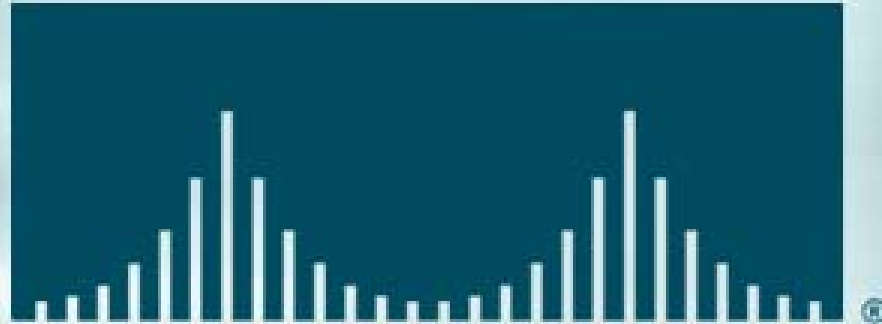




CISCO SYSTEMS



Troubleshooting MPLS for Traffic Engineering

Session RST-330

Agenda

- **Introduction**
- **Configuration**
- **Verifying Your Configuration**
- **Monitoring the State of the Tunnel**
- **Finding the Root Cause of the Problem**
- **Common Problem Scenarios**
- **Summary**

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- **Background**
- **Prerequisites**
 - Knowledge of IP routing**
 - MPLS basics**
 - Cisco CLI (right IOS)**

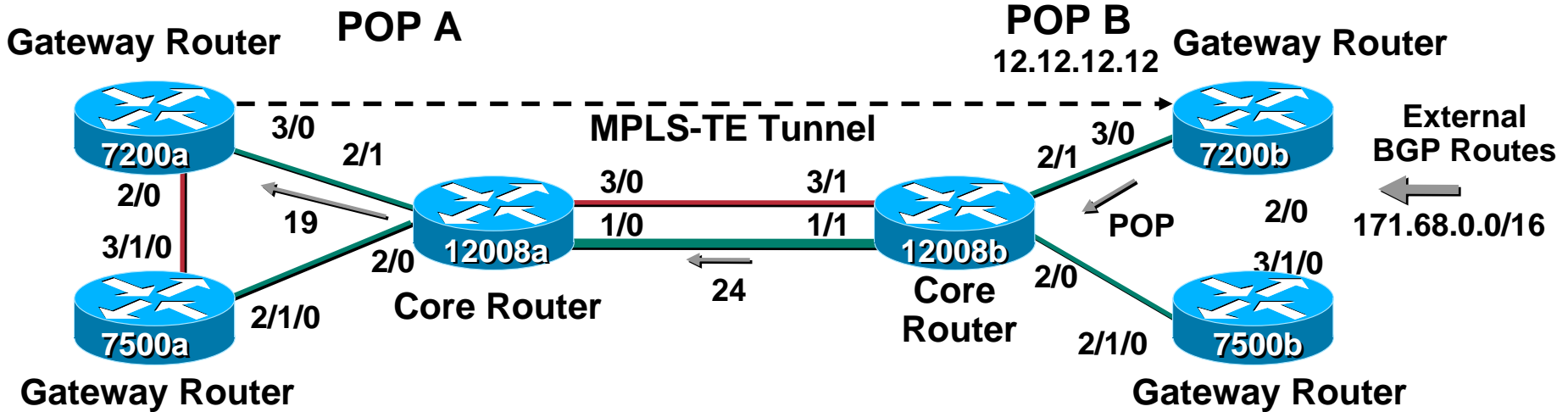
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Configuration

- **Common configuration (all nodes)**
- **Headend configuration**

Example SP Network



	7200a	7500a	12008a	12008b	7200b	7500b
7200a	4.4.4.4 (loop)	10.0.1.0	10.0.3.0			
7500a	10.0.1.0	3.3.3.3 (lo0)	10.0.2.0			
12008a	10.0.3.0	10.0.2.0	5.5.5.5	10.0.4.0 (3/0) 10.0.5.0 (1/0)		
12008b				10.0.4.0 (3/1) 10.0.5.0 (1/1)	10.0.17.0	10.0.19.0
7200b				10.0.17.0	12.12.12.12 (lo0)	10.0.18.0
7500b				10.0.19.0	10.0.18.0	13.13.13.13 (lo0)

Configuration

- **Common configuration (all nodes)**
- **Headend configuration**

Common Configuration

- **Global configuration**
- **Interface level configuration**
- **Routing protocol configuration**

Global Configuration

- ***ip cef <distributed>***
- ***mpls traffic-eng tunnels***

Interface Level Configuration

- *mpls traffic-eng tunnels*
- *ip rsvp bandwidth 155000 155000 <sub-pool 40000>*
- *mpls traffic-eng administrative-weight <0-4294967295>*
- *mpls traffic-eng attribute-flags<0x0-0xFFFFFFFF>*
- *mpls traffic-eng backup-path tunnel*
- *mpls traffic-eng flooding thresholds up/down <1-100>*

Routing Protocol Configuration

- **OSPF:**

mpls traffic-eng area <0-4294967295>

*mpls traffic-eng router-id **loopback0***

- **ISIS:**

mpls traffic-eng <level1/level2>

*mpls traffic-eng router-id **loopback0***

metric-style wide

- **Common configuration (all nodes)**
- **Headend configuration**

Headend Configuration

```
- interface tunnel 1
  tunnel destination 12.12.12.12
  ip unnumbered loopback0
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng affinity 0x0 mask 0x1
  tunnel mpls traffic-eng autoroute (metric|absolute|relative) | announce
  tunnel mpls traffic-eng bandwidth 155000 <sub-pool 40000>
  tunnel mpls traffic-eng fast-reroute
  tunnel mpls traffic-eng path-option 5 explicit name path-list1
  tunnel mpls traffic-eng path-option 6 dynamic
  tunnel mpls traffic-eng priority 7 7
  tunnel mpls traffic-eng record-route
```


Headend Configuration (Cont.)

```
- ip explicit-path name path-list1 enable
  next-address 10.0.3.5
  next-address 10.0.5.11 (11.11.11.11)
  next-address 10.0.17.12
  next-address 12.12.12.12
```

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Verifying Your Configuration

- **show run**
- **show run interface tunnel 1**
- **show run interface pos 3/0**
- **show run | begin ^router ospf**

Verifying Your Configuration

```
mpls-7200a#show run interface tunnel 1
Building configuration...
Current configuration:
interface Tunnel1
  ip unnumbered Loopback0
  no ip directed-broadcast
  no ip route-cache cef
  tunnel destination 12.12.12.12
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng path-option 1 explicit name sbp
end
```

Verifying Your Configuration

```
mpls-7200a#show run interface pos 3/0
Building configuration...
Current configuration:
!
interface POS3/0
  ip address 10.0.3.4 255.255.255.0
  no ip directed-broadcast
  load-interval 30
  mpls traffic-eng tunnels
  tag-switching ip
  crc 32
  clock source internal
```

Verifying Your Configuration

```
mpls-7200a#show run | begin ^router ospf
router ospf 100
  log-adjacency-changes
  auto-cost reference-bandwidth 100000
  network 4.4.4.4 0.0.0.0 area 0
  network 10.0.0.0 0.255.255.255 area 0
  mpls traffic-eng router-id Loopback0
  mpls traffic-eng area 0
!
```

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Monitoring the State of the Tunnel

- **show ip interface brief**
- **show interface tunnel 1**
- **show mpls traffic-eng tunnels brief**
- **show mpls traffic-eng tunnels t1**
- **show mpls traffic-eng tunnels summary**
- **show mpls traffic-eng role head**

Monitoring the State of the Tunnel

```
mpls-7200a#show mpls traffic-eng tunnels brief
```

Signalling Summary:

```
LSP Tunnels Process:          running
RSVP Process:                 running
Forwarding:                   enabled
Periodic reoptimization:     every 3600 seconds, next in
2434 seconds
```

TUNNEL NAME	DESTINATION	UP IF	DOWN
IF STATE/PROT			
mpls-7200a_t0 unknown up/down	12.12.12.12	-	
mpls-7200a_t1 up/up	12.12.12.12	-	PO3/0

```
Displayed 2 (of 2) heads, 0 (of 0) midpoints, 0 (of 0) tails
```

Monitoring the State of the Tunnel

```
mpls-7200a#show mpls traffic-eng tunnels t1
```

```
Name: mpls-7200a_t1 (Tunnel1) Destination:  
12.12.12.12
```

Status:

```
Admin: up Oper: up Path: valid Signalling:  
connected
```

```
path option 1, type explicit sbp (Basis for Setup, path weight 3)
```

Config Parameters:

```
Bandwidth: 0 kbps (Global) Priority: 7 7 Affinity:  
0x0/0xFFFF
```

```
AutoRoute: disabled LockDown: disabled
```

Monitoring the State of the Tunnel

InLabel : -

OutLabel : POS3/0, 19

RSVP Signalling Info:

Src 4.4.4.4, Dst 12.12.12.12, Tun_Id 1, Tun_Instance 64

RSVP Path Info:

My Address: 4.4.4.4

Explicit Route: 10.0.3.5 10.0.5.11 10.0.17.12 12.12.12.12

Record Route: NONE

Tspec: ave rate=0 kbits, burst=1000 bytes, peak rate=0 kbits

RSVP Resv Info:

Record Route: NONE

Fspec: ave rate=0 kbits, burst=1000 bytes, peak rate=Inf

Monitoring the State of the Tunnel

Shortest Unconstrained Path Info:

Path Weight: 3

Explicit Route: 10.0.3.5 10.0.5.11 10.0.17.12 12.12.12.12

History:

Current LSP:

Uptime: 31 days, 17 hours, 45 minutes

Prior LSP:

ID: path option 1 [15]

Removal Trigger: path verification failed

Monitoring the State of the Tunnel

```
mpls-7200a#show mpls traffic-eng tunnels summary
```

Signalling Summary:

LSP Tunnels Process: running

RSVP Process: running

Forwarding: enabled

Head: 2 interfaces, 1 active signalling attempts, 1 established
7 activations, 6 deactivations

Midpoints: 0, Tails: 0

Periodic reoptimization: every 3600 seconds, next in 1510
seconds

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Finding the Root Cause of the Problem

“Has to Be Related to One of These”

- **Someone configured it wrong?**

“I have never ever made a configuration error!”

- **“Ok, sometimes I do; so how do I find out what has gone wrong?”**

Finding the Root Cause of the Problem

Cisco.com

How MPLS–TE Works

- **Information distribution**
- **Path calculation**
- **Path setup**
- **Forwarding traffic down a tunnel**

Finding the Root Cause of the Problem

Is the Information Distribution Correct?

- **show ip ospf database opaque-area**
- **show isis database verbose gsr2.00-00**
- **debug ip ospf mpls traffic-eng advertisements**
- **debug isis mpls traffic-eng (adv/events)**

Finding the Root Cause of the Problem

How Is the Headend Coming to This Conclusion? (PCALC)

- **show mpls traffic-eng topology brief**
- **show mpls traffic-eng topology igp-id ospf 11.11.11.11**
- **show mpls traffic-eng tunnels topology path destination 12.12.12.12 <bandwidth | priority | affinity>**
- **show mpls traffic-eng tunnels topology path tunnel1 <bandwidth | priority | affinity>**

Finding the Root Cause of the Problem

What Do the Mid-Points and Tail Look Like?

- **show mpls traffic-eng link-management <advertisements | admission-control | bandwidth>**
- **show ip rsvp <reservation | interface>**
- **debug mpls traffic-eng link-management <advertisements | admission-control | bandwidth>**

Finding the Root Cause of the Problem

Cisco.com

Headend Thinks There Is a Viable Path; Could There Be a Signaling Problem?

- **show mpls traffic-eng tunnel t1**
- **debug ip rsvp path 101 detail**
- **debug ip rsvp resv 101 detail**

Finding the Root Cause of the Problem

Cisco.com

Is the Traffic Mapped to the Tunnel Correctly?

- **show ip route 171.68.0.0**
- **show ip cef 171.68.0.0 <detail | internal>**

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Common Problem Scenarios

- **My tunnel does not come up**
- **My tunnel is up but no traffic is going down the tunnel**
- **Traffic is going down the tunnel but is being black-holed somewhere in the middle**
- **I added a new path option but traffic is still taking the old path**
- **I cannot get load balancing to work**

My Tunnel Does Not Come Up

- **Is it admin down?**
- **Is the path valid?**
- **What is the signaling state?**

My Tunnel Does Not Come Up

Is It Admin Down?

```
mpls-7200a#show mpls traffic-eng tunnel t1
```

```
Name: mpls-7200a_t1 (Tunnel1) Destination:  
12.12.12.12
```

Status:

```
Admin: admin-down Oper: down Path: not valid Signalling:  
Down
```

```
path option 1, type explicit sbp
```

My Tunnel Does Not Come Up

Is the Path Valid?

```
mpls-7200a#sh mpls traffic-eng tunnel t1
```

```
Name: mpls-7200a_t1 (Tunnell)
```

```
Destination: 12.12.12.12
```

```
Status:
```

```
Admin: up Oper: down Path: not valid
```

```
Signalling: Down
```

```
path option 1, type explicit sbp
```

My Tunnel Does Not Come Up

Why Is the Path Not Valid?

- **debug mpls traffic-eng path**

```
mpls-7200a#debug mpls traffic-eng path lookup
```

```
TE-PCALC: Tunnel1 Path Setup to 12.12.12.12: FULL_PATH
```

```
8w4d: TE-PCALC: bw 0, min_bw 0, metric: 0
```

```
8w4d: TE-PCALC: setup_pri 7, hold_pri 7
```

```
8w4d: TE-PCALC: affinity_bits 0x0, affinity_mask 0xFFFF
```

```
8w4d: TE-PCALC_PATH: create_path_hoplist:ip addr 10.0.5.11  
unknown.
```

My Tunnel Does Not Come Up

Why Is Link 10.0.5.11 Unknown?

```
mpls-7200a#show mpls traffic-eng topology igp-id ospf 11.11.11.11  
brief
```

```
IGP Id: 11.11.11.11, MPLS TE Id:11.11.11.11 Router Node
```

```
link[0 ]:Nbr IGP Id: 12.12.12.12, gen:28
```

```
frag_id 1, Intf Address:10.0.17.11, Nbr Intf  
Address:10.0.17.12
```

```
admin_weight:1, attribute_flags:0x0
```

```
link[1 ]:Nbr IGP Id: 5.5.5.5, gen:28
```

```
frag_id 2, Intf Address:10.0.4.11, Nbr Intf  
Address:10.0.4.5
```

```
admin_weight:1, attribute_flags:0x0
```

Traffic Not Going Down the Tunnel

- **Is the traffic statically mapped?**
- **Are you using auto-route announce?**
- **Do you have an ip address for your tunnel? (ip unnumbered loop0)**

Traffic Not Going Down the Tunnel

If It Is NOT Taking the Tunnel

```
mpls-7200a#show ip cef 171.68.0.0
171.68.0.0/16, version 161, cached adjacency to POS3/0
0 packets, 0 bytes
tag information from 12.12.12.12/32, shared
  local tag: 24
  fast tag rewrite with PO3/0, point2point, tags imposed {27}
via 12.12.12.12, 0 dependencies, recursive
  next hop 10.0.3.5, POS3/0 via 12.12.12.12/32
  valid cached adjacency
  tag rewrite with PO3/0, point2point, tags imposed {27}
```

Traffic Not Going Down the Tunnel

If It Is Taking the Tunnel

```
mpls-7200a#show ip cef 171.68.0.0
171.68.0.0/16, version 161
0 packets, 0 bytes
tag information from 12.12.12.12/32, shared, unshareable
  local tag: 24
  fast tag rewrite with Tu1, point2point, tags imposed {19}
via 12.12.12.12, 0 dependencies, recursive
  next hop 12.12.12.12, Tunnel1 via 12.12.12.12/32
  valid adjacency
tag rewrite with Tu1, point2point, tags imposed {19}
```

Traffic Not Going Down the Tunnel

If It Is Taking the Tunnel

```
mpls-7200a#show mpls traffic-eng autoroute
```

```
MPLS TE autorouting enabled
```

```
destination 12.12.12.12 has 1 tunnels
```

```
Tunnel1 (traffic share 0, nexthop 12.12.12.12)
```

```
mpls-7200a#show ip cef 171.68.0.0
```

```
171.68.0.0/16, version 161
```

```
0 packets, 0 bytes
```

```
tag information from 12.12.12.12/32, shared
```

```
local tag: 24
```

```
fast tag rewrite with Tu1, point2point, tags imposed {19}
```

```
via 12.12.12.12, 0 dependencies, recursive
```

```
next hop 12.12.12.12, Tunnel1 via 12.12.12.12/32
```

```
valid adjacency
```

```
tag rewrite with Tu1, point2point, tags imposed {19}
```


Traffic Not Going Down the Tunnel

Tunnel is up/up

```
mpls-7200a#show mpls tr tun t1 brief
```

```
Signalling Summary:
```

```
LSP Tunnels Process:      running
RSVP Process:             running
Forwarding:               enabled
Periodic reoptimization:  every 3600 seconds, next in 3058 seconds
Periodic fastreroute:     every 300 seconds, next in 58 seconds
Periodic auto-bw collection: every 300 seconds, next in 58 seconds
```

TUNNEL NAME	DESTINATION	UP IF	DOWN IF	STATE/PROT
Primary tunnel 7200a->12008a...	12.12.12.12	-	PO3/0	up/up

Traffic Not Going Down the Tunnel

Tunnel is up/up

- No traffic over the tunnel interface:

```
mpls-7200a#show ip cef tunnel 1
```

Prefix	Next Hop	Interface
--------	----------	-----------

```
mpls-7200a#
```

Traffic Not Going Down the Tunnel

Tunnel is up/up

- Do we have static route or autoroute announce?:

```
interface Tunnell
  description Primary tunnel 7200a->12008a->12008c->7200c
  no ip address
  tunnel destination 12.12.12.12
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng autoroute announce
  tunnel mpls traffic-eng path-option 5 explicit name primary
  tunnel mpls traffic-eng path-option 6 dynamic
  tunnel mpls traffic-eng record-route
end
```

Traffic Not Going Down the Tunnel

Oops no ip address on tunnel interface!

```
interface Tunnell
  description Primary tunnel 7200a->12008a->12008c->7200c
  no ip address
  no ip directed-broadcast
  no ip route-cache cef
  tunnel destination 12.12.12.12
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng autoroute announce
  tunnel mpls traffic-eng priority 7 7
  tunnel mpls traffic-eng bandwidth 100
  tunnel mpls traffic-eng path-option 5 explicit name primary
  tunnel mpls traffic-eng path-option 6 dynamic
  tunnel mpls traffic-eng record-route
end
```

Traffic Not Going Down the Tunnel

IP addresses added back to tunnel interface

```
interface Tunnell
  description Primary tunnel 7200a->12008a->12008c->7200c
  ip unnumbered Loopback0
  no ip directed-broadcast
  no ip route-cache cef
  tunnel destination 12.12.12.12
  tunnel mode mpls traffic-eng
  tunnel mpls traffic-eng autoroute announce
  tunnel mpls traffic-eng priority 7 7
  tunnel mpls traffic-eng bandwidth 100
  tunnel mpls traffic-eng path-option 5 explicit name primary
  tunnel mpls traffic-eng path-option 6 dynamic
  tunnel mpls traffic-eng record-route
end
```

Traffic Not Going Down the Tunnel

Traffic flows over tunnel1 once again

```
mpls-7200a#show ip cef tunnel 1
```

Prefix	Next Hop	Interface
10.0.18.0/24	10.0.3.5	POS3/0
	0.0.0.0	Tunnel1
10.0.87.0/24	10.0.3.5	POS3/0
	0.0.0.0	Tunnel1
10.1.1.1/32	0.0.0.0	Tunnel1
10.1.1.2/32	0.0.0.0	Tunnel1
12.12.12.12/32	0.0.0.0	Tunnel1
171.68.0.0/16	12.12.12.12	Tunnel1

Traffic Going Down Tunnel but Getting Black-Holed

- **Determine location of black hole**
- **Cause of black hole**

Where Is the Black Hole?

- **Using traceroute**

Is MPLS forwarding the problem?

Use IP packets with options set

- **Using counters**

show mpls forwarding detail (midpoints)

show interface tunnel 1 (headend)

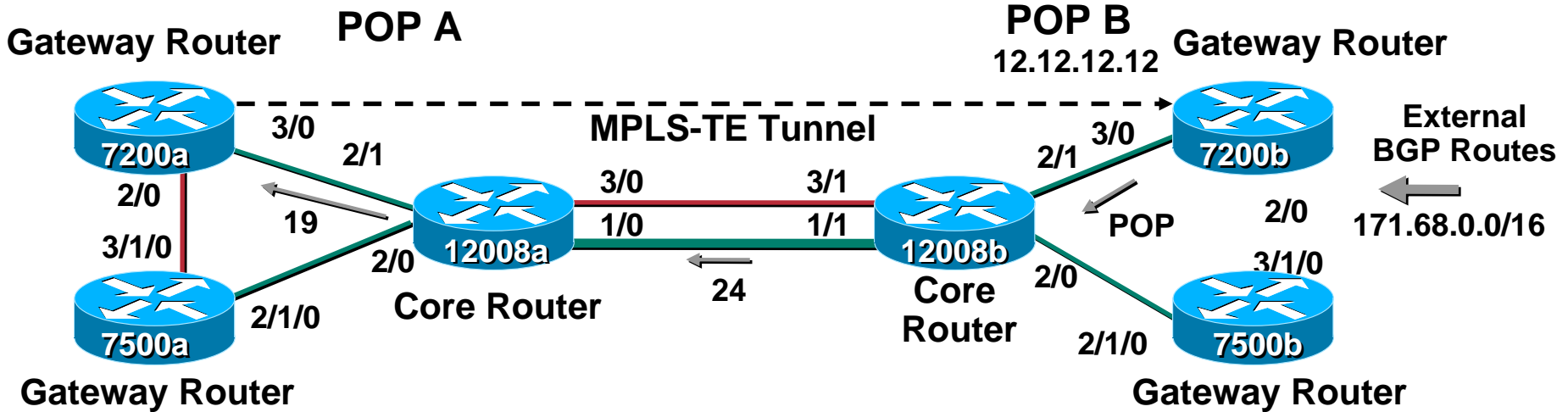
Cause of the Black-Holing

- **Are packets arriving with a label?**
- **Is this the label we are expecting to receive?**

Cause of the Black-Holing

- **Check the labels manually for correct mapping**
 - Headend should have imposed a label of 19**
 - Midpoint1 should label-swap it with 24**
 - Midpoint2 should pop the label**
- **show ip cef**
- **show mpls forwarding**

Example SP Network



	7200a	7500a	12008a	12008b	7200b	7500b
7200a	4.4.4.4 (loop)	10.0.1.0	10.0.3.0			
7500a	10.0.1.0	3.3.3.3 (lo0)	10.0.2.0			
12008a	10.0.3.0	10.0.2.0	5.5.5.5	10.0.4.0 (3/0) 10.0.5.0 (1/0)		
12008b				10.0.4.0 (3/1) 10.0.5.0 (1/1)	10.0.17.0	10.0.19.0
7200b				10.0.17.0	12.12.12.12 (lo0)	10.0.18.0
7500b				10.0.19.0	10.0.18.0	13.13.13.13 (lo0)

Cause of the Black-Holing

Headend mpls-7200a

```
mpls-7200a#show ip cef 171.68.0.0
171.68.0.0/16, version 161
0 packets, 0 bytes
tag information from 12.12.12.12/32, shared
  local tag: 24
  fast tag rewrite with Tu1, point2point, tags imposed {19}
via 12.12.12.12, 0 dependencies, recursive
  next hop 12.12.12.12, Tunnel1 via 12.12.12.12/32
  valid adjacency
  tag rewrite with Tu1, point2point, tags imposed {19}
```

Cause of the Black-Holing

Midpoint1 mpls-12008a

```
mpls-7200a#show ip cef 171.68.0.0
171.68.0.0/16, version 161
0 packets, 0 bytes
tag information from 12.12.12.12/32, shared
  local tag: 24
  fast tag rewrite with Tu1, point2point, tags imposed {19}
via 12.12.12.12, 0 dependencies, recursive
  next hop 12.12.12.12, Tunnel1 via 12.12.12.12/32
  valid adjacency
  tag rewrite with Tu1, point2point, tags imposed {19}
```

Cause of the Black-Holing

Midpoint1 mpls-12008a

```
mpls-12008a#show mpls forwarding-table labels 19 detail
```

Local	Outgoing	Prefix	Bytes tag	Outgoing	Next Hop
tag	tag or VC	or Tunnel Id	switched	interface	
19	24	4.4.4.4 1 [8324]	22932234	PO1/0	point2point

```
MAC/Encaps=4/8, MTU=4474, Tag Stack{24}
```

```
0F008847 00018000
```

```
No output feature configured
```

Cause of the Black-Holing

Incoming Eng2 Line Card on GSR?

```
mpls-12008c#execute-on slot 1 show controller psa phb <detail>
===== Line Card (Slot 1) =====

---- PSA(phb) 0 - HDLC TAG packet: top tag 24 cos 0 ttl 0xFD
IP:      vers 4 hl 5 tos 0x0 tl 100 ttl 0xFF proto icmp
        src 4.4.4.4 dst 12.12.12.12

bufhdr:  loq 0x001F oq 0x001F stoff 20 l3 size 100

tagrew:  loq ABBA mtu 45489 oq ABBA ai 45489 oi ABBAB1B1 oacl ABBA (encaps
size 11)
```

I Added a New Path Option but Traffic Is Still Taking the Old Path

- **Is new path valid?**
- **Has reoptimization timer kicked in?**

Show mpls traffic-eng summary

Force reoptimization:

mpls traffic-eng reoptimize <tunnel>

I Cannot Get Load Balancing to Work

- **Is it supposed to load balance**
 - Load balancing per packet?**
 - Load balancing per destination (default)**
 - MPLS-TE picks one of the links**
 - If you need to force load-balancing build separate tunnels over each link**
- **Unequal Cost Load Balancing**
- **show ip cef 12.12.12.12 internal**
 - Shows load share tables**
 - Unequal cost load sharing possible**

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- **Know your MPLS-TE components:**
OSPF/ISIS flooding, RSVP, MPLS, general troubleshooting skills
- **Zero in on the problem (related to component) and use the right tool**
- **Be systematic**

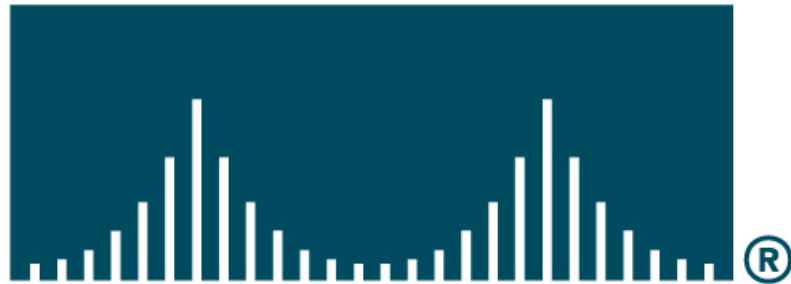
Troubleshooting MPLS for Traffic Engineering

Session RST-330

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Session RST-330

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