



Deploying MPLS Traffic Engineering

How It Works, How to Configure It, and Why You Really Want It

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Agenda

- **Things to Remember**
- **Why You Want MPLS TE**
- **Minimum TE Transit Config**
- **Minimum TE Headend Config**
- **Basic Options**
- **Verifying Tunnel Setup**
- **Deployment Strategy**

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Things to Remember

- **Tunnels are unidirectional**
- **Routing protocols are not run over TE tunnels**

Agenda

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Why You Want MPLS TE

- **Most backbones have underutilized capacity and over utilized capacity**
- **TE lets you use paths other than IGP**
- **Unequal-cost loadsharing!**

Agenda

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- **Minimum TE Transit Config**
- **Minimum TE Headend Config**
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Minimum TE Transit Config

- **What code to use?**

12.0S, 12.1, 12.1T

Most networks are running 12.0S

Minimum TE Transit Config

```
R1(config)#ip cef
```

- **CEF necessary for all MPLS features**
- **Can also be 'ip cef distributed' on some platforms (GSR, 7500)**

Minimum TE Transit Config

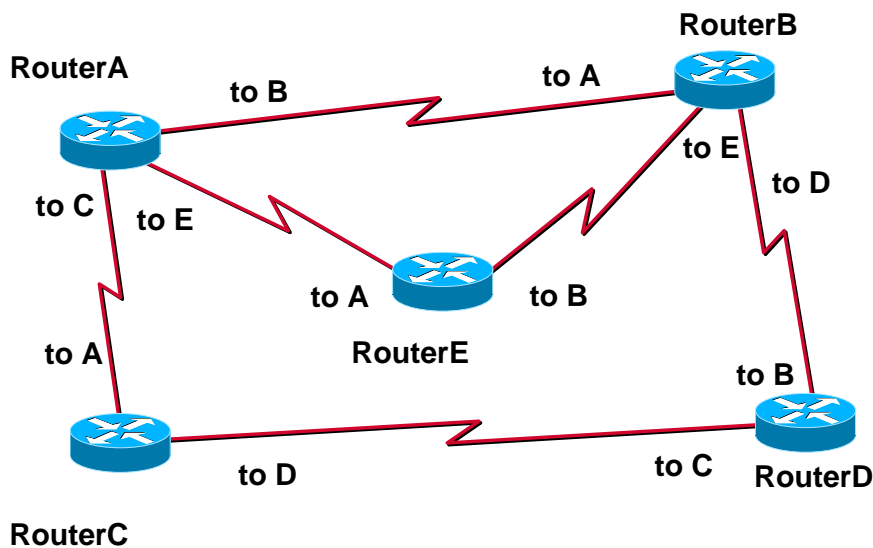
- IGP **must** be link-state (OSPF or IS-IS)
- path determination could not work on DV without being extremely ugly

TE is all about calculating paths other than the shortest one

Distance-vector protocols don't have enough information in them to do this

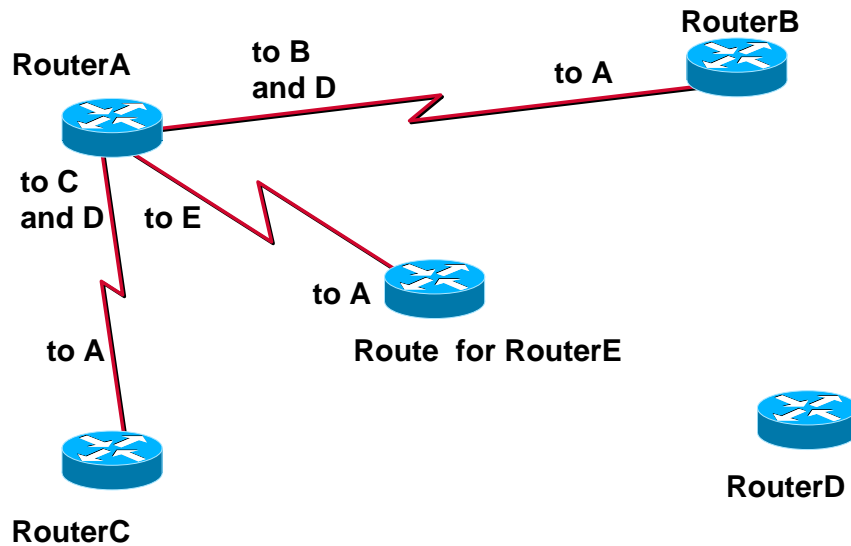
Minimum TE Transit Config

- Link-state view of the network



Minimum TE Transit Config

- Router A's DV view of the network



Minimum TE Transit Config

```
R1(config)#interface Loopback0
```

```
R1(config-if)#ip address
```

```
192.168.1.1 255.255.255.255
```

- Configure loopbacks everywhere
- Loopbacks must be /32
- Loopback must be in your IGP

Minimum TE Transit Config

```
R1(config)#mpls traffic-eng tunnels
```

- Enables TE on the router
- Global command

Minimum TE Transit Config

```
R1(config-if)#  
mpls traffic-eng tunnels
```

- Enables RSVP signaling on an interface
- This is needed on **both** ends of any link an LSP could pass over

Minimum TE Transit Config

Configuring IS-IS for MPLS TE

```
router isis
  mpls traffic-eng level <1 or 2>
  mpls traffic-eng router-id loop0
  metric-style wide
```

Minimum TE Transit Config

Configuring IS-IS for MPLS TE

```
mpls traffic-eng router-id loop0
```

- **Must explicitly configure RID**

Minimum TE Transit Config

Configuring IS-IS for MPLS TE

`mpls traffic-eng level <1 or 2>`

- **TE support is currently single-area**
- **Most ISP backbones are all L1 or L2**

Minimum TE Transit Config

Configuring IS-IS for MPLS TE

`metric-style wide`

- **Wide metrics necessary for IS-IS TE**
- **Must transition IGP to wide metric**
- **See MPLS TE feature docs on CCO**

Minimum TE Transit Config

Configuring OSPF for MPLS TE

```
router ospf <pid>  
  mpls traffic-eng area <area>  
  mpls traffic-eng router-id loop0
```

Minimum TE Transit Config

Configuring OSPF for MPLS TE

```
mpls traffic-eng area <area>
```

- **OSPF support currently single area**
- **Typically TE is in area 0 (backbone)**

Minimum TE Transit Config

Configuring OSPF for MPLS TE

```
mpls traffic-eng router-id loop0
```

- **Must explicitly configure RID**

Agenda

- Things to Remember
- Minimum TE Transit Config
- **Minimum TE Headend Config**
- Basic Options
- Other Useful Features
- Verifying Tunnel Setup
- Deployment Strategy

Minimum TE Headend Config

```
interface Tunnel0
  ip unnumbered Loopback0
  tunnel mode mpls traffic-eng
  tunnel destination <tail RID>
  tunnel mpls traffic-eng autoroute announce
  tunnel mpls traffic-eng path-option <priority>
    dynamic
```

Minimum TE Headend Config

```
interface Tunnel0
```

- **Creates LSP headend**
- **Remember, MPLS tunnels are **unidirectional****

Minimum TE Headend Config

```
ip unnumbered Loopback0
```

- Gives the headend an IP address
- Tunnel inf. must have an IP address

Cisco IOS® will not route IP across an interface with no IP address

Minimum TE Headend Config

```
tunnel mode mpls traffic-eng
```

- Tells IOS this is an MPLS TE tunnel
- Other choices would be GRE, etc...

Minimum TE Headend Config

```
tunnel destination <addr>
```

- Gives tail end of the tunnel
- Destination must be tailend RID

Minimum TE Headend Config

```
tunnel mpls traffic-eng
```

```
    autoroute announce
```

- Announces tunnel tail reachability to the RIB
- Without this, tunnel comes up but is not used

Minimum TE Headend Config

```
tunnel mpls traffic-eng path-option <priority>  
dynamic
```

- **Need to tell the tunnel how to calculate its path**
- **'path-option' has other knobs; this is the minimum**

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Basic Options

Minimal Setup to Make LSP != IGP

- **RSVP**
- **Dynamic vs. explicit path**
- **Tunnel bandwidth**

Basic Options

```
R1(config-if)#ip rsvp  
    bandwidth <x> <y>
```

- **Needed to allow non-zero BW res.**
- **x = max reservable bw**
- **y = max reservable bw for single LSP**
- **no fallback BW on a tunnel**

Basic Options

Unequal-cost load balancing!

```
interface Tunnel0
  tunnel destination 1.2.3.4
  tunnel mpls traffic-eng bandwidth 3

interface Tunnel1
  tunnel destination 1.2.3.4
  tunnel mpls traffic-eng bandwidth 1
```

Basic Options

Unequal-cost load balancing!

```
VXR-6#
Routing entry for 192.168.1.4/32
  Known via "isis", distance 115, metric 30, type level-2
  Redistributing via isis
  Last update from 192.168.1.4 on Tunnel0, 00:00:12 ago
  Routing Descriptor Blocks:
  * 192.168.1.4, from 192.168.1.4, via Tunnel1
    Route metric is 30, traffic share count is 1
  192.168.1.4, from 192.168.1.4, via Tunnel0
    Route metric is 30, traffic share count is 3
```

Basic Options

- Load-balancing is not perfect
- CEF has 16 buckets to store adjacency info in
- 1:9 or 1:10:100 won't work the way you think

1:9 ends up as 1:15

1:10:100 ends up as 1:4:9

Basic Options

```
tunnel mpls traffic-eng path-option  
<prio> <dynamic|explicit <id|name>  
[ID|NAME]>
```

- **dynamic = router calculates path**
- **Router will take best IGP path that meets BW requirements**
- **BW req. of 0 == normal IGP path**

Basic Options

```
tunnel mpls traffic-eng path-option  
<prio> <dynamic|explicit <id|name>  
[ID|NAME]>
```

- **explicit = take specified path**
- **Path is a list of RIDs**
- **Strict source-routing of IP traffic**

Basic Options

```
ip explicit-path <id|name> [ID|NAME]  
  next-address 192.168.1.1  
  next-address 192.168.2.1  
  ...
```

- **explicit = take specified path**
- **Router sets up path you specify**
- **Strict source-routing of IP traffic**
- **Each hop is a RID**

Basic Options

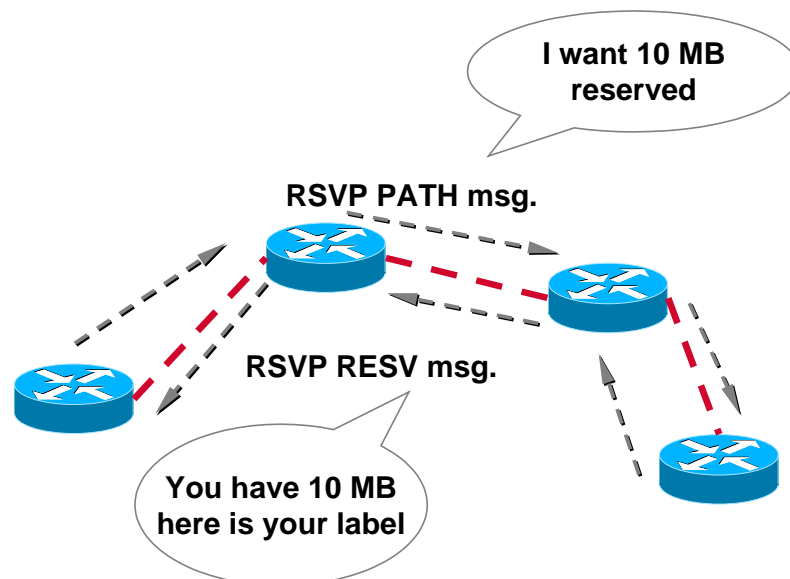
VXR-6(cfg-ip-expl-path)#?

Explicit-Path configuration commands:

append-after	Append additional entry after specified index
exit	Exit from explicit-path configuration mode
index	Specify the next entry index to add, edit (or delete)
list	Re-list all or part of the explicit path entries
next-address	Specify the next (adjacent) address in the path
no	Delete a specific explicit-path entry index

Basic Options

- How RSVP sets up a path



Basic Options

- Use tunnel priorities for fallback paths
- Good idea to have last fallback a dynamic tunnel

Basic Options

- Multiple tunnel priorities

```
interface Tunnel0
```

```
    tunnel mpls traffic-eng path-  
option 10 explicit name first-path
```

```
    tunnl mpls traffic-eng path-  
option 20 explicit name second-path
```

```
    tunnel mpls traffic-eng path-  
option 30 dynamic
```

Agenda

- Things to Remember
- Minimum TE Transit Config
- Minimum TE headend Config
- Basic Options
- Other Useful Features
- **Verifying Tunnel Setup**
- Deployment Strategy

Verifying Tunnel Setup

- **sh int tun<x>**
up/up == tunnel is up/LSP is successfully built
- **sh ip route <tunnel dest>**
should be via the configured tunnel(s)
- **sh mpls traffic-eng tunnels**
lots of options under here

Verifying Tunnel Setup

- **sh int tun<x>**

up/up == tunnel is up/LSP is successfully built

```
VXR-6#sh int tun0
Tunnel0 is up, line protocol is up
Hardware is Tunnel0
...
Encapsulation TUNNEL, loopback not set
Keepalive set (10 sec)
Tunnel source 192.168.1.6, destination 192.168.1.4
```

Verifying Tunnel Setup

- **sh ip route <tunnel dest>**

should be directly connected via tunnel

```
VXR-6#sh ip rou 192.168.1.4
Routing entry for 192.168.1.4/32
Known via "isis", distance 115, metric 30, type level-2
...
Routing Descriptor Blocks:
* 192.168.1.4, from 192.168.1.4, via Tunnel0
  Route metric is 30, traffic share count is 1
```

Verifying Tunnel Setup

- **sh mpls traffic-eng tunnels**

lots of options here

```
VXR-6#sh mpls traffic-eng tunnels ?
Tunnel      Tunnel interface
brief       Brief summary of tunnel status and configuration
destination Restrict display to tunnels with this destination
name        Restrict display to tunnels with this name
role        Restrict display to tunnels with specified role
source-id   Tunnel identifier address/id
summary     Show summary information
up          Restrict display to tunnels in up state
<cr>
```

Verifying Tunnel Setup

- **sh mpls traffic-eng tunnels <intf>**

```
VXR-6#sh mpls traffic-eng tunnels Tunnel0
Name: VXR-6_t0 (Tunnel0) Destination: 192.168.1.4
Status:
  Admin: up      Oper: up      Path: valid      Signalling: connected

  path option 10, type dynamic (Basis for Setup, path weight 20)

Config Paramters:
  Bandwidth: 6      Priority: 7 7      Affinity: 0x0/0xFFFF
  AutoRoute: enabled LockDown: disabled
...
RSVP Path Info:
  My Address: 192.168.4.6
  Explicit Route: 192.168.4.5 192.168.6.5 192.168.6.4 192.168.1.4
  Record Route: NONE
  Tspec: ave rate=6 kbits, burst=1000 bytes, peak rate=6 kbits
```

Verifying Tunnel Setup

- **sh mpls traffic-eng tunnels brief**

```
VXR-6#sh mpls traffic-eng tunnels brief
Signalling Summary:
  LSP Tunnels Process:      running
  RSVP Process:            running
  Forwarding:              enabled
  Periodic reoptimization: every 10 seconds, next in 5 seconds
TUNNEL NAME                DESTINATION    STATUS    STATE
VXR-6_t0                   192.168.1.4   up       up
VXR-6_t1                   192.168.1.4   up       up
VXR-4_t0                   192.168.1.6   signalled up
Displayed 2 (of 2) heads, 0 (of 0) midpoints, 1 (of 1) tails
```

Verifying Tunnel Setup

- **sh mpls traffic-eng tunnels summary**

```
VXR-6#sh mpls tr tu summary
Signalling Summary:
  LSP Tunnels Process:      running
  RSVP Process:            running
  Forwarding:              enabled
  Head: 2 interfaces, 2 active signalling attempts, 2 established
      24 activations, 22 deactivations
  Midpoints: 0, Tails: 1
  Periodic reoptimization: every 10 seconds, next in 8 seconds
```

Agenda

- Things to Remember
- Minimum TE Transit Config
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- Basic Options
- Other Useful Features
- Verifying Tunnel Setup
- **Deployment Strategy**

Deployment Strategy

Two strategies to TE deployment

- **Full mesh of TE tunnels**
“Proper”—more complex procedure,
but more benefits overall
- **As needed to clear up congestion**
“Hack”—may be harder to
track over time

Deployment Strategy

- **TE tunnel bandwidth is not policed**
- **Ratio is more important than actual bandwidth for small hacks**
- **Actual BW use is more important for large-scale deployment**

Deployment Strategy

Full Mesh of TE Tunnels—Steps

- 1) **Enable CEF everywhere**
- 2) **Config your IGP, RSVP**
- 3) **Configure full mesh of zero-bandwidth tunnels**
- 4) **Turn up tunnels via ‘autoroute announce’**

Deployment Strategy

Full Mesh of TE Tunnels—Steps

- 5) Let tunnels run for 1–2 weeks
- 6) Add BW requirements to tunnels
- 7) Use off-line tools if necessary

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Deployment Strategy

As Needed to Clear Up Congestion

- 1) Enable CEF everywhere
- 2) Config your IGP, RSVP
- 3) Configure TE tunnels around congested links

One IGP tunnel, one or more
explicit-path tunnels

Deployment Strategy

As Needed to Clear Up Congestion

4) Turn up tunnels one at a time via 'autoroute announce'

5) Add BW requirements to tunnels

Tunnel BW **ratio** is important



Deploying MPLS for Backbone VPNs

Agenda

- **MPLS-VPN Terminology**
- **Network Topology**
- **Step By Step Configuration Guideline**
 - Sample configuration (VRF, interfaces)
 - PE-CE Routing Protocol configuration (Static, RIPv2, BGP, OSPF)
 - MP-BGP configuration
- **MPLS VPN Scaling**
 - Route-Reflectors, Filters
- **MPLS VPN Internet Routing**

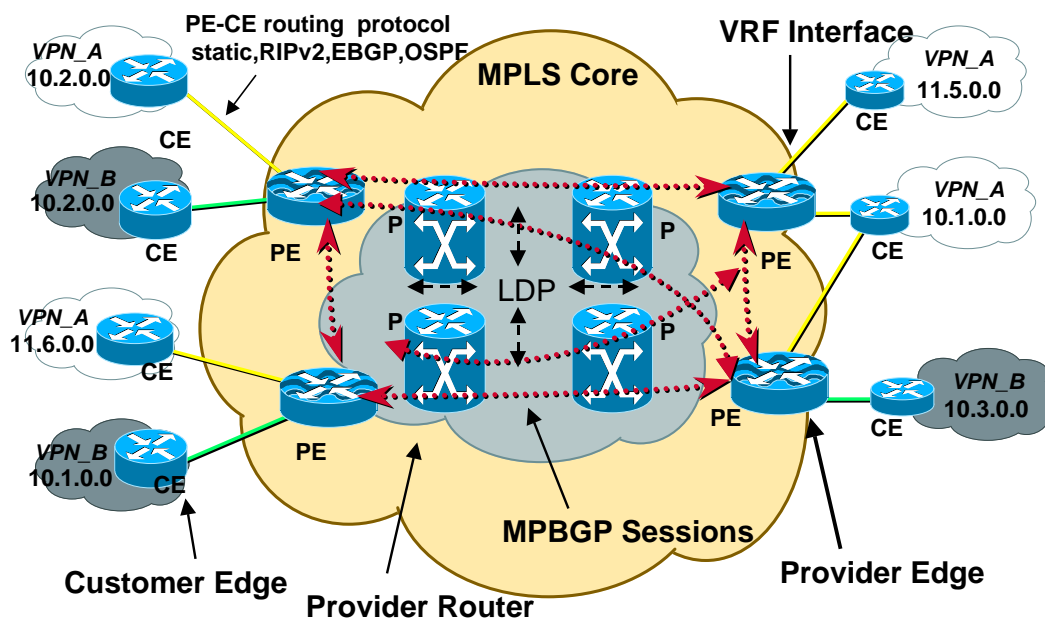
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MPLS VPN Network



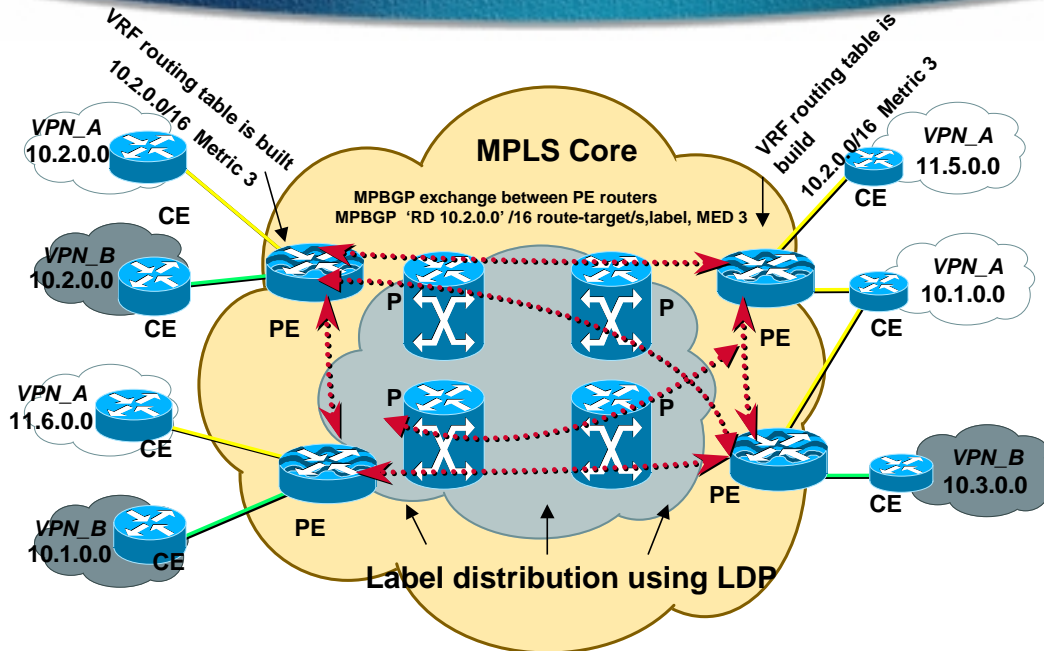
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Working of MPLS VPN Network



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MPLS-VPN Terminology

- **Provider Network (P-Network)**
The backbone under control of a Service Provider
- **Customer Network (C-Network)**
Network under customer control
- **CE router**
Customer Edge router. Part of the C-network and interfaces to a PE router

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MPLS-VPN Terminology

- **Site**

Set of (sub)networks part of the C-network and co-located

A site is connected to the VPN backbone through one or more PE/CE links

- **PE router**

Provider Edge router. Part of the P-Network and interfaces to CE routers

- **P router**

Provider (core) router, without knowledge of VPN

MPLS-VPN Terminology

- **Route-Target**

64 bits identifying routers that should receive the route

- **Route Distinguisher**

Attributes of each route used to uniquely identify prefixes among VPNs (64 bits)

VRF based (not VPN based)

- **VPN-IPv4 addresses**

Address including the 64 bits Route Distinguisher and the 32 bits IP address

MPLS-VPN Terminology

- **VRF**

VPN Routing and Forwarding Instance

Routing table and FIB table

Populated by routing protocol contexts

- **VPN-Aware network**

A provider backbone where MPLS-VPN is deployed

Agenda

- **MPLS-VPN Terminology**
- **Network Topology**
- **Step By Step Configuration Guideline**

Sample configuration (VRF, interfaces)

**PE-CE Routing Protocol configuration
(Static, RIPv2, BGP, OSPF)**

MP-BGP configuration

- **MPLS VPN Scaling**
Route-Reflectors, Filters
- **MPLS VPN Internet Routing**

Step By Step Configuration Guideline

- **LDP configuration in MPLS backbone**
- **VPN knowledge is on PE routers**
- **PE router have to be configured for**
 - VRF and Route Distinguisher**
 - VRF import/export policies (based on Route-target)**
 - Routing protocol used with CEs**
(Static, RIPv2, BGP)
 - MP-BGP between PE routers**

Step By Step Configuration Guideline

- **Configure LDP in MPLS backbone**
 - On all interfaces in MPLS backbone configure**
tag-switching ip
- **Verify the configuration**
 - Show tag forwarding**
 - Show tag tdp neighbour**
 - Labels for Non BGP routes are created**
 - Note: Configuration will be slightly**
different in future IOS

Step By Step Configuration Guideline

Configure VRF instance on PE router

```
ip vrf <vrf-symbolic-name>      (Name of the VPN site)
rd <route-distinguisher-value>
route-target import <Import route-target community>
route-target export <Import route-target community>
```

example:

```
ip vrf VPN-A
rd 100:1
route-target export 100:1
route-target import 100:1
```

Step By Step Configuration Guideline

Configure VRF instance on PE router

rd <route-distinguisher-value>

You may pick a unique **rd** for each **vrf** interface.

Ease in manageability

Can achieve load sharing using unique **rd** every where

route-target import <Import route-target community>

route-target export <Import route-target community>

dictates who will receive the routes

Inter VPN connectivity is very simple by importing **route-target** form other VPN

It can be same value as **rd**

Step By Step Configuration Guideline

Identify VRF Interface on PE Router

```
Interface Serial0
ip address 192.168.10.1 255.255.255.0
ip vrf forwarding VPN-A
```

Verify the configuration

Show ip vrf interface

Interface	IP-Address	VRF	Protocol
Serial0	192.168.10.1	VPN-A	up

Step By Step Configuration Guideline

Configure Routing Protocol Between Provider and Customer (PE and CE)

- **Supported protocols**
Static, RIPv2, eBGP, OSPF
- **Learned routes will populate the VRF associated to the interface where the protocol is configured**
- **Same routing protocol instance with different routing contexts**

Step By Step Configuration Guideline PE-CE Routing Protocol (Static)

Static routes into VRFs need outgoing interface

```
ip vrf VPN-A
rd 100:1
route-target both 100:1
!
Interface Serial0
ip address 192.168.10.1 255.255.255.0
ip vrf forwarding VPN-A
```

```
ip route vrf VPN-A 10.0.0.0 255.0.0.0 Serial0 192.168.10.2
```

Verify the configuration

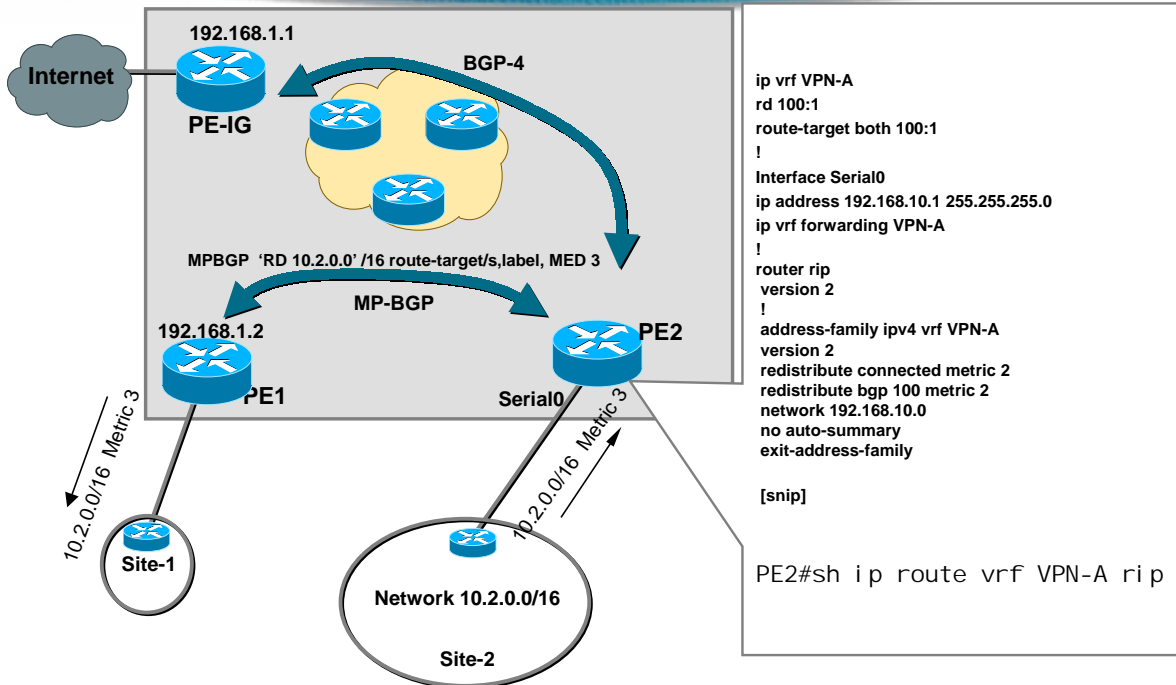
```
sh ip route vrf VPN-A
C 192.168.10.0/24 is directly connected, Serial0
S 10.0.0.0/8 [1/0] via 192.168.10.2, Serial0
```

Step By Step Configuration Guideline PE-CE Routing Protocol (RIPv2)

- Routing contexts are defined within the routing protocol instance
- Address-family router sub-command

```
Router rip
version 2
address-family ipv4 vrf <vrf-symbolic-name>
...
any common router sub-command
...
```

Step By Step Configuration Guideline PE-CE Routing Protocol (RIPv2)



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Step By Step Configuration Guideline PE-CE Routing Protocol (RIPv2)

- **RIPv2/BGP interaction**

During redistribution,

RIP metric propagated BGP MED

**BGP MED automatically propagated
into RIP metric**

**Allows transparency of RIP metric
through the MPLS backbone**

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Step By Step Configuration Guideline PE-CE Routing Protocol (RIPv2)

- **Use RIP with stub sites and when convergence is not an issue**

Step By Step Configuration Guideline PE-CE Routing Protocol (BGP)

BGP uses same “address-family” command
Router BGP <asn>
...
address-family ipv4 vrf <vrf-symbolic-name>
...
any common router BGP sub-command
...

Step By Step Configuration Guideline PE-CE Routing Protocol (BGP)

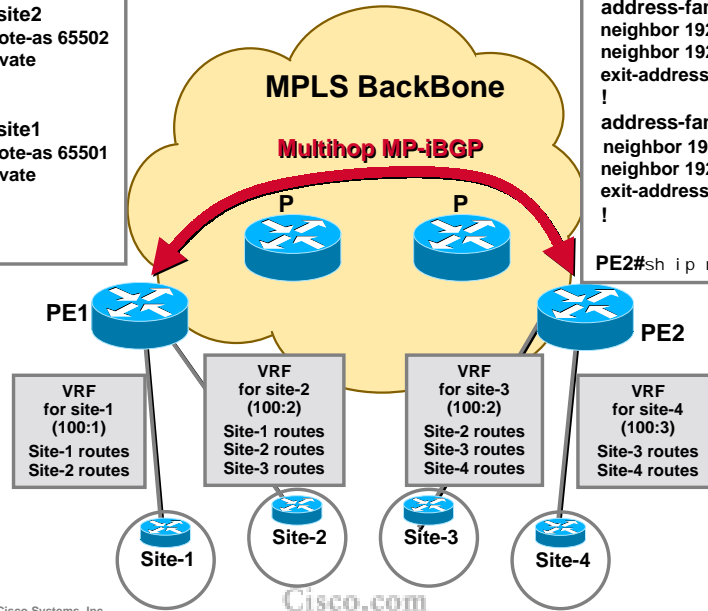
```

router bgp 100
no bgp default ipv4-unicast
neighbor 7.7.7.7 remote-as 100
neighbor 7.7.7.7 update-source Loop0
!
address-family ipv4 vrf site2
neighbor 192.168.62.2 remote-as 65502
neighbor 192.168.62.2 activate
exit-address-family
!
address-family ipv4 vrf site1
neighbor 192.168.61.1 remote-as 65501
neighbor 192.168.61.1 activate
exit-address-family
!
    
```

```

router bgp 100
no bgp default ipv4-unicast
neighbor 6.6.6.6 remote-as 100
neighbor 6.6.6.6 update-source Loop0
!
address-family ipv4 vrf site4
neighbor 192.168.74.4 remote-as 65504
neighbor 192.168.74.4 activate
exit-address-family
!
address-family ipv4 vrf site3
neighbor 192.168.73.3 remote-as 65503
neighbor 192.168.73.3 activate
exit-address-family
!
    
```

```
PE2#sh ip route vrf si te3 bgp 100
```



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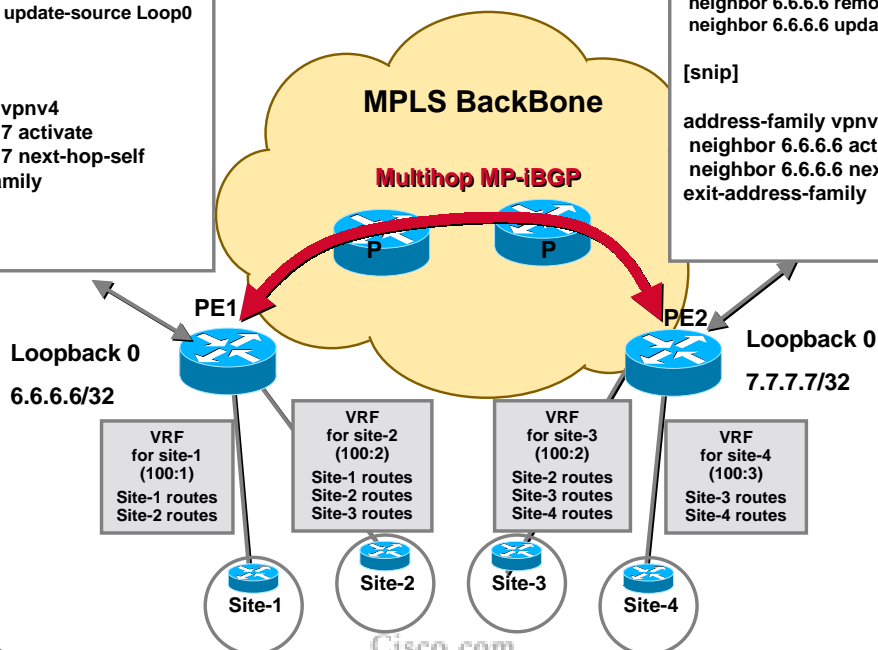
Step By Step Configuration Guideline MPBGP

```

router bgp 100
no bgp default ipv4-unicast
neighbor 7.7.7.7 remote-as 100
neighbor 7.7.7.7 update-source Loop0
!
[snip]
address-family vpnv4
neighbor 7.7.7.7 activate
neighbor 7.7.7.7 next-hop-self
exit-address-family
    
```

```

router bgp 100
no bgp default ipv4-unicast
neighbor 6.6.6.6 remote-as 100
neighbor 6.6.6.6 update-source Loop0
!
[snip]
address-family vpnv4
neighbor 6.6.6.6 activate
neighbor 6.6.6.6 next-hop-self
exit-address-family
    
```



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Step By Step Configuration Guideline MPBGP

Verify the working of MPBGP

```
sh ip bgp vpnv4 ?  
  all  Display information about all VPNv4 NLRI s  
  rd   Display information for a route distinguisher  
  vrf  Display information for a VPN Routing/Forwarding instance
```

example:

```
sh ip bgp vpnv4 rd 100:1
```

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 - MP-BGP configuration
- **MPLS VPN Scaling**
 - Route-Reflectors, Filters
- **MPLS VPN Internet Routing**

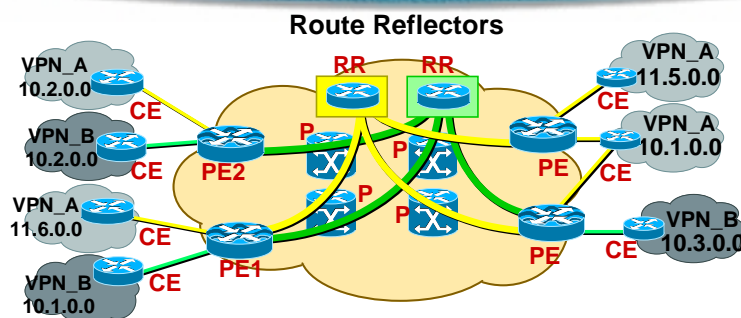
MPLS-VPN Scaling BGP

- Existing BGP techniques can be used to scale the route distribution: route reflectors
- Each edge router needs only the information for the VPNs it supports

Directly connected VPNs

- RRs are used to distribute VPN routing information

MPLS-VPN Scaling BGP

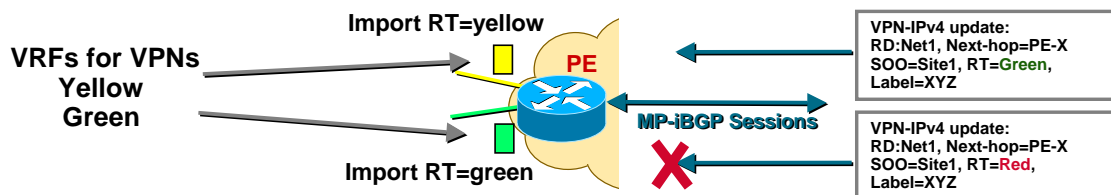


- Route reflectors may be partitioned
 - Each RR store routes for a set of VPNs
- Thus, no BGP router needs to store **all** VPNs information
- PEs will peer to RRs according to the VPNs they directly connect

MPLS-VPN Scaling BGP Updates Filtering

- iBGP full mesh between PEs results in flooding all VPNs routes to all PEs
- Scaling problems when large amount of routes. In addition PEs need only routes for attached VRFs
- **Therefore each PE will discard any VPN-IPv4 route that hasn't a route-target configured to be imported in any of the attached VRFs**
- This reduces significantly the amount of information each PE has to store
- Volume of BGP table is equivalent of volume of attached VRFs (nothing more)

MPLS-VPN Scaling BGP Updates Filtering



- Each VRF has an import and export policy configured
- Policies use route-target attribute (extended community)
- PE receives MP-iBGP updates for VPN-IPv4 routes
- If route-target is equal to any of the import values configured in the PE, the update is accepted
- Otherwise it is silently discarded

Agenda

- **MPLS-VPN Terminology**
- **Network Topology**
- **Step By Step Configuration Guideline**
 - Sample configuration (VRF, interfaces)
 - PE-CE Routing Protocol configuration (Static,RIPv2, BGP,OSPF)
 - MP-BGP configuration
- **MPLS VPN Scaling**
 - Route-Reflectors, Filters
- **MPLS VPN Internet Routing**

MPLS VPN Internet Routing

- **In a VPN, sites may need to have Internet connectivity**
- **Connectivity to the Internet means:**
 - Being able to reach Internet destinations
 - Being able to be reachable from any Internet source
- **Security mechanism **must** be used as in **any** other kind of Internet connectivity**

MPLS VPN Internet Routing

- The Internet routing table is treated separately
- In the VPN backbone the Internet routes are in the global routing table of PE routers
- Labels are not assigned to external (BGP) routes
- P routers need not (and will not) run BGP

MPLS-VPN Internet Connectivity

- 1) VRF Specific default route
- 2) Separate sub-interface (non VRF)
May run BGP Between PE and CE

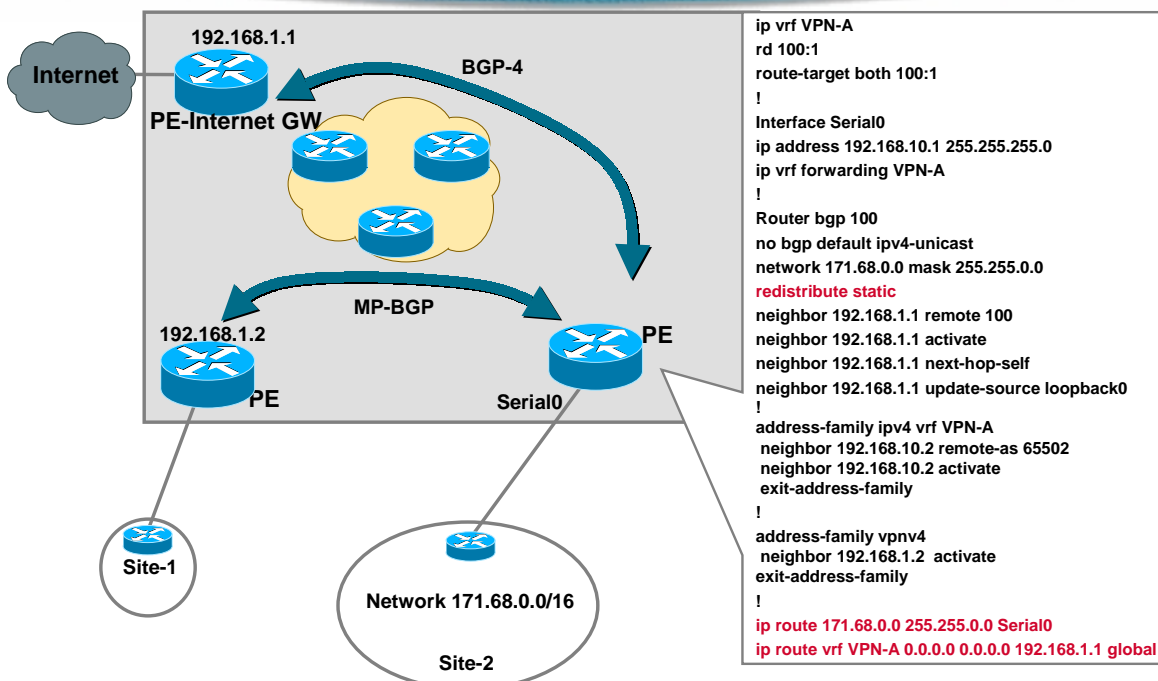
MPLS VPN Internet Routing VRF Specific Default Route

- A default route is installed into the site VRF and pointing to a Internet Gateway
- The default route is **not** part of any VPN

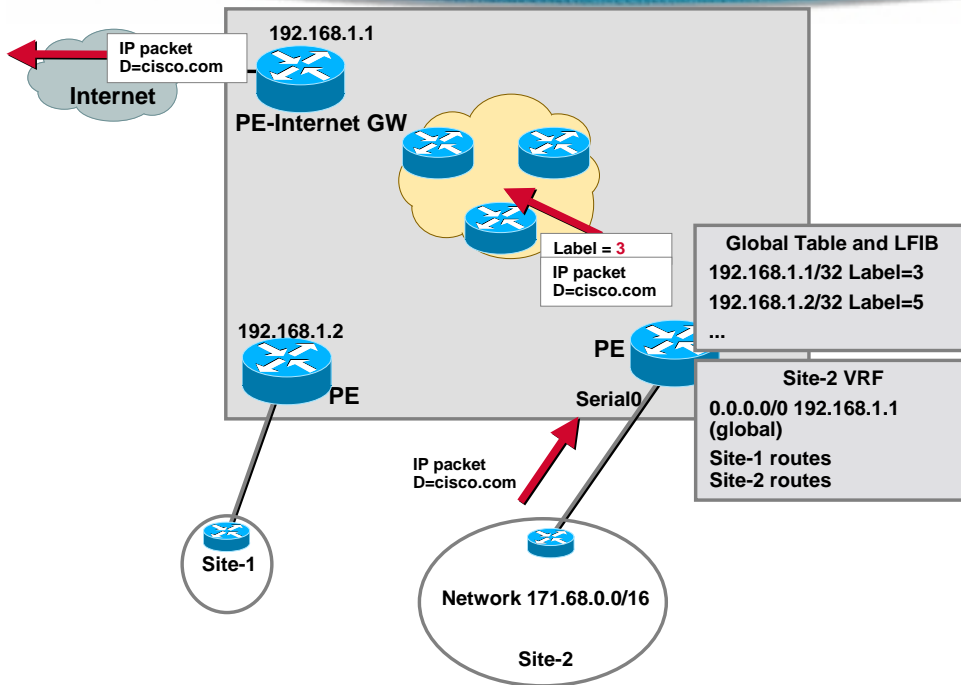
A single label is used for packets forwarded according to the default route

The label is the IGP label corresponding to the IP address of the Internet gateway known in the IGP

MPLS VPN Internet Routing VRF Specific Default Route



MPLS VPN Internet Routing VRF Specific Default Route



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MPLS VPN Internet Routing VRF Specific Default Route

- PE router originates CE routes for the Internet
Customer (site) routes are known in the site VRF
Not in the global table
The PE/CE interface is NOT known in the global table.
However:
A static route for customer routes and pointing to the PE/CE interface is installed in the global table
This static route is redistributed into BGP-4 global table and advertised to the Internet Gateway
- The Internet gateway knows customer routes and with the PE address as next-hop

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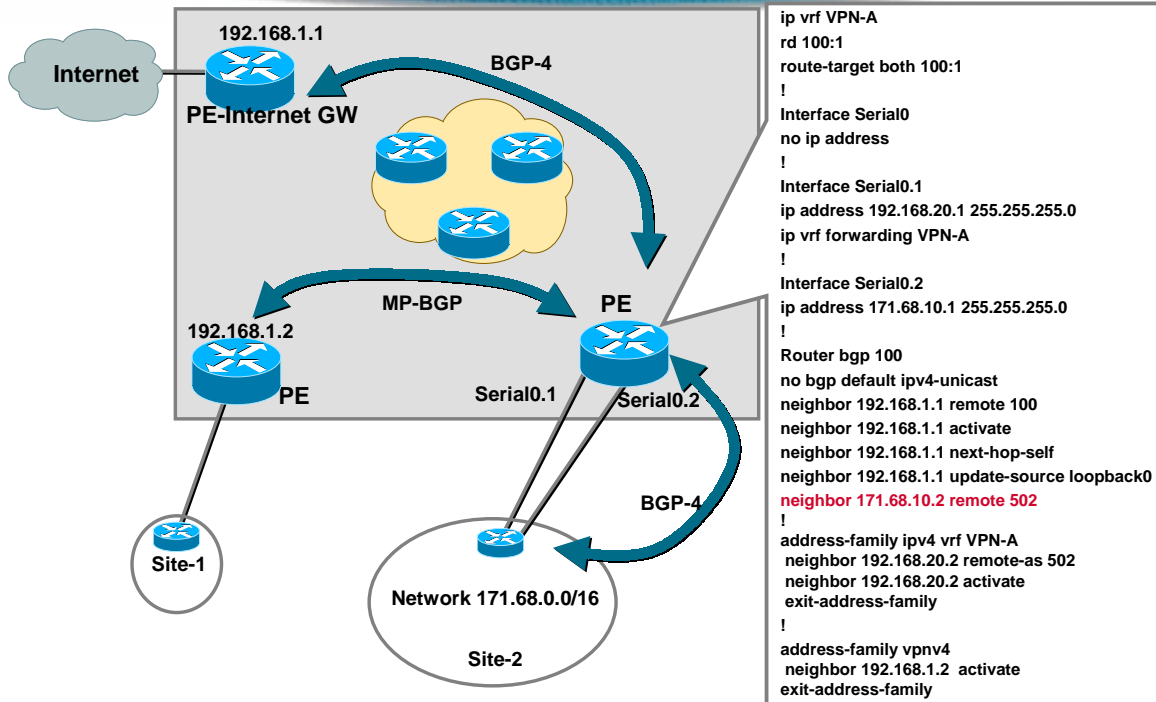
MPLS VPN Internet Routing VRF Specific Default Route

- **The Internet Gateway specified in the default route (into the VRF) need NOT to be directly connected**
- **Different Internet gateways can be used for different VRFs**
- **Using default route for Internet routing does NOT allow any other default route for intra-VPN routing**

MPLS VPN Internet Routing VRF Specific Default Route

- **PE routers need not to hold the Internet table**
- **PE routers will use BGP-4 sessions to originate customer routes**
- **Packet forwarding is done with a single label identifying the Internet Gateway IP address**

MPLS VPN Internet Routing Separated (Sub)interfaces



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MPLS VPN Internet Routing Separated (Sub)interfaces

- If CE wishes to receive and announce routes from/to the Internet

A dedicated BGP session is used over a separate (sub) interface

The PE imports CE routes into the global routing table and advertise them to the Internet

The interface is not part of any VPN and does not use any VRF

Default route or Internet routes are exported to the CE

PE needs to have Internet routing table

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MPLS VPN Internet Routing Separated (Sub)interfaces

- The PE uses separate (sub)interfaces with the CE

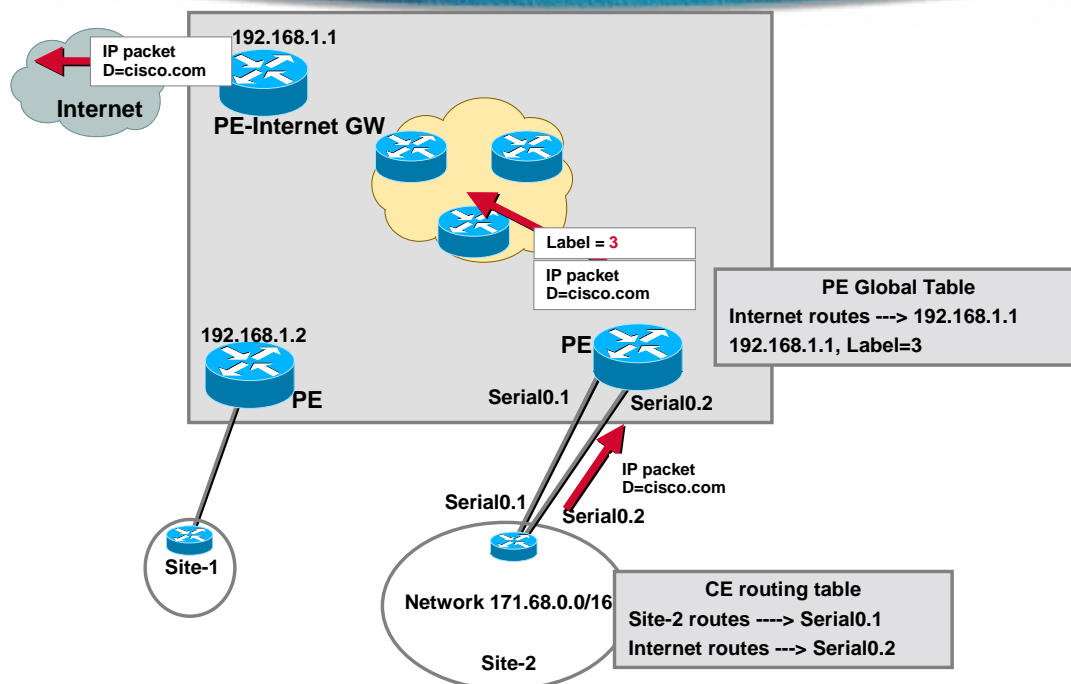
One (sub)interface for VPN routing

Associated to a VRF

One (sub)interface for Internet routing

Associated to the global routing table

MPLS VPN Internet Routing Separated (Sub)interfaces



MPLS VPN—Configuration Cheat Sheet

- **Identify PE routers**
- **Configure VRF instance for each VPN**
 - Design rd and route-target assignments
- **Configure MP-BGP between PEs (Route-Reflector or full-mesh)**
- **Identify Interfaces going to VPN sites**
 - Assign interfaces to the VRF instance
- **Choose the routing protocol between PE and CE**
 - Configure necessary redistribution between MP-BGP and VRF routing protocol

MPLS VPN—Configuration PE Router Commands

- **All show commands are VRF based**
 - Show ip route vrf <vrf-symbolic-name> ...
 - Show ip protocol vrf <vrf-symbolic-name>
 - Show ip cef <vrf-symbolic-name> ...
 - ...
- **PING, Telnet, Traceroute commands are VRF based**
 - ping vrf <vrf-symbolic-name>
 - telnet /vrf <vrf-symbolic-name>
 - traceroute vrf <vrf-symbolic-name>



Deploying MPLS for Backbone VPNs

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