MikroTik
ROUTING THE WORLD

MIKROTIK路由协议精英培训

MPLS BGP VPN基本原理

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前 言

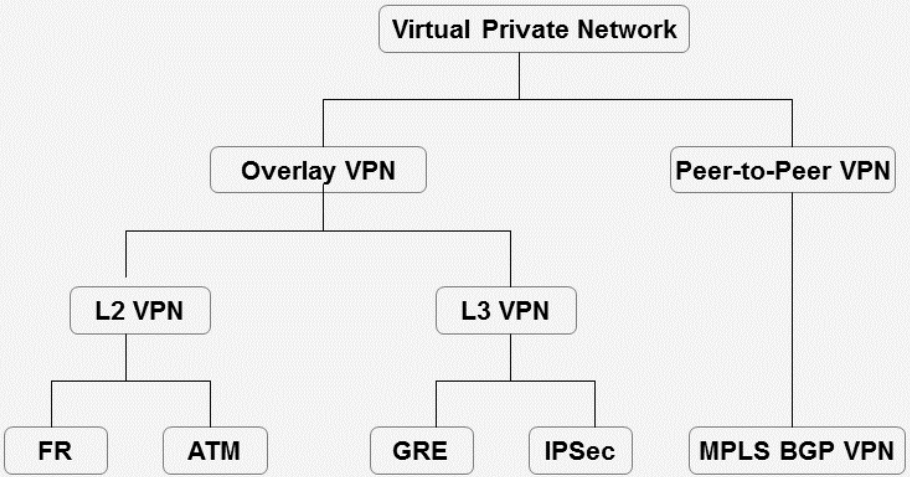
本课程介绍MPLS BGP VPN的基本架构，从控制平面和数据平面两个方面介绍基本实现原理，并对其中涉及的基本概念做初步介绍。

培训目标

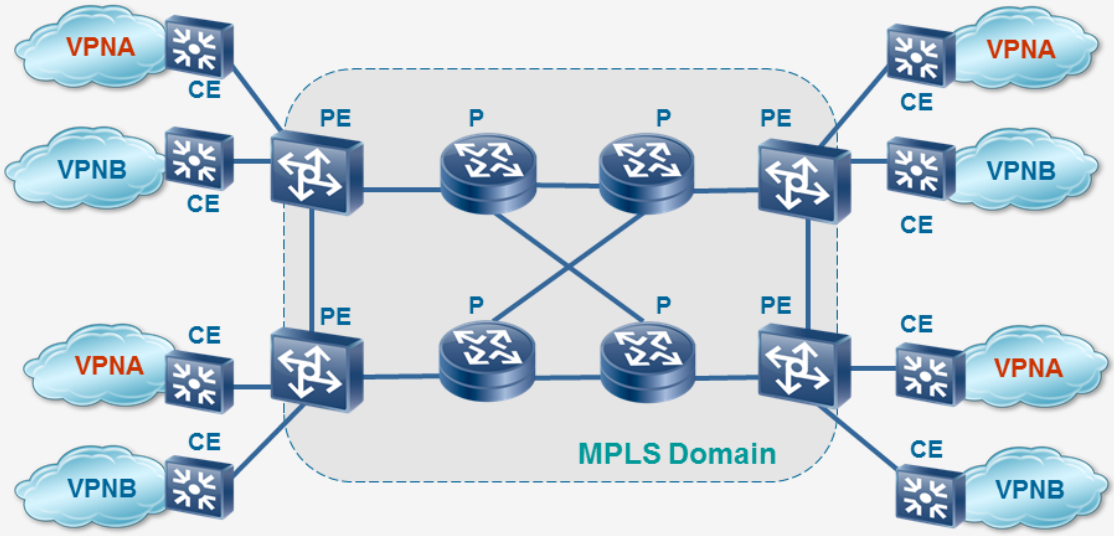
学习完此课程，您将会：

- 掌握MPLS BGP VPN模型
- 掌握MPLS BGP VPN中的基本概念
- 掌握MPLS BGP VPN路由传递和标签分发
- 掌握MPLS BGP VPN数据转发流程

VPN分类


Virtual Private Network
Overlay VPN
Peer-to-Peer VPN
L2 VPN
L3 VPN
FR
ATM
GRE
IPSec
MPLS BGP VPN

MPLS BGP VPN网络结构



MPLS BGP VPN 基本工作原理

路由信息发布

- 本地CE到入口PE路由信息交换
- 入口PE到出口PE路由信息交换
- 出口PE到出口CE路由信息交换

标签分发

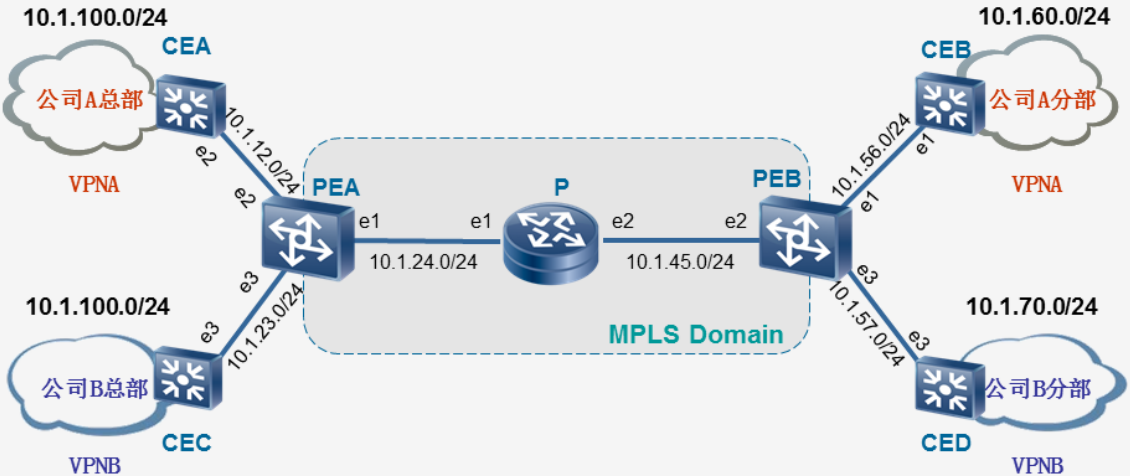
- 公网标签的分发
- 私网标签的分发

VPN报文转发

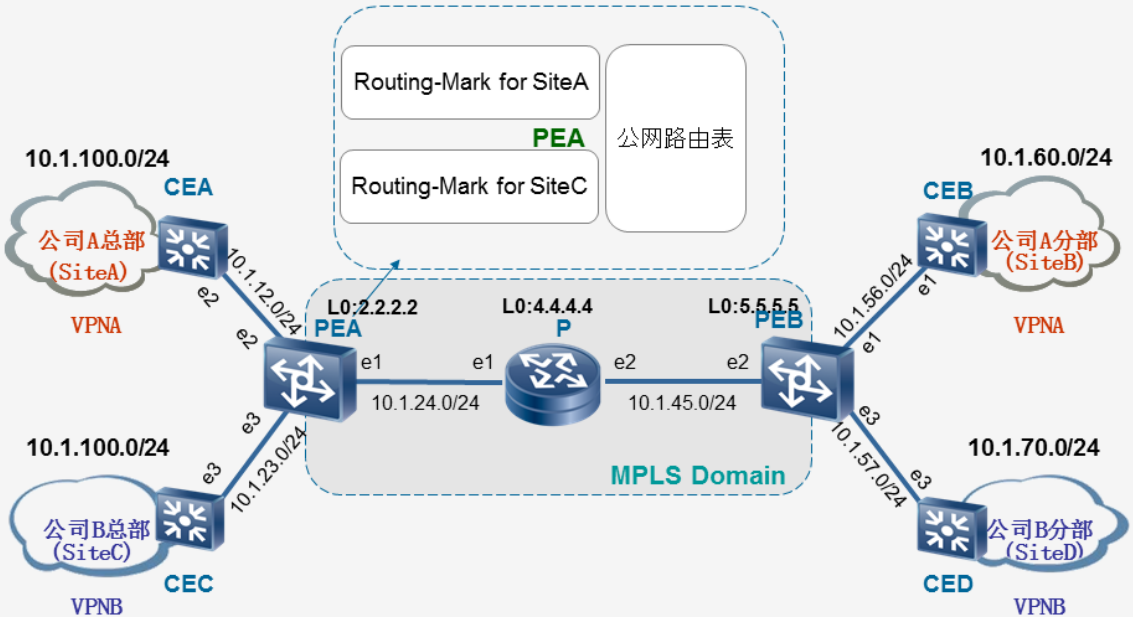
- 封装两层标签
- 外层标签用于报文在公网上的转发
- 内层标签用于指示报文到达哪个Site

如何解决同一PE上不同VPN用户地址空间重叠问题

PEA连接的公司A总部和公司B总部使用相同的IP地址空间



VRF: VPN Routing & Forwarding--- Routing-Mark



VRF和接口的绑定关系

VRF即VPN-instance

PE	VPN-instance	接口	Site
PEA	vpna	Ether2	SiteA（公司A总部）
	vpnb	Ether1	SiteC（公司B总部）
PEB	vpna	Ether1	SiteB（公司A分部）
	vpnb	Ether3	SiteD（公司B分部）

PEA VRF for SiteA（公司A总部）路由转发表

```
[admin@Ros-PEA] > ip route print detail 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
 0 ADC  dst-address=10.1.12.0/24 pref-src=10.1.12.2 gateway=eth2 gateway-status=eth2 reachable
distance=0 scope=10 routing-mark=vpna

 1 ADb  dst-address=10.1.60.0/24 gateway=3.3.3.3 gateway-status=3.3.3.3 recursive via 10.1.24.4
eth1 distance=200 scope=40 target-scope=30 routing-mark=vpna 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:100:1,
OSPF Domain ID:0x0005:0x0 0x0 0x0 0x0 0x0 0x0"

 2 ADo  dst-address=10.1.100.0/24 gateway=10.1.12.1 gateway-status=10.1.12.1 on vpna reachable via  eth2
distance=110 scope=20 target-scope=10 routing-mark=vpna bgp-ext-communities="OSPF Route Type:0.0.0.0:2:0,
OSPF Router ID:1.0.0.1:0,OSPF Domain ID:0x0005:0x0 0x0 0x0 0x0 0x0 0x0" ospf-metric=20 ospf-type=intra-area
```

PEA VRF for SiteC（公司B总部）路由转发表

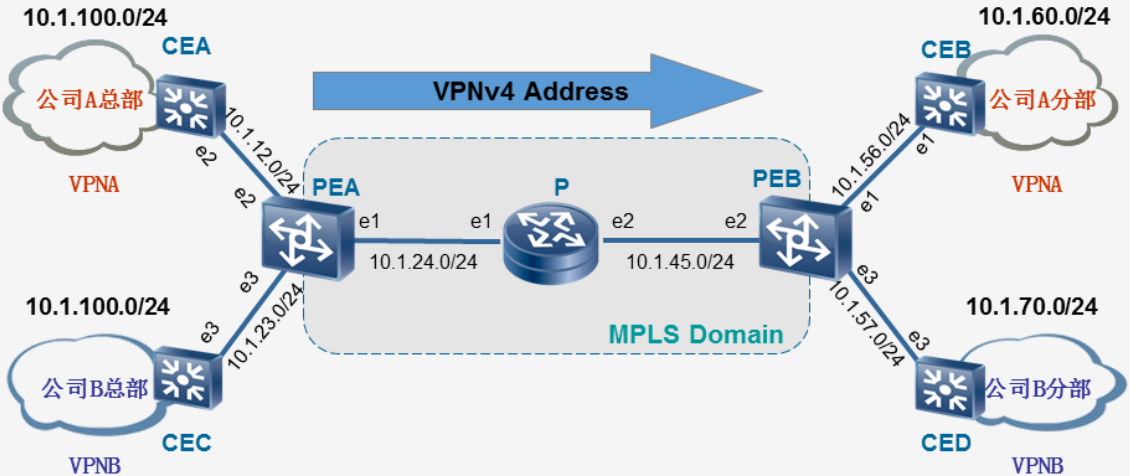
```
[admin@Ros-PEA] > ip route print detail where routing-mark=vpnb
Flags: X - disabled, A - active, D - dynamic, C - connect, S - static, r - rip, b - bgp, o - ospf,
m - mme, B - blackhole, U - unreachable, P - prohibit
 0 ADC  dst-address=10.1.23.0/24 pref-src=10.1.23.2 gateway=eth3 gateway-status=eth3 reachable distance=0
scope=10 routing-mark=vpnb

 1 ADb  dst-address=10.1.70.0/24 gateway=3.3.3.3 gateway-status=3.3.3.3 recursive via 10.1.24.4 eth1
distance=200 scope=40 target-scope=30 routing-mark=vpnb 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"

 2 ADo  dst-address=10.1.100.0/24 gateway=10.1.23.3 gateway-status=10.1.23.3 on vpnb reachable via eth3
distance=110 scope=20 target-scope=10 routing-mark=vpnb bgp-ext-communities="OSPF Route Type:0.0.0.0:2:0,
OSPF Router ID:1.0.0.2:0,OSPF Domain ID:0x0005:0x0 0x0 0x0 0x0 0x0 0x0" ospf-metric=20 ospf-type=intra-area
[admin@Ros-PEA] >
```

如何区分不同的VPN中相同的IP地址前缀

公司A总部和公司B总部的路由信息通过MP-BGP传递到PEB



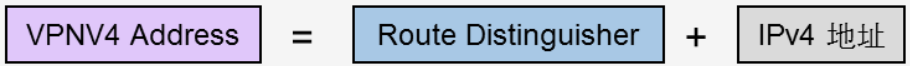
RD：Route Distinguisher

RD：Route Distinguisher

- 64bits前缀

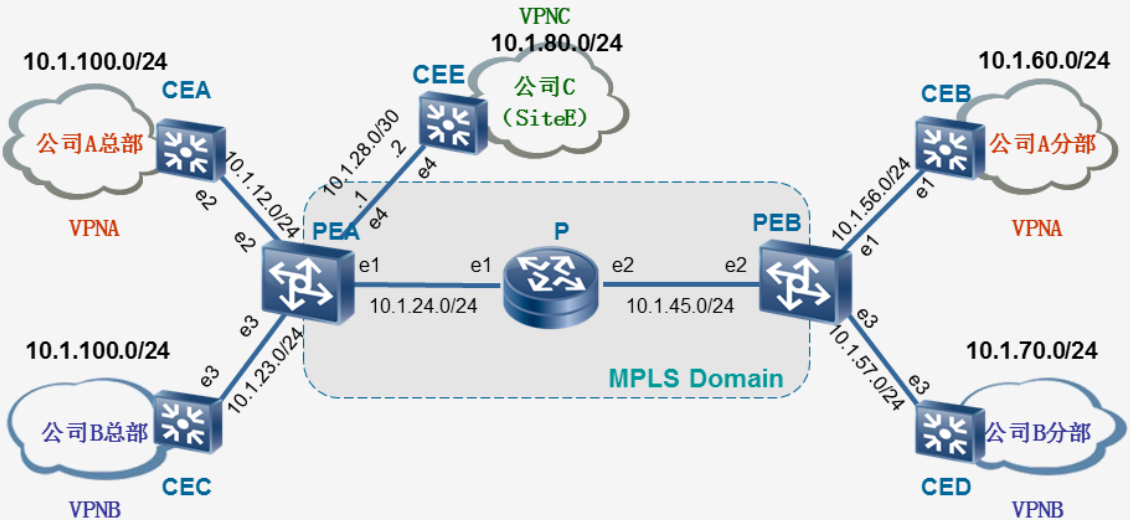
VPNv4 Address

- 由64bit的RD加上IPv4地址构成
- RD唯一，VPNV4地址唯一



对端PE如何判断将VPNV4路由注入到指定VRF中

CEA同时可以与VPNA和VPNC通信



PEA VRF for SiteA（公司A总部）路由转发表

```
[admin@Ros-PEA] > ip route print detail 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
 0 ADC  dst-address=10.1.12.0/24 pref-src=10.1.12.2 gateway=eth2 gateway-status=eth2 reachable distance=0
scope=10 routing-mark=vpna

 1 ADb  dst-address=10.1.60.0/24 gateway=3.3.3.3 gateway-status=3.3.3.3 recursive via 10.1.24.4 eth1
distance=200 scope=40 target-scope=30 routing-mark=vpna 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"

 2 ADb  dst-address=10.1.80.0/24 gateway=10.1.28.8 gateway-status=10.1.28.8 on vpnc reachable via eth4
distance=20 scope=40 target-scope=10 routing-mark=vpna bgp-ext-communities="OSPF Route Type:0.0.0.0:2:0,
OSPF Router ID:1.0.0.3:0,RT:300:1,OSPF Domain ID:0x0005:0x0 0x0 0x0 0x0 0x0 0x0"

 3 ADo  dst-address=10.1.100.0/24 gateway=10.1.12.1 gateway-status=10.1.12.1 on vpna reachable via eth2
distance=110 scope=20 target-scope=10 routing-mark=vpna bgp-ext-communities="OSPF Route Type:0.0.0.0:2:0,
OSPF Router ID:1.0.0.1:0,OSPF Domain ID:0x0005:0x0 0x0 0x0 0x0 0x0 0x0" ospf-metric=20 ospf-type=intra-area
```

PEA VRF for SiteE（公司C）路由转发表

```
[admin@Ros-PEA] > ip route print detail where routing-mark=vpnc
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
 0 ADC  dst-address=10.1.28.0/24 pref-src=10.1.28.2 gateway=eth4 gateway-status=eth4 reachable distance=0
scope=10 routing-mark=vpnc

 1 ADo  dst-address=10.1.80.0/24 gateway=10.1.28.8 gateway-status=10.1.28.8 on vpnc reachable via  eth4
distance=110 scope=20 target-scope=10 routing-mark=vpnc bgp-ext-communities="OSPF Route Type:0.0.0.0:2:0,
OSPF Router ID:1.0.0.3:0,OSPF Domain ID:0x0005:0x0 0x0 0x0 0x0 0x0 0x0" ospf-metric=20 ospf-type=intra-area

 2 ADb  dst-address=10.1.100.0/24 gateway=10.1.12.1 gateway-status=10.1.12.1 on vpna reachable via eth2
distance=20 scope=40 target-scope=10 routing-mark=vpnc bgp-ext-communities="OSPF Route Type:0.0.0.0:2:0,
OSPF Router ID:1.0.0.1:0,RT:100:1,OSPF Domain ID:0x0005:0x0 0x0 0x0 0x0 0x0 0x0"
```

PEA VRF for SiteC（公司B总部）路由转发表

```
[admin@Ros-PEA] > ip route print detail 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
 0 ADC  dst-address=10.1.23.0/24 pref-src=10.1.23.2 gateway=eth3 gateway-status=eth3 reachable
distance=0 scope=10 routing-mark=vpnb

 1 ADb  dst-address=10.1.70.0/24 gateway=3.3.3.3 gateway-status=3.3.3.3 recursive via 10.1.24.4 eth1
distance=200 scope=40 target-scope=30 routing-mark=vpnb 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"

 2 ADo  dst-address=10.1.100.0/24 gateway=10.1.23.3 gateway-status=10.1.23.3 on vpnb reachable via eth3
distance=110 scope=20 target-scope=10 routing-mark=vpnb bgp-ext-communities="OSPF Route Type:0.0.0.0:2:0,
OSPF Router ID:1.0.0.2:0,OSPF Domain ID:0x0005:0x0 0x0 0x0 0x0 0x0 0x0" ospf-metric=20 ospf-type=intra-area
```

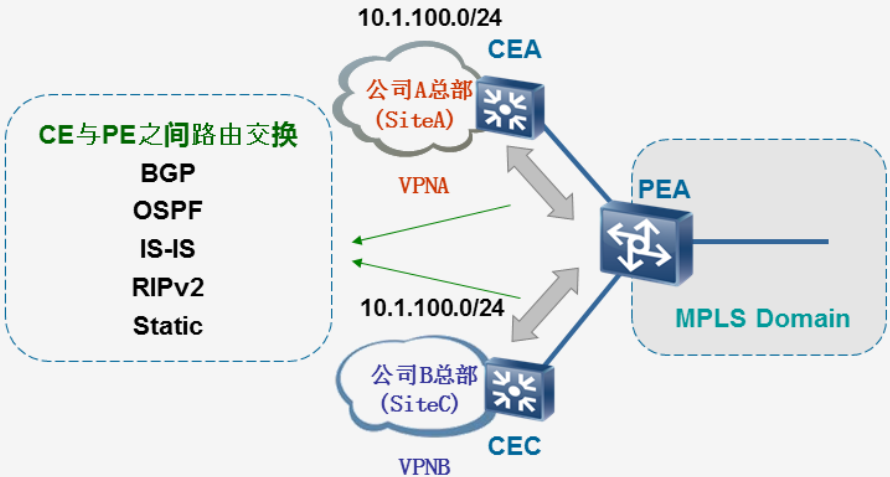
Route Target

Route Target为路由的扩展属性

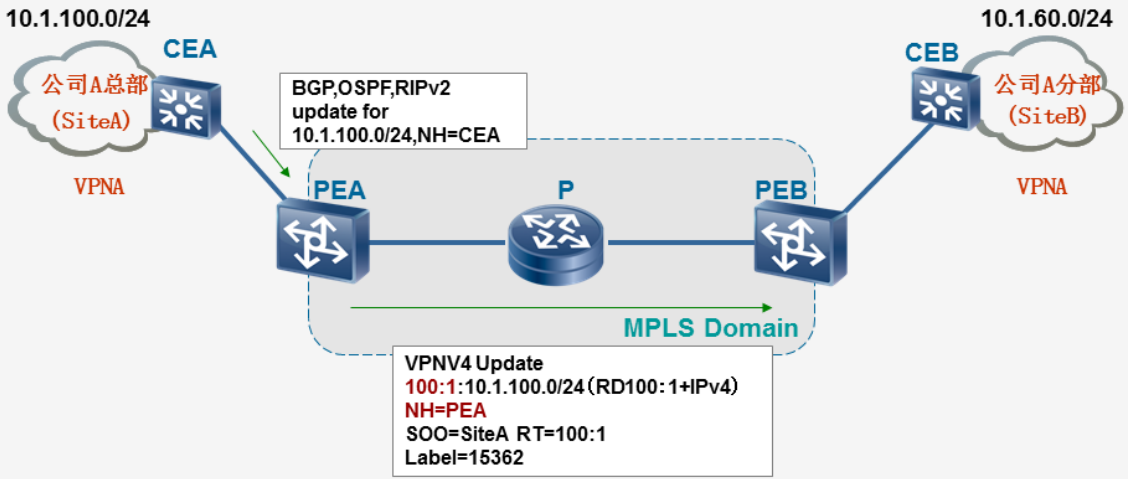
- Export Route Target
- Import Route Target

PE	VPN-instance	Export Route Target	Import Route Target
PEA	vpna	100:1	100:1
		300:1	300:1
	vpnb	200:1	200:1
	vpnc	300:1	300:1
PEB	vpna	100:1	100:1
	vpnb	200:1	200:1

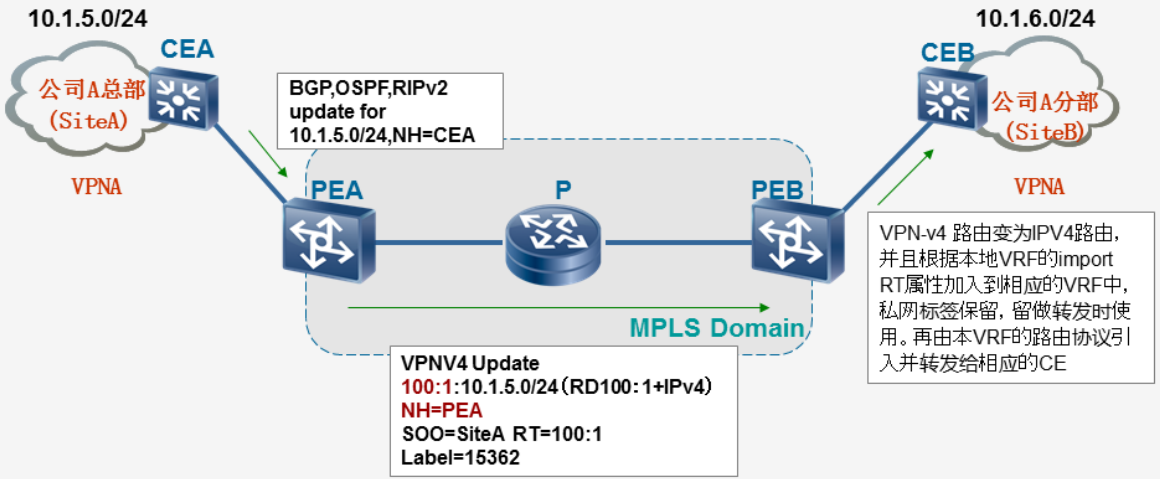
MPLS L3 VPN CE与PE之间路由信息的交换



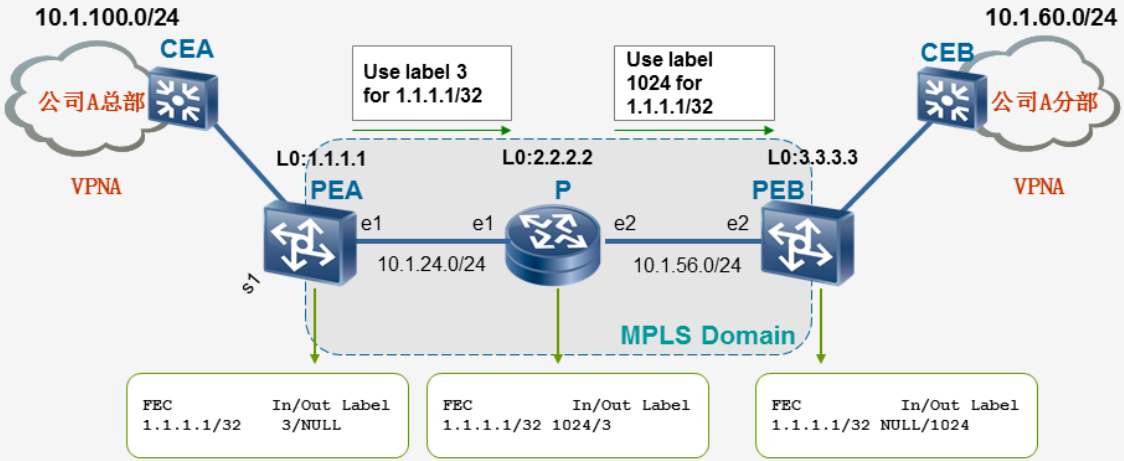
MP-IBGP 交换路由信息以及私网标签分配过程



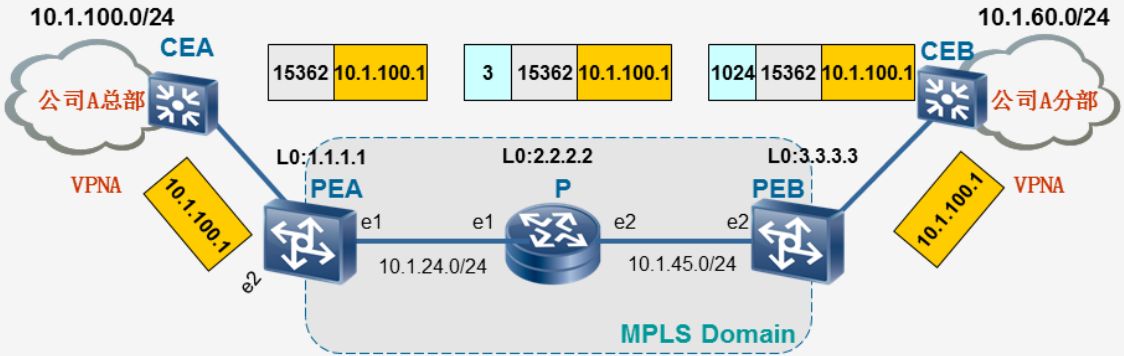
MP-BGP路由注入VRF过程



公网标签分配过程


10.1.100.0/24
CEA
公司A总部
VPNA
Use label 3
for 1.1.1.1/32
Use label
1024 for
1.1.1.1/32
10.1.60.0/24
CEB
公司A分部
VPNA
L0:1.1.1.1
PEA
L0:2.2.2.2
P
L0:3.3.3.3
PEB
e1
e1
e2
e2
10.1.24.0/24
10.1.56.0/24
s1
MPLS Domain
FEC In/Out Label
1.1.1.1/32 3/NULL
FEC In/Out Label
1.1.1.1/32 1024/3
FEC In/Out Label
1.1.1.1/32 NULL/1024

数据转发过程


10.1.100.0/24
CEA
公司A总部
VPNA
10.1.100.1
e2
L0:1.1.1.1
PEA
e1
10.1.24.0/24
L0:2.2.2.2
P
e1
e2
10.1.45.0/24
L0:3.3.3.3
PEB
e2
15362 10.1.100.1
3 15362 10.1.100.1
1024 15362 10.1.100.1
10.1.60.0/24
CEB
公司A分部
VPNA
10.1.100.1
MPLS Domain

总 结

什么是Routing-Mark？ Routing-Mark中维护哪些路由信息？

RD和RT的作用分别是什么？

简述MPLS BGP VPN路由信息的发布过程

简述MPLS BGP VPN中VPN数据的转发过程

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谢谢

Routing The World !