Vlanif111]ip address 10.0.111.11 255.255.255.0
[S1-Vlanif111]int vlan 114
[S1-Vlanif114]ip address 10.0.114.11 255.255.255.0
[S1]interface loopback 0
[S1-LoopBack0]ip address 10.0.11.11 255.255.255.255
[S1-LoopBack0]interface GigabitEthernet 0/0/1
[S1-GigabitEthernet0/0/1]port link-type access
[S1-GigabitEthernet0/0/1]port default vlan 111
[S1-GigabitEthernet0/0/1]interface GigabitEthernet 0/0/4
[S1-GigabitEthernet0/0/4]port link-type access
[S1-GigabitEthernet0/0/4]port default vlan 114
[S1-GigabitEthernet0/0/4]ospf
[S1-ospf-1]area 0
[S1-ospf-1-area-0.0.0.0]network 10.0.111.11 0.0.0.0
[S1-ospf-1-area-0.0.0.0]network 10.0.114.11 0.0.0.0
[S1-ospf-1-area-0.0.0.0]network 10.0.11.11 0.0.0.0
```

Habilite o OSPF nos segmentos de rede de G0/0/1 e da Loopback0

do R4.

```
[R4]ospf
[R4-ospf-1]area 0
[R4-ospf-1-area-0.0.0.0]network 10.0.114.4 0.0.0.0
[R4-ospf-1-area-0.0.0.0]network 10.0.4.4 0.0.0.0
```

Verifique se os roteadores aprenderam as rotas associadas com as interfaces Loopback0 de outros dispositivos.

```
[R1]display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 23        Routes : 23

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

        10.0.1.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
        10.0.4.4/32  OSPF    10   2           D   10.0.111.11 GigabitEthernet0/0/1
       10.0.11.11/32 OSPF    10   1           D   10.0.111.11 GigabitEthernet0/0/1
       10.0.12.0/24  Direct  0    0           D   10.0.12.1       Serial1/0/0
       10.0.12.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
       10.0.12.2/32  Direct  0    0           D   10.0.12.2       Serial1/0/0
     10.0.12.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
       10.0.14.0/24  Direct  0    0           D   10.0.14.1       Serial3/0/0
       10.0.14.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
       10.0.14.4/32  Direct  0    0           D   10.0.14.4       Serial3/0/0
     10.0.14.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
       10.0.15.0/24  Direct  0    0           D   10.0.15.1       Serial2/0/0
       10.0.15.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
       10.0.15.3/32  Direct  0    0           D   10.0.15.3       Serial2/0/0
     10.0.15.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.111.0/24  Direct  0    0           D   10.0.111.1  GigabitEthernet0/0/1
      10.0.111.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.111.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
      10.0.114.0/24  OSPF    10   2           D   10.0.111.11 GigabitEthernet0/0/1
       127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
       127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
255.255.255.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0

[S1]display ip routing-table
Route Flags: R - relay, D - download to fib
```

```
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 11        Routes : 11

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

        10.0.1.1/32  OSPF    10   1           D   10.0.111.1      Vlanif111
        10.0.4.4/32  OSPF    10   1           D   10.0.114.4      Vlanif114
    10.0.11.11/32  Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.111.0/24  Direct  0    0           D   10.0.111.11     Vlanif111
   10.0.111.11/32  Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.114.0/24  Direct  0    0           D   10.0.114.11     Vlanif114
   10.0.114.11/32  Direct  0    0           D   127.0.0.1       InLoopBack0
     10.1.11.0/24  Direct  0    0           D   10.1.11.11      LoopBack1
    10.1.11.11/32  Direct  0    0           D   127.0.0.1       InLoopBack0
     127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
     127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0

<R4>display ip routing-table
Route Flags: R - relay, D - download to fib
------------------------------------------------------------------------------
Routing Tables: Public
         Destinations : 18        Routes : 18

Destination/Mask    Proto   Pre  Cost      Flags NextHop         Interface

        10.0.1.1/32  OSPF    10   2           D   10.0.114.11 GigabitEthernet0/0/1
        10.0.4.4/32  Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.11.11/32  OSPF    10   1           D   10.0.114.11 GigabitEthernet0/0/1
     10.0.14.0/24  Direct  0    0           D   10.0.14.4       Serial1/0/0
     10.0.14.1/32  Direct  0    0           D   10.0.14.1       Serial1/0/0
     10.0.14.4/32  Direct  0    0           D   127.0.0.1       InLoopBack0
   10.0.14.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
     10.0.45.0/24  Direct  0    0           D   10.0.45.4   GigabitEthernet0/0/0
     10.0.45.4/32  Direct  0    0           D   127.0.0.1       InLoopBack0
   10.0.45.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
    10.0.111.0/24  OSPF    10   2           D   10.0.114.11 GigabitEthernet0/0/1
    10.0.114.0/24  Direct  0    0           D   10.0.114.4  GigabitEthernet0/0/1
    10.0.114.4/32  Direct  0    0           D   127.0.0.1       InLoopBack0
  10.0.114.255/32  Direct  0    0           D   127.0.0.1       InLoopBack0
     127.0.0.0/8   Direct  0    0           D   127.0.0.1       InLoopBack0
     127.0.0.1/32  Direct  0    0           D   127.0.0.1       InLoopBack0
127.255.255.255/32 Direct  0    0           D   127.0.0.1       InLoopBack0
```

```
255.255.255.255/32  Direct  0    0          D   127.0.0.1       InLoopBack0
```

Configurar BGP em R1, R4, e S1 e usar suas interfaces Loopback0 para estabelecer relacionamentos com seus pares. Use o grupo de pares AS64512 para configuração.

A função de balanceamento de carga de BGP é desabilitada por padrão. Ativar o balanceamento de carga em todos os roteadores e definir o número máximo de caminhos de custo igual para 4.

```
[R1]bgp 64512
[R1-bgp]group as64512 internal
[R1-bgp]peer 10.0.11.11 group as64512
[R1-bgp]peer 10.0.11.11 connect-interface LoopBack 0
[R1-bgp]maximum load-balancing 4

[S1]bgp 64512
[S1-bgp]group as64512 internal
[S1-bgp]peer 10.0.4.4 group as64512
[S1-bgp]peer 10.0.4.4 connect-interface LoopBack 0
[S1-bgp]maximum load-balancing 4
[S1-bgp]peer 10.0.1.1 group as64512
[S1-bgp]peer 10.0.1.1 connect-interface LoopBack 0

[R4]bgp 64512
[R4-bgp]group as64512 internal
[R4-bgp]peer 10.0.11.11 group as64512
[R4-bgp]peer 10.0.11.11 connect-interface LoopBack 0
[R4-bgp]maximum load-balancing 4
```

Configure EBGP no R1, R2, R3, R4 e no R5. Estabelecer relações entre pares usando os endereços IP de interfaces físicas. Para a topologia de AS, consulte o diagrama.

```
[R1]bgp 64512
[R1-bgp]peer 10.0.12.2 as-number 200
[R1-bgp]peer 10.0.15.3 as-number 100

[R2]bgp 200
[R2-bgp]peer 10.0.12.1 as-number 64512
[R2-bgp]peer 10.0.23.3 as-number 100
[R2-bgp]maximum load-balancing 4

[R3]bgp 100
```

```
[R3-bgp]peer 10.0.23.2 as-number 200
[R3-bgp]peer 10.0.35.5 as-number 100
[R3-bgp]peer 10.0.15.1 as-number 64512
[R3-bgp]maximum load-balancing 4

[R4]bgp 64512
[R4-bgp]peer 10.0.45.5 as-number 100

[R5]bgp 100
[R5-bgp]peer 10.0.35.3 as-number 100
[R5-bgp]peer 10.0.45.4 as-number 64512
[R5-bgp]maximum load-balancing 4
```

Step 3 **Configure o atributo AS-PATH.**

Criar Loopback1 em S1, que usa o endereço IP 10.1.11.11/24. Execute o comando **network** para anunciar a rota 10.1.11.0/24 para BGP.

```
[S1]interface loopback 1
[S1-LoopBack1]ip address 10.1.11.11 255.255.255.0
[S1-LoopBack1]bgp 64512
[S1-bgp]network 10.1.11.11 255.255.255.0
```

Verifique a tabela de roteamento BGP no R2. A rota 10.1.11.0/24 seleciona o próximo salto com base no atributo **AS-PATH**.

```
[R2]display bgp routing-table

 BGP Local router ID is 10.0.12.2
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete


 Total Number of Routes: 2
      Network         NextHop       MED       LocPrf    PrefVal Path/Ogn

 *>   10.1.11.0/24   10.0.12.1                              0      64512i
 *                   10.0.23.3                              0      100 64512i
```

A largura de banda entre o R1 e R4 é limitada; entretanto, R2 precisa acessar o segmento de rede 10.1.11.0/24 por meio do AS 100.

O atributo **AS-PATH** é usado para mudar de seleção de caminho.

Criar a política de roteamento as_path no R1 para adicionar os mesmos dois números AS para a rota 10.1.11.0/24.

```
[R1]acl number 2001
[R1-acl-basic-2001]rule 5 permit source 10.1.11.0 0.0.0.255
[R1-acl-basic-2001]route-policy as_path permit node 10
[R1-route-policy]if-match acl 2001
[R1-route-policy]apply as-path 64512 64512 additive
```

Criar uma política de roteamento em R1 para que o atributo **AS-PATH** da rota que R2 aprende de R1 tenha três valores.

```
[R1]bgp 64512
[R1-bgp]peer 10.0.12.2 route-policy as_path export
```

Veja a tabela de roteamento BGP no R2.

```
<R2>display bgp routing-table

 BGP Local router ID is 10.0.12.2
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete


 Total Number of Routes: 2
      Network            NextHop        MED        LocPrf    PrefVal Path/Ogn

 *>   10.1.11.0/24     10.0.23.3                               0       100 64512i
 *                     10.0.12.1                               0       64512 64512
64512i
```

R2 acessa o segmento de rede 10.1.11.0/24 através de AS 100.

Step 4 **Configure o atributo Origin.**

Veja a tabela de roteamento do R3.

```
<R3>display bgp routing-table

 BGP Local router ID is 10.0.15.3
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
```

```
            Origin : i - IGP, e - EGP, ? - incomplete


Total Number of Routes: 2
     Network          NextHop       MED      LocPrf    PrefVal Path/Ogn

*>   10.1.11.0/24     10.0.15.1                            0      64512i
* i                   10.0.35.5               100          0      64512i
```

O próximo salto da rota para segmento de rede 10.1.11.0/24 é R1.

Espera-se que R3 irá acessar AS 64512 através de R5. Verificou-se que o valor do atributo **Origin** contido no percurso 10.1.11.0/24 é **IGP**.

Alterar o status da rota que R1 anuncia para R3 para "incomplete".

```
[R1]route-policy 22 permit node 10
[R1-route-policy]if-match acl 2001
[R1-route-policy]apply origin incomplete
[R1-route-policy]bgp 64512
[R1-bgp]peer 10.0.15.3 route-policy 22 export
```

Após a política de roteamento ter tido efeito, visualizar a tabela de roteamento BGP de R3.

```
<R3>display bgp routing-table

 BGP Local router ID is 10.0.15.3
 Status codes: * - valid, > - best, d - damped,
             h - history,  i - internal, s - suppressed, S - Stale
             Origin : i - IGP, e - EGP, ? - incomplete


 Total Number of Routes: 2
      Network          NextHop       MED       LocPrf    PrefVal Path/Ogn

 *>i  10.1.11.0/24     10.0.35.5               100          0      64512i
 *                     10.0.15.1                            0      64512?
```

O próximo salto da rota de R3 para o segmento de rede 10.1.11.0/24 é R5.

Step 5 **Configure o atributo Local-Pref.**

O atributo **Local-Pref** tem uma alta prioridade na seleção de caminho.

Modificando o atributo **Local-Pref** pode-se mudar a seleção de caminho.

Criar Loopback1 no R3 com endereço IP 10.1.3.3/24. Anuncie a rota 10.1.3.0/24 ao BGP.

```
[R3]interface loopback 1
[R3-LoopBack1]ip address 10.1.3.3 255.255.255.0
[R3-LoopBack1]bgp 100
[R3-bgp]network 10.1.3.3 255.255.255.0
```

Criar Loopback1 no R5 com endereço IP 10.1.5.5/24. Anuncie a rota 10.1.5.0/24 ao BGP.

```
[R5]interface loopback 1
[R5-LoopBack1]ip address 10.1.5.5 255.255.255.0
[R5-LoopBack1]bgp 100
[R5-bgp]network 10.1.5.5 255.255.255.0
```

Veja a tabela de roteamento do S1.

```
[S1]display bgp routing-table

 Total Number of Routes: 5

 BGP Local router ID is 10.0.111.11
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete

     Network            NextHop       MED        LocPrf    PrefVal Path/Ogn

*>i  10.1.3.0/24    10.0.1.1        0          100          0      100i
* i                 10.0.4.4                   100          0      100i
*>i  10.1.5.0/24    10.0.1.1                   100          0      100i
* i                 10.0.4.4        0          100          0      100i
*>   10.1.11.0/24   0.0.0.0         0                       0      i
```

Espera-se que o tráfego para o segmento de rede 10.1.5.0/24

chegará através R4 e que o tráfego para o segmento de rede 10.1.3.0/24 chegará através de R1.

Criar a política de roteamento Pref4 em R4, encontrar a rota 10.1.5.0/24, e definir o atributo **Local-Pref** da rota para **110.**

Criar a política de roteamento Pref1 em R1, encontrar a rota 10.1.3.0/24, defina o atributo **Local-Pref** da rota para **110**, aplicar a política de roteamento para o grupo de pares IBGP.

```
[R4]acl number 2001
[R4-acl-basic-2001]rule 5 permit source 10.1.5.0 0.0.0.255
[R4-acl-basic-2001]quit
[R4]route-policy Pref4 permit node 10
[R4-route-policy]if-match acl 2001
[R4-route-policy]apply local-preference 110
[R4-route-policy]route-policy Pref4 permit node 20
[R4-route-policy]bgp 64512
[R4-bgp]peer as64512 route-policy Pref4 export

[R1]acl number 2002
[R1-acl-basic-2002]rule 5 permit source 10.1.3.0 0.0.0.255
[R1-acl-basic-2002]route-policy Pref1 permit node 10
[R1-route-policy]if-match acl 2002
[R1-route-policy]apply local-preference 110
[R1-route-policy]route-policy Pref1 permit node 20
[R1-route-policy]bgp 64512
[R1-bgp]peer as64512 route-policy Pref1 export
```

Veja a tabela de roteamento BGP do S1.

```
[S1]display bgp routing-table

 Total Number of Routes: 3

 BGP Local router ID is 10.0.111.11
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete

     Network            NextHop       MED        LocPrf    PrefVal Path/Ogn

 *>i  10.1.3.0/24       10.0.1.1       0          110         0      100i
* i                     10.0.4.4                  100         0      100i
```

```
 *>i  10.1.5.0/24       10.0.4.4        0          110        0      100i
* i                     10.0.1.1        0          100        0      100i
 *>   10.1.11.0/24      0.0.0.0         0                     0      i
```

Os caminhos podem ser selecionados com base no atributo **Local-Pref**. A rota com maior valor de atributo é selecionada em primeiro lugar.

Step 6 **Configure o atributo MED.**

Excluir a política de roteamento a partir do step 4 que altera o caminho para a rota 10.1.11.0/24 em AS 100 usando o atributo **Origin**. Neste passo, o atributo **MED** é modificado para alterar a seleção de caminho.

```
[R1]undo route-policy 22
[R1]bgp 64512
[R1-bgp]undo peer 10.0.15.3 route-policy 22 export
```

Criar a política de roteamento med no R1, definir o atributo **MED** para **100** para a rota 10.1.11.0/24, e aplicar a política de roteamento para os pares R3.

```
[R1]route-policy med permit node 10
[R1-route-policy]if-match acl 2001
[R1-route-policy]apply cost 100
[R1-route-policy]bgp 64512
[R1-bgp]peer 10.0.15.3 route-policy med export
```

Veja a tabela de roteamento BGP do R3.

```
<R3>dis bgp routing-table

 BGP Local router ID is 10.0.15.3
 Status codes: * - valid, > - best, d - damped,
               h - history,  i - internal, s - suppressed, S - Stale
               Origin : i - IGP, e - EGP, ? - incomplete


 Total Number of Routes: 4
      Network         NextHop       MED        LocPrf    PrefVal Path/Ogn

 *>   10.1.3.0/24    0.0.0.0        0                    0       i
 *>i  10.1.5.0/24    10.0.35.5      0          100       0       i
```

```
 *>i  10.1.11.0/24  10.0.35.5               100       0      64512i
 *                  10.0.15.1      100                0      64512i
```

A rota com o menor atributo **MED** é selecionada primeiro.

O efeito de modificar o atributo **MED** é o mesmo que o de modificar o atributo **Origin**.

Exercícios Adicionais: Analisar e Verificar

Desativar S1/0/0 de R1 após a conclusão das operações no step 6. Neste caso, o que é o valor do atributo **MED** para a rota 10.1.11.0/24 aprendida pelo R2?

Pode uma política de roteamento ser usada para excluir um AS a partir do atributo **AS-PATH**?

2.5 Configurações Finais

```
<R1>display current-configuration
[V200R001C00SPC200]
#
 sysname R1
#
interface Serial1/0/0
 link-protocol ppp
 ip address 10.0.12.1 255.255.255.0
#
interface Serial3/0/0
 link-protocol ppp
 ip address 10.0.14.1 255.255.255.0
#
interface GigabitEthernet0/0/1
 ip address 10.0.111.1 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 10.0.15.1 255.255.255.0
#
interface LoopBack0
 ip address 10.0.1.1 255.255.255.255
```

```
#
bgp 64512
 peer 10.0.12.2 as-number 200
 peer 10.0.15.3 as-number 100
 group as64512 internal
 peer 10.0.11.11 as-number 64512
 peer 10.0.11.11 group as64512
 peer 10.0.11.11 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  maximum load-balancing 4
  peer 10.0.12.2 enable
  peer 10.0.12.2 route-policy as_path export
  peer 10.0.15.3 enable
  peer 10.0.15.3 route-policy med export
  peer as64512 enable
  peer as64512 route-policy Pref1 export
  peer 10.0.11.11 enable
  peer 10.0.11.11 group as64512
#
ospf 1
 area 0.0.0.0
  network 10.0.1.1 0.0.0.0
  network 10.0.111.1 0.0.0.0
#
route-policy as_path permit node 10
 if-match acl 2001
 apply as-path 64512 64512 additive
#
route-policy Pref1 permit node 10
 if-match acl 2002
 apply local-preference 110
#
route-policy Pref1 permit node 20
#
route-policy med permit node 10
 if-match acl 2001
 apply cost 100
#
return

<R2>display current-configuration
```

```
[V200R001C00SPC200]
#
 sysname R2
#
interface Serial1/0/0
 link-protocol ppp
 ip address 10.0.12.2 255.255.255.0
#
interface Serial2/0/0
 link-protocol ppp
 ip address 10.0.23.2 255.255.255.0
#
interface LoopBack0
 ip address 10.0.2.2 255.255.255.0
#
bgp 200
 peer 10.0.12.1 as-number 64512
 peer 10.0.23.3 as-number 100
 #
 ipv4-family unicast
  undo synchronization
  maximum load-balancing 4
  peer 10.0.12.1 enable
  peer 10.0.23.3 enable
#
return
```

```
<R3>display current-configuration
[V200R001C00SPC200]
#
 sysname R3
#
interface Serial2/0/0
 link-protocol ppp
 ip address 10.0.23.3 255.255.255.0
#
interface Serial3/0/0
 link-protocol ppp
 ip address 10.0.35.3 255.255.255.0
#
interface GigabitEthernet0/0/2
 ip address 10.0.15.3 255.255.255.0
#
```

```
interface LoopBack0
 ip address 10.0.3.3 255.255.255.255
#
interface LoopBack1
 ip address 10.1.3.3 255.255.255.0
#
bgp 100
 peer 10.0.15.1 as-number 64512
 peer 10.0.23.2 as-number 200
 peer 10.0.35.5 as-number 100
 #
 ipv4-family unicast
  undo synchronization
  network 10.1.3.0 255.255.255.0
  maximum load-balancing 4
  peer 10.0.15.1 enable
  peer 10.0.23.2 enable
  peer 10.0.35.5 enable
#
return
```

```
<R4>display current-configuration
[V200R001C00SPC200]
#
 sysname R4
#
interface Serial1/0/0
 link-protocol ppp
 ip address 10.0.14.4 255.255.255.0
#
interface GigabitEthernet0/0/0
 ip address 10.0.45.4 255.255.255.0
#
interface GigabitEthernet0/0/1
 ip address 10.0.114.4 255.255.255.0
#
interface LoopBack0
 ip address 10.0.4.4 255.255.255.255
#
bgp 64512
 peer 10.0.45.5 as-number 100
 group as64512 internal
 peer 10.0.11.11 as-number 64512
```

```
 peer 10.0.11.11 group as64512
 peer 10.0.11.11 connect-interface LoopBack0
 #
 ipv4-family unicast
  undo synchronization
  maximum load-balancing 4
  peer 10.0.45.5 enable
  peer as64512 enable
  peer as64512 route-policy Pref4 export
  peer 10.0.11.11 enable
  peer 10.0.11.11 group as64512
#
ospf 1
 area 0.0.0.0
  network 10.0.114.4 0.0.0.0
  network 10.0.4.4 0.0.0.0
#
route-policy Pref4 permit node 10
 if-match acl 2001
 apply local-preference 110
#
route-policy Pref4 permit node 20
#
return

<R5>display current-configuration
[V200R001C00SPC200]
#
 sysname R5
#
interface Serial1/0/0
 link-protocol ppp
 ip address 10.0.35.5 255.255.255.0
#
interface GigabitEthernet0/0/0
 ip address 10.0.45.5 255.255.255.0
#
interface LoopBack0
 ip address 10.0.5.5 255.255.255.255
#
interface LoopBack1
 ip address 10.1.5.5 255.255.255.0
#
```

```
bgp 100
 peer 10.0.35.3 as-number 100
 peer 10.0.45.4 as-number 64512
 #
 ipv4-family unicast
  undo synchronization
  network 10.1.5.0 255.255.255.0
  maximum load-balancing 4
  peer 10.0.35.3 enable
  peer 10.0.45.4 enable
#
return
```