

MIKROTIK路由协议精英培训

MPLS BGP VPN配置与实现



前言

本课程以MPLS BGP VPN常用简单组网为例，介绍了MPLS BGP VPN基本的配置思路，同时深入介绍了MPLS BGP VPN中涉及到的基本概念。

培训目标

学习完此课程，您将会：

- 掌握MPLS BGP VPN基本配置
- 掌握MPLS BGP VPN中使用的BGP扩展属性

目 录

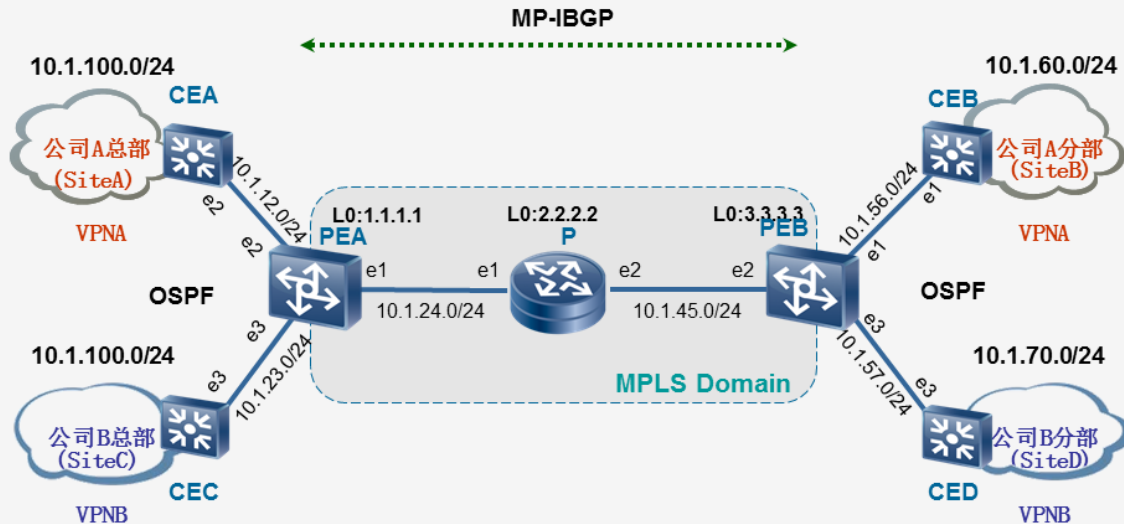
理解与配置VPN-instance

理解与配置PE-CE BGP

理解与配置MP-BGP

理解与配置PE-CE之间路由协议

MPLS BGP VPN基本配置



配置VPN-routing-mark

配置CE和PE之间的OSPF

配置MPLS骨干网IGP

配置MPLS LDP，建立公网LSP

配置PE之间的MP-IBGP

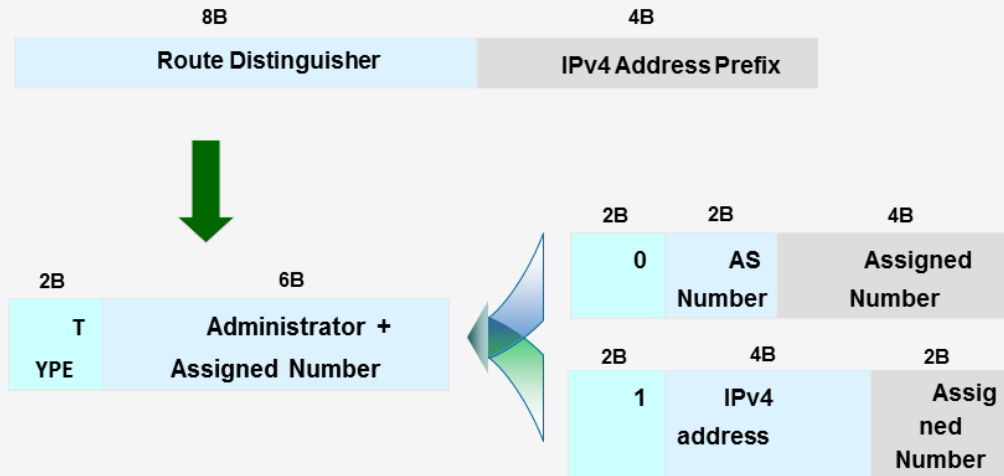
配置VPN-routing-mark

```
[admin@Ros-PEA] > /ip route vrf add export-route-targets=100:1  
import-route-targets=100:1 interfaces=eth2 route-distinguisher=100:1  
routing-mark=vpna
```

```
[admin@Ros-PEA] > /ip route vrf add export-route-targets=200:1  
import-route-targets=200:1 interfaces=eth3 route-distinguisher=200:1  
routing-mark=vpnb
```

VPNv4 & RD

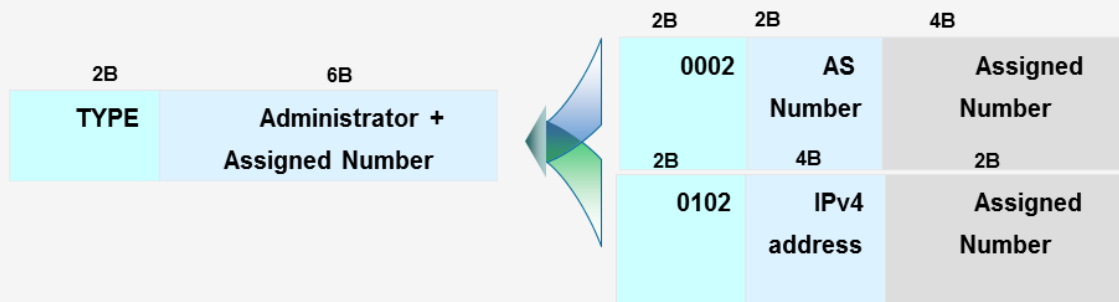
VPN-IPv4 Address



Route Target

Route Target

- Import Route Target
- Export Route Target



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理解与配置VPN-instance

理解与配置PE-CE OSPF

理解与配置MP-BGP

理解与配置PE-CE之间路由协议

配置CE与PE之间的OSPF

```
[admin@Ros-PEA] > /routing ospf instance add name=ospf1 redistribute-bgp=as-type-1 router-id=1.0.0.1 routing-table=vpna  
[admin@Ros-PEA] > /routing ospf area add instance=ospf1 name=01a0  
[admin@Ros-PEA] > /routing ospf network add area=01a0 network=10.1.12.0/24
```

```
[admin@Ros-CEA] > /routing ospf network add network=10.1.100.0/24 area=backbone  
[admin@Ros-CEA] > /routing ospf network add network=10.1.100.0/24 area=backbone
```

```
[admin@Ros-PEA] > routing ospf neighbor print  
0 instance=ospf1 router-id=10.1.12.1 address=10.1.12.1 interface=eth2 priority=1 dr-address=10.1.12.1  
backup-dr-address=10.1.12.2 state="Full" state-changes=6 ls-retransmits=0  
ls-requests=0 db-summaries=0 adjacency=48m7s
```

配置CE与PE之间的OSPF

```
[admin@Ros-PEA] > /ip route print where routing-mark=vpna
```

Flags: X - disabled, A - active, D - dynamic, C - connect, S - static, r - rip, b - bgp, o - ospf, m - mme, B - blackhole, U - unreachable, P - prohibit

#	DST-ADDRESS	PREF-SRC	GATEWAY	DISTANCE
0 ADC	10.1.12.0/24	10.1.12.2	eth2	0
1 ADo	10.1.100.0/24		10.1.12.1	110

目 录

理解与配置VPN-instance

理解与配置PE-CE OSPF

理解与配置MP-BGP

理解与配置PE-CE之间路由协议

配置MPLS骨干网IGP

```
[admin@Ros-02] > ip route print
Flags: X - disabled, A - active, D - dynamic, C - connect, S - static, r - rip, b - bgp, o - ospf,
m - mme, B - blackhole, U - unreachable, P - prohibit
```

#	DST-ADDRESS	PREF-SRC	GATEWAY	DISTANCE
0	ADC 10.1.12.0/24	10.1.12.2	eth2	0
1	ADC 10.1.23.0/24	10.1.23.2	eth3	0
2	ADC 1.1.1.1/32	1.1.1.1	1o0	0
3	ADo 2.2.2.2/32		10.1.24.4	110
4	ADo 3.3.3.3/32		10.1.24.4	110
5	ADC 10.1.24.0/24	10.1.24.2	eth1	0
6	ADo 10.1.45.0/24		10.1.24.4	110

配置LDP

```
[admin@Ros-PEA] > mpls ldp neighbor print
```

```
Flags: X - disabled, D - dynamic, O - operational, T - sending-targeted-hello, V - vpls
```

#	TRANSPORT	LOCAL-TRANSPORT	PEER	SEND-TARGETED	ADDRESSES
0 DO	2.2.2.2	1.1.1.1	2.2.2.2:0	no	2.2.2.2 10.1.24.4 10.1.45.4

```
[admin@Ros-P] > mpls ldp neighbor print
```

```
Flags: X - disabled, D - dynamic, O - operational, T - sending-targeted-hello, V - vpls
```

#	TRANSPORT	LOCAL-TRANSPORT	PEER	SEND-TARGETED	ADDRESSES
0 DO	3.3.3.3	2.2.2.2	3.3.3.3:0	no	3.3.3.3 10.1.45.5 10.1.56.5 10.1.57.5
1 DO	1.1.1.1	2.2.2.2	1.1.1.1:0	no	1.1.1.1 10.1.12.2 10.1.23.2 10.1.24.2 10.1.28.2

```
[admin@Ros-PEB] > mpls ldp neighbor print
```

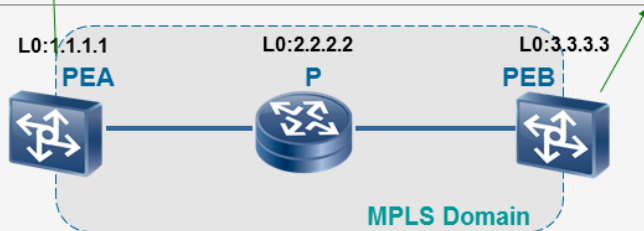
```
Flags: X - disabled, D - dynamic, O - operational, T - sending-targeted-hello, V - vpls
```

#	TRANSPORT	LOCAL-TRANSPORT	PEER	SEND-TARGETED	ADDRESSES
0 DO	2.2.2.2	3.3.3.3	2.2.2.2:0	no	2.2.2.2 10.1.24.4 10.1.45.4

配置MP-IBGP

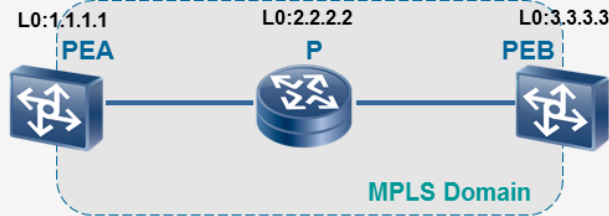
```
[admin@Ros-PEA] > /routing bgp instance set default as=100
[admin@Ros-PEA] > /routing bgp instance vrf add redistribute-ospf=yes routing-mark=vpna
[admin@Ros-PEA] > /routing bgp instance vrf add redistribute-ospf=yes routing-mark=vpnb
[admin@Ros-PEA] > /routing bgp peer add address-families=vpn4 name=r3 remote-address=3.3.3.3
remote-as=100 update-source=lo0
```

```
[admin@Ros-PEB] > /routing bgp instance set default as=100
[admin@Ros-PEB] > /routing bgp instance vrf add redistribute-ospf=yes routing-mark=vpna
[admin@Ros-PEB] > /routing bgp instance vrf add redistribute-ospf=yes routing-mark=vpnb
[admin@Ros-PEB] > /routing bgp peer add address-families=vpn4 name=r1 remote-address=1.1.1.1
remote-as=100 update-source=lo0
```



配置MP-IBGP

```
[admin@Ros-PEA] > routing bgp peer print  
Flags: X - disabled, E - established  
#   INSTANCE      REMOTE-ADDRESS  REMOTE-AS  
0 E default       3.3.3.3         100
```

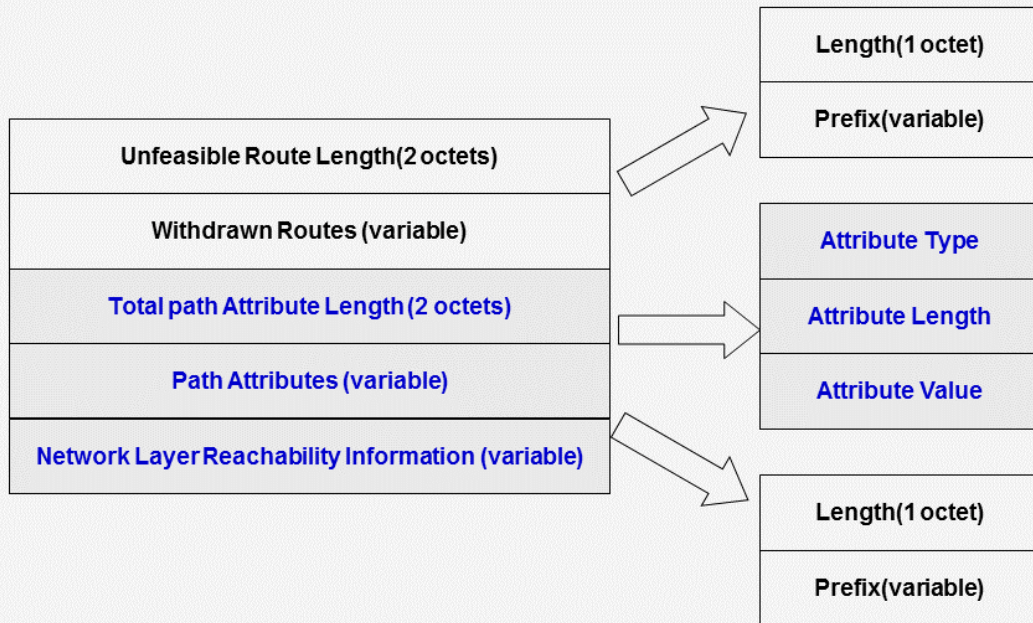


BGP协议的扩展

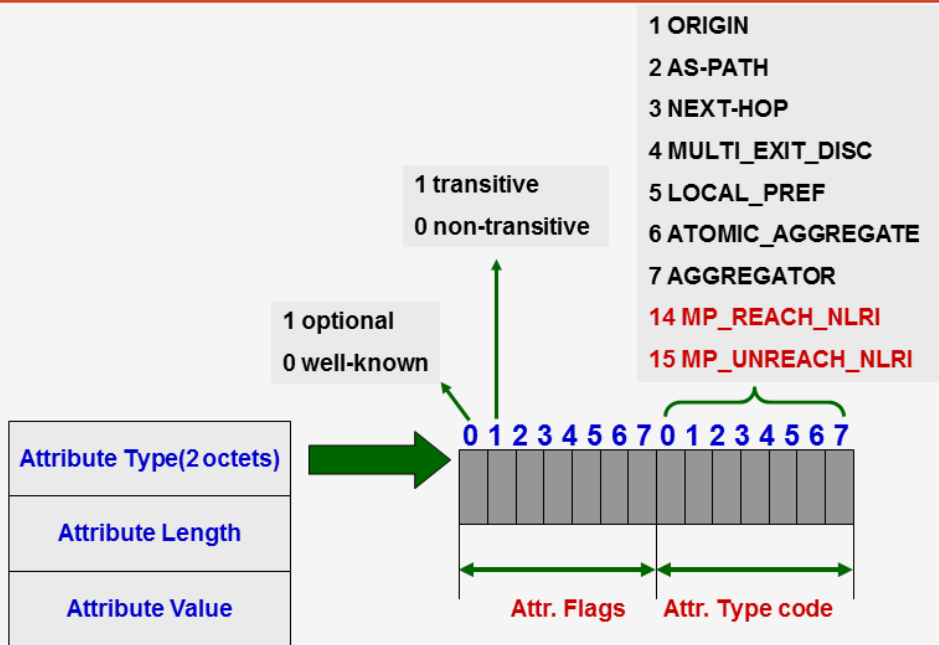
承载多种网络层协议的路由信息

- IPv6单播
- 6PE
- 多播 (IPv4 ,IPv6)
- MPLS VPN (IPv4 ,IPv6)
- CLNS

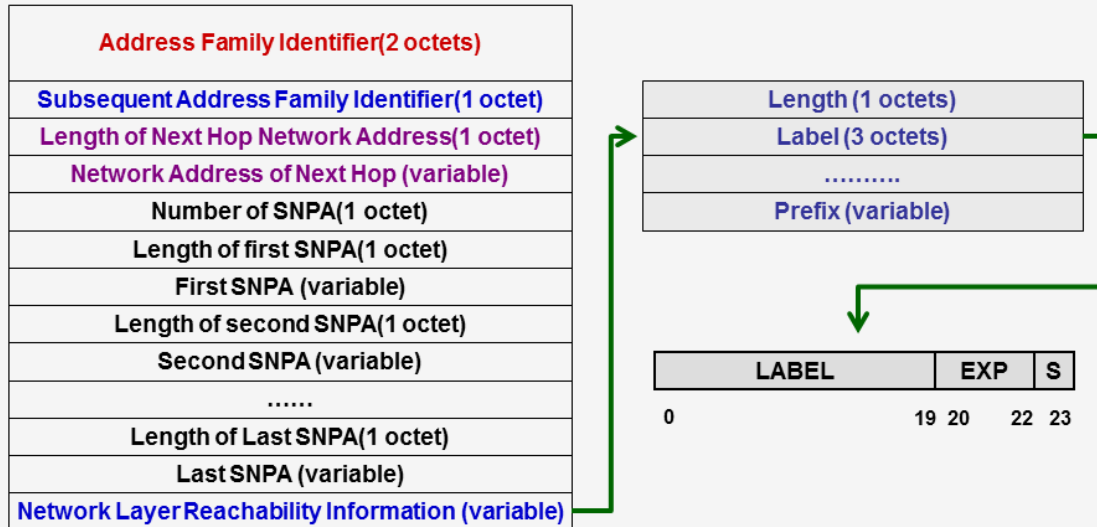
BGP Update Message



Path Attributes



MP_REACH_NLRI



MP_UNREACH_NLRI

Address Family Identifier(2 octets)
Subsequent Address Family Identifier(1 octet)
Withdrawn Routes (variable)

 需要撤销的路由的NLRI

MP-BGP能力协商

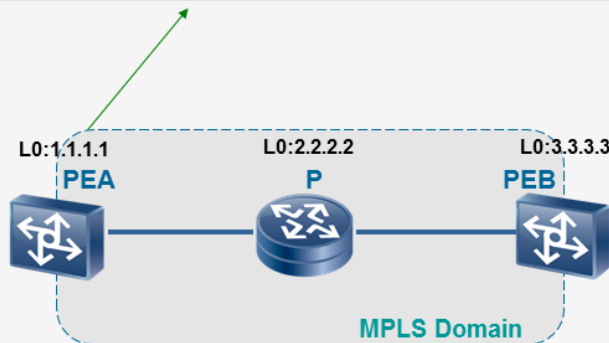
```
15:28:02 route,bgp,debug,packet OPEN Message capabilities option
15:28:02 route,bgp,debug,packet      Lenght=14
15:28:02 route,bgp,debug,packet OPEN Message capability
15:28:02 route,bgp,debug,packet      Code=route refresh capability
15:28:02 route,bgp,debug,packet      Lenght=0
15:28:02 route,bgp,debug,packet OPEN Message capability
15:28:02 route,bgp,debug,packet      Code=AS 4-octet capability
15:28:02 route,bgp,debug,packet      Lenght=4
15:28:02 route,bgp,debug,packet OPEN Message capability
15:28:02 route,bgp,debug,packet      Code=multiprotocol capability
15:28:02 route,bgp,debug,packet      Lenght=4
15:28:02 route,bgp,debug,state Entering OpenConfirm state
15:28:02 route,bgp,debug,state      RemoteAddress=1.1.1.1
```

MP-BGP携带私网标签

```
[admin@Ros-02] > routing bgp vpnv4-route print detail
```

```
Flags: L - label-present
```

```
0 L route-distinguisher=100:1 dst-address=10.1.60.0/24 gateway=3.3.3.3 interface=eth1 in-label=19  
out-label=19 bgp-local-pref=100 bgp-med=21 bgp-origin=igp bgp-ext-communities="OSPF Route Type:  
0.0.0.0:2:0, OSPF Router ID:1.0.0.6:0, RT:100:2, OSPF Domain ID:0x0005:0x0 0x0 0x0 0x0 0x0 0x0"  
1 L route-distinguisher=200:1 dst-address=10.1.70.0/24 gateway=3.3.3.3 interface=eth1 in-label=20  
out-label=20 bgp-local-pref=100 bgp-med=21 bgp-origin=igp bgp-ext-communities="OSPF Route Type:  
0.0.0.0:2:0, OSPF Router ID:1.0.0.7:0, RT:200:1, OSPF Domain ID:0x0005:0x0 0x0 0x0 0x0 0x0 0x0"
```



数据转发 (PEA)

```
[admin@Ros-PEA] > ip route print where routing-mark=vpna
```

Flags: X - disabled, A - active, D - dynamic, C - connect, S - static, r - rip, b - bgp,
o - ospf, m - mme, B - blackhole, U - unreachable, P - prohibit

#	DST-ADDRESS	PREF-SRC	GATEWAY	DISTANCE
0 ADC	10.1.12.0/24	10.1.12.2	eth2	0
1 ADb	10.1.60.0/24		3.3.3.3	200
2 ADb	10.1.80.0/24		10.1.28.8	20
3 ADo	10.1.100.0/24		10.1.12.1	110

```
[admin@Ros-PEA] > mpls forwarding-table print
```

Flags: L - ldp, V - vpls, T - traffic-eng

#	IN-LABEL	OUT-LABELS	DESTINATION	INTERFACE	NEXTHOP
0 L 18		16	3.3.3.3/32	eth1	10.1.24.4

数据转发 (P)

```
[admin@Ros-P] > mpls forwarding-table print
```

```
Flags: L - ldp, V - vpls, T - traffic-eng
```

#	IN-LABEL	OUT-LABELS	DESTINATION	INTERFACE	NEXTHOP
0	expl-null				
1	L 16		3.3.3.3/32	eth2	10.1.45.5
2	L 17		1.1.1.1/32	eth1	10.1.24.2

数据转发 (PEB)

```
▶ Frame 2: 74 bytes on wire (592 bits), 74 bytes captured (592 bits) on interface 0
▶ Ethernet II, Src: 50:00:00:04:00:01 (50:00:00:04:00:01), Dst: 50:00:00:05:00:01 (50:00:00:05:00:01)
▶ MultiProtocol Label Switching Header, Label: 20, Exp: 0, S: 1, TTL: 253
  0000 0000 0000 0001 0100 ..... = MPLS Label: 20
  .... 000. .... = MPLS Experimental Bits: 0
  .... 1 .... = MPLS Bottom Of Label Stack: 1
  .... 1111 1101 = MPLS TTL: 253
▶ Internet Protocol Version 4, Src: 10.1.100.1, Dst: 10.1.70.1
▶ Internet Control Message Protocol
```

```
[admin@Ros-PEB] > mpls forwarding-table print
```

Flags: L - ldp, V - vpls, T - traffic-eng

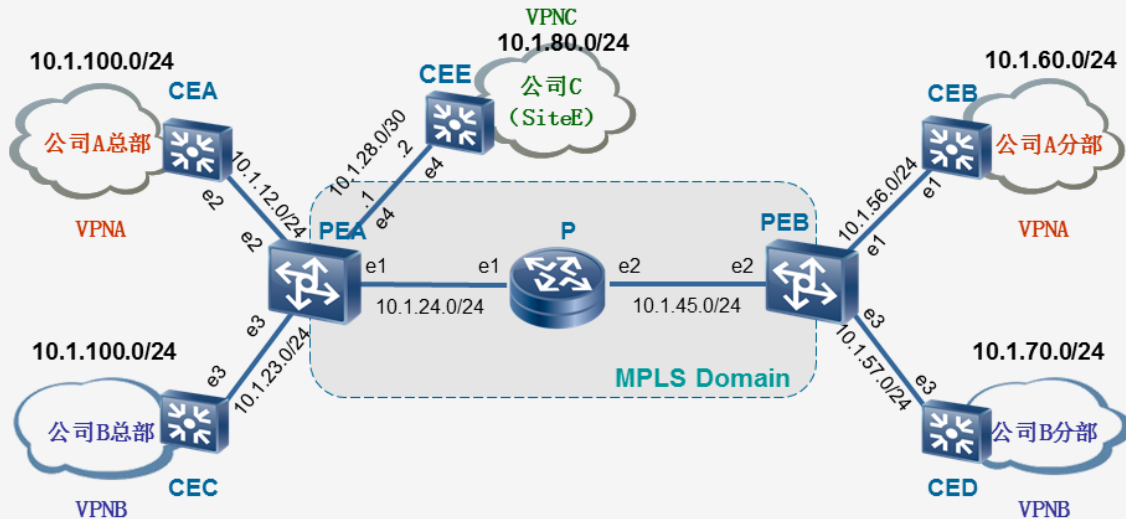
#	IN-LABEL	OUT-LABELS	DESTINATION	INTERFACE	NEXTHOP
0	expl-null				
1	L 16		2.2.2.2/32	eth2	10.1.45.4
2	L 17		10.1.24.0/24	eth2	10.1.45.4
3	L 18	17	1.1.1.1/32	eth2	10.1.45.4
4	19		10.1.60.0/24@vpna		
5	20		10.1.70.0/24@vpnb		

```
[admin@Ros-PEB] > ip route print where routing-mark=vpnb
```

Flags: X - disabled, A - active, D - dynamic, C - connect, S - static, r - rip, b - bgp, o - ospf,
m - mme, B - blackhole, U - unreachable, P - prohibit

#	DST-ADDRESS	PREF-SRC	GATEWAY	DISTANCE
0	ADC 10.1.57.0/24	10.1.57.5	eth3	0
1	ADo 10.1.70.0/24		10.1.57.7	110
2	ADb 10.1.100.0/24		1.1.1.1	200

自动路由过滤



自动路由过滤

```
[admin@Ros-PEA] > routing bgp vpnv4-route print
```

Flags: L - label-present

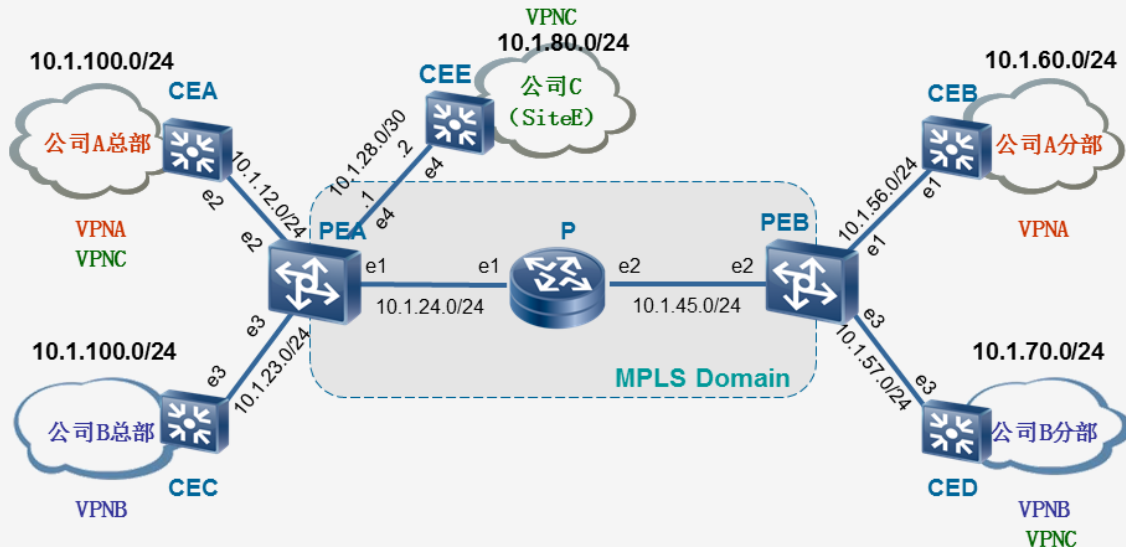
#	ROUTE-DISTINGUISHER	DST-ADDRESS	GATEWAY	INTERFACEIN-LABEL	OUT-LABEL
0	L 100:1	10.1.100.0/24	1.1.1.1	eth2	19
1	L 200:1	10.1.100.0/24	1.1.1.1	eth2	21
2	L 300:1	10.1.80.0/24	1.1.1.1	eth2	20
3	L 100:1	10.1.60.0/24	10.1.56.6	eth1	19
4	L 200:1	10.1.70.0/24	10.1.57.7	eth3	20

```
[admin@Ros-PEA] > ip route print where routing-mark=vpna
```

Flags: X - disabled, A - active, D - dynamic, C - connect, S - static, r - rip,
b - bgp, o - ospf, m - mme, B - blackhole, U - unreachable, P - prohibit

#	DST-ADDRESS	PREF-SRC	GATEWAY	DISTANCE
0	ADC 10.1.56.0/24	10.1.56.5	eth1	0
1	ADo 10.1.60.0/24		10.1.56.6	110
2	ADb 10.1.100.0/24		1.1.1.1	200

路由更新 (Route Refresh)



MP-BGP Route Refresh

```
[admin@Ros-PEB] > routing bgp peer refresh-all
```

```
12:17:40 route,bgp,debug,packet ROUTE_REFRESH Message
```

```
12:17:40 route,bgp,debug,packet RemoteAddress=1.1.1.1
```

```
12:17:40 route,bgp,debug,packet MessageLength=23
```

```
12:17:40 route,bgp,debug,packet,raw Sent UPDATE message
```

```
12:17:40 route,bgp,debug,packet,raw RemoteAddress=1.1.1.1
```

```
12:17:40 route,bgp,debug,packet,raw Length=114
```

```
12:17:40 route,bgp,debug,packet,raw FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
```

```
12:17:40 route,bgp,debug,packet,raw 00 72 02 00 00 00 5B 40 01 01 00 40 02 00 80 04
```

```
12:17:40 route,bgp,debug,packet,raw 04 00 00 00 15 40 05 04 00 00 00 64 C0 10 20 80
```

```
12:17:40 route,bgp,debug,packet,raw 00 00 00 00 00 02 00 80 01 01 00 00 07 00 00 00
```

```
12:17:40 route,bgp,debug,packet,raw 02 00 C8 00 00 00 01 00 05 00 00 00 00 00 00 80
```

```
12:17:40 route,bgp,debug,packet,raw 0E 20 00 01 80 0C 00 00 00 00 00 00 00 00 03 03
```

```
12:17:40 route,bgp,debug,packet,raw 03 03 00 70 00 01 41 00 00 00 C8 00 00 00 01 0A
```

```
12:17:40 route,bgp,debug,packet,raw 01 46
```

目 录

理解与配置VPN-instance

理解与配置PE-CE BGP

理解与配置MP-BGP

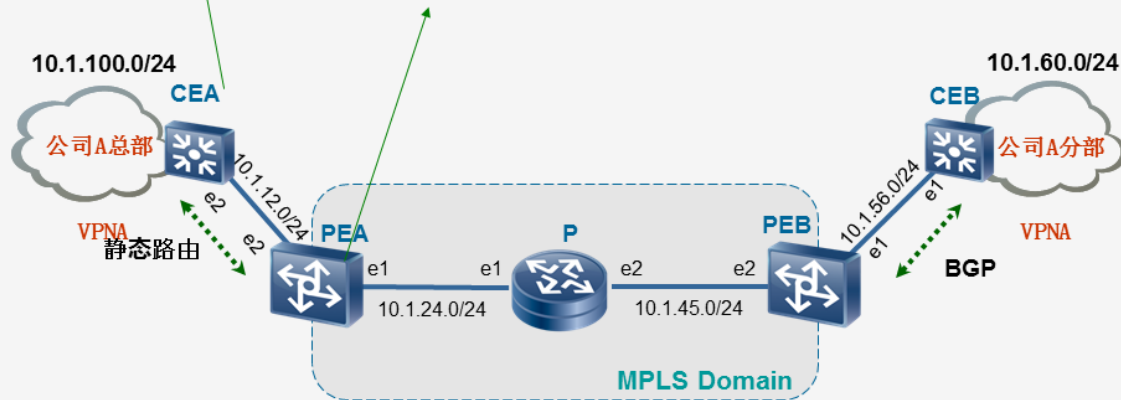
理解与配置PE-CE之间路由协议

- 静态路由
- RIP
- OSPF
- eBGP
- IS-IS

配置PE与CE之间使用静态路由

```
[admin@Ros-CEA] > ip route-static 0.0.0.0 0.0.0.0 10.1.12.2
```

```
[admin@Ros-PEA] > ip route add routing-mark=vpna dst-address=10.1.100.0/24 gateway=10.1.12.1[PEA]bgp 100
[admin@Ros-PEA] > routing bgp instance vrf set redistribute-static=yes
```



配置PE与CE之间使用静态路由

```
[admin@Ros-CEA] > ip route print
```

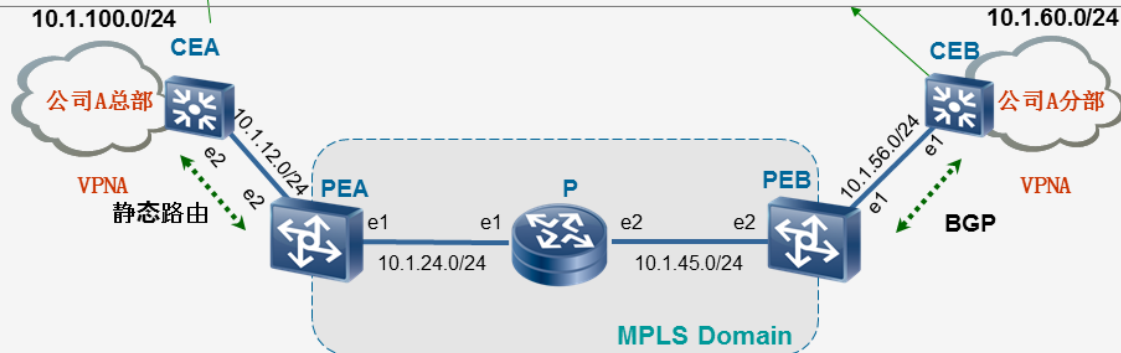
Flags: X - disabled, A - active, D - dynamic, C - connect, S - static, r - rip, b - bgp, o - ospf,
m - mme, B - blackhole, U - unreachable, P - prohibit

#	DST-ADDRESS	PREF-SRC	GATEWAY	DISTANCE
0 ADC	0.0.0.0/0	10.1.12.1	eth2	0

```
[admin@Ros-CEB] > ip route print
```

Flags: X - disabled, A - active, D - dynamic, C - connect, S - static, r - rip, b - bgp, o - ospf,
m - mme, B - blackhole, U - unreachable, P - prohibit

#	DST-ADDRESS	PREF-SRC	GATEWAY	DISTANCE
0 ADb	10.1.100.0/24	10.1.56.5	eth1	0



总 结

VPN-instance中应该有哪些路由信息？

VPNv4地址由什么构成？

PE之间使用什么接口建立MP-IBGP邻居？

MP-IBGP传递VPNv4路由信息时，携带什么样的扩展属性？

PE-CE之间可以运行什么样的路由协议？

谢谢

Routing The World !