# MPLS TE with Forwarding Adjacency

« MPLS TE with Static Routing (/workbook/view/service-provider-v4/task/mpls-te-with-static-routing-Mjg4NA%3D%3D) | MPLS TE with Targeted LDP Adjacencies (/workbook/view/service-provider-v4/task/mpls-te-with-targeted-ldp-adjacencies-Mjg4NQ%3D%3D) »

Last updated: April 22, 2016

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Note:

**Initial Configuration & Diagrams**: Load the initial configuration files for the section named **MPLS TE with IS-IS**, which can be found in CCIE SPv4 Topology Diagrams & Initial Configurations (http://labs.ine.com/workbook/view/service-provider-v4/task/ccie-spv4-topology-diagrams-initial-configs). Refer to the **Base IPv4 Diagram** in order to complete this task.

## Task

- Configure R3, R4, R5, and R6 to support MPLS TE tunnels as follows:
  - Enable MPLS TE support for the IS-IS Level 2 core.
  - Set the IS-IS MPLS TE Router-ID to be the Loopback0 interfaces.
  - Enable support for RSVP and MPLS TE on all transit interfaces running IS-IS in the core.
- Configure an MPLS TE tunnel from R3 to R6, and from R6 to R3 as follows:
  - Unnumber the tunnel to R3's and R6' Loopback0 interface respectively.
  - Set the tunnel destination as R6's and R3' Loopback0 interface respectively.
  - For the R3 to R6 tunnel, configure an explicit path of R4-R5-R6.
  - For the R6 to R3 tunnel, configure an explicit path of R5-R4-R3.
  - Ensure these tunnels can be seen by the rest of the ISIS routers, including R2 and XR1, as a single link in the topology.
  - Change the metric of the tunnel so that traffic between R2 and XR2's Loopback0 traverses the tunnel.

## Configuration **Click to *collapse***

```
R2:
router isis
 metric-style wide
!
```

```
R3:
mpls traffic-eng tunnels
!
interface GigabitEthernet1.34
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
interface GigabitEthernet1.36
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
router isis
 metric-style wide
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng level-2
!
ip explicit-path name R3_TO_R6 enable
 next-address 4.4.4.4
 next-address 5.5.5.5
 next-address 6.6.6.6
!
interface Tunnel0
 ip unnumbered Loopback0
 tunnel mode mpls traffic-eng
 tunnel destination 6.6.6.6
 tunnel mpls traffic-eng forwarding-adjacency
 tunnel mpls traffic-eng path-option 1 explicit name R3_TO_R6
 isis metric 5 level-2
```

```
R4:
mpls traffic-eng tunnels
!
interface GigabitEthernet1.34
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
interface GigabitEthernet1.45
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
interface GigabitEthernet1.46
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
router isis
 metric-style wide
```

```
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng level-2

R5:
mpls traffic-eng tunnels
!
interface GigabitEthernet1.45
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
interface GigabitEthernet1.56
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
router isis
 metric-style wide
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng level-2

R6:
mpls traffic-eng tunnels
!
interface GigabitEthernet1.36
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
interface GigabitEthernet1.46
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
interface GigabitEthernet1.56
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
router isis
 metric-style wide
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng level-2
!
ip explicit-path name R6_TO_R3 enable
 next-address 5.5.5.5
 next-address 4.4.4.4
 next-address 3.3.3.3
!
interface Tunnel0
 ip unnumbered Loopback0
 tunnel mode mpls traffic-eng
 tunnel destination 3.3.3.3
 tunnel mpls traffic-eng forwarding-adjacency
 tunnel mpls traffic-eng path-option 1 explicit name R6_TO_R3
 isis metric 5 level-2


XR1:
```

```
router isis 1
 address-family ipv4 unicast
  metric-style wide
```

## Verification

Another way to forward traffic down TE tunnels is by using Forwarding Adjacencies. Without forwarding adjacencies the TE tunnels are not advertised into IGP, thus no other routers besides the local device with the tunnel configured know about the LSP. With Forwarding Adjacency, the TE tunnel can be advertised as a link into the IGP, and other routers in the network can make use of it without even realizing that the link is a TE tunnel.

If the TE tunnel between R3-R6 and R6-R3 did not have Forwarding Adjacency enabled, R2 and XR1 would have no way to know about the TE tunnel when computing SPF. Even if R3 configured a low metric on the tunnel, when R2 runs normal SPF, it would select the shortest path from its point of view, ignoring the tunnel from R3 to R6 as it does not know about this "link". Note that this occurs because the tunnel is not advertised into IGP. At this point one may thing that `autoroute announce` may help. However, in this scenario, `autoroute announce` would only help R3 and R6, but it would have no effect on how R2 forwards traffic. Static routes wouldn't work either, as this only influences how R3/R6 forwards traffic into the tunnel.

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The Forwarding Adjacency TE tunnel "link" can be advertised with a lower cost into the IGP so that other routers in the network use it for traffic forwarding. From an SPF point of view this is seen as a direct point-to-point link between R3 and R6. Yet the LSP is from R3-R4-R5-R6.

Note however that this new link can not be used to signal other tunnels over it. IF R2 wants to signal an LSP to XR1, the tunnel would make use of the physical links in the network, not the Forwarding Adjacency. Additionally, the tunnel must be bidirectional in order for it to be considered as a link by other routers in the network. If R3 has a tunnel to R6, R6 must also have a tunnel to R3. This restriction is caused by the IGP's bidirectional check - in order to use a link, it must see both ends of the link in the LSPs/LSAs.

The metric of this link was changed to 5 so that it would be preferred by R2 and XR1 when forwarding traffic between their loopbacks. This can be seen in the ISIS database:

```
R3#show isis database R3.00-00 detail



IS-IS Level-2 LSP R3.00-00
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00            * 0x00000009   0x2039        669               0/0/0
  Area Address: 49.0001
  NLPID:        0xCC
   Router ID:    3.3.3.3
  Hostname: R3
  Metric: 10         IS-Extended R3.03
  Metric: 10         IS-Extended R3.02
  Metric: 10         IS-Extended R3.01
   Metric: 5          IS-Extended R6.00
  IP Address:   3.3.3.3
  Metric: 0          IP 3.3.3.3/32
  Metric: 10         IP 20.2.3.0/24
  Metric: 10         IP 20.3.4.0/24
  Metric: 10         IP 20.3.6.0/24
```

Notice that R2 and XR1 also see this link in their IGP database - thus is can be taken into consideration when computing SPF.

```
R2#show isis database R3.00-00 detail

Tag null:

IS-IS Level-2 LSP R3.00-00
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00              0x00000009   0x2039        630               0/0/0
  Area Address: 49.0001
  NLPID:        0xCC
   Router ID:    3.3.3.3
  Hostname: R3
  Metric: 10         IS-Extended R3.03
  Metric: 10         IS-Extended R3.02
  Metric: 10         IS-Extended R3.01
   Metric: 5          IS-Extended R6.00
  IP Address:   3.3.3.3
  Metric: 0          IP 3.3.3.3/32
  Metric: 10         IP 20.2.3.0/24
  Metric: 10         IP 20.3.4.0/24
  Metric: 10         IP 20.3.6.0/24

RP/0/0/CPU0:XR1#show isis database  R3.00-00 detail
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IS-IS 1 (Level-2) Link State Database
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime  ATT/P/OL
R3.00-00              0x00000009   0x2039        607             0/0/0
  Area Address: 49.0001
  NLPID:        0xcc
   Router ID:    3.3.3.3
  Hostname:     R3
  Metric: 10         IS-Extended R3.03
  Metric: 10         IS-Extended R3.02
  Metric: 10         IS-Extended R3.01
   Metric: 5          IS-Extended R6.00
  IP Address:   3.3.3.3
  Metric: 0          IP-Extended 3.3.3.3/32
  Metric: 10         IP-Extended 20.2.3.0/24
  Metric: 10         IP-Extended 20.3.4.0/24
  Metric: 10         IP-Extended 20.3.6.0/24
```

However, as mentioned previously, notice that this new link is not available for TE signaling. Only the physical link between R3 and R6 is available for this purpose.

```
R4#show mpls traffic-eng topology 3.3.3.3

IGP Id: 0000.0000.0003.00, MPLS TE Id:3.3.3.3 Router Node  (isis  level-2) id 8
      link[0]: Broadcast, DR: 0000.0000.0003.03, nbr_node_id:6, gen:262
       frag_id: 0, Intf Address: 20.3.6.3
       TE metric: 10, IGP metric: 10 , attribute flags: 0x0
      SRLGs: None
      physical_bw: 1000000 (kbps), max_reservable_bw_global: 750000 (kbps)
      max_reservable_bw_sub: 0 (kbps)

                           Global Pool       Sub Pool
          Total Allocated  Reservable        Reservable
          BW (kbps)        BW (kbps)         BW (kbps)
          ---------------  -----------       ----------
    bw[0]:            0          750000               0
    bw[1]:            0          750000               0
    bw[2]:            0          750000               0
    bw[3]:            0          750000               0
    bw[4]:            0          750000               0
    bw[5]:            0          750000               0
    bw[6]:            0          750000               0
    bw[7]:            0          750000               0


      link[1]: Broadcast, DR: 0000.0000.0003.02, nbr_node_id:10, gen:262
       frag_id: 0, Intf Address: 20.3.4.3
       TE metric: 10, IGP metric: 10 , attribute flags: 0x0
      SRLGs: None
      physical_bw: 1000000 (kbps), max_reservable_bw_global: 750000 (kbps)
      max_reservable_bw_sub: 0 (kbps)

                           Global Pool       Sub Pool
          Total Allocated  Reservable        Reservable
          BW (kbps)        BW (kbps)         BW (kbps)
          ---------------  -----------       ----------
    bw[0]:            0          750000               0
    bw[1]:            0          750000               0
    bw[2]:            0          750000               0
    bw[3]:            0          750000               0
    bw[4]:            0          750000               0
    bw[5]:            0          750000               0
    bw[6]:            0          750000               0
    bw[7]:            0          750000               0
```

This can also be gleaned from the ISIS database.

```
R3#show isis database R3.00-00 verbose



IS-IS Level-2 LSP R3.00-00
LSPID                 LSP Seq Num  LSP Checksum  LSP Holdtime      ATT/P/OL
R3.00-00            * 0x0000000A   0x1E3A        1007              0/0/0
  Area Address: 49.0001
  NLPID:        0xCC
  Router ID:    3.3.3.3
  Hostname: R3
  Metric: 10         IS-Extended R3.03
    Affinity: 0x00000000
    Interface IP Address: 20.3.6.3
    Physical BW: 1000000 kbits/sec
    Reservable Global Pool BW: 750000 kbits/sec
    Global Pool BW Unreserved:
      [0]:   750000 kbits/sec, [1]:   750000 kbits/sec
      [2]:   750000 kbits/sec, [3]:   750000 kbits/sec
      [4]:   750000 kbits/sec, [5]:   750000 kbits/sec
      [6]:   750000 kbits/sec, [7]:   750000 kbits/sec
  Metric: 10         IS-Extended R3.02
    Affinity: 0x00000000
    Interface IP Address: 20.3.4.3
    Physical BW: 1000000 kbits/sec
    Reservable Global Pool BW: 750000 kbits/sec
    Global Pool BW Unreserved:
      [0]:   750000 kbits/sec, [1]:   750000 kbits/sec
      [2]:   750000 kbits/sec, [3]:   750000 kbits/sec
      [4]:   750000 kbits/sec, [5]:   750000 kbits/sec
      [6]:   750000 kbits/sec, [7]:   750000 kbits/sec
  Metric: 10         IS-Extended R3.01
  Metric: 5          IS-Extended R6.00
  IP Address:   3.3.3.3
  Metric: 0          IP 3.3.3.3/32
  Metric: 10         IP 20.2.3.0/24
  Metric: 10         IP 20.3.4.0/24
  Metric: 10         IP 20.3.6.0/24
```

Final verification for this task can be observed by forwarding traffic between the loopbacks of R2 and XR1. Notice that both of these devices are not participating in TE. The point of this task was demonstrating how a TE tunnel can be made available to other IGP nodes.

```
R2#traceroute 19.19.19.19 source 2.2.2.2

Type escape sequence to abort.

Tracing the route to 19.19.19.19

VRF info: (vrf in name/id, vrf out name/id)

  1 20.2.3.3 4 msec 1 msec 1 msec

  2 20.3.4.4 [MPLS: Label 19 Exp 0] 2 msec 3 msec 8 msec

  3 20.4.5.5 [MPLS: Label 19 Exp 0] 30 msec 30 msec 30 msec

  4 20.5.6.6 19 msec 10 msec 10 msec

  5 20.6.19.19 10 msec *  3 msec


R2#show mpls traffic-eng topology

Signalling error holddown: 10 sec Global Link Generation 267



RP/0/0/CPU0:XR1#traceroute 2.2.2.2 source 19.19.19.19

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Type escape sequence to abort.

Tracing the route to 2.2.2.2


 1  20.6.19.6 0 msec  0 msec  0 msec

 2  20.5.6.5 [MPLS: Label 17 Exp 0] 0 msec  0 msec  0 msec

 3  20.4.5.4 [MPLS: Label 16 Exp 0] 0 msec  0 msec  0 msec

 4  20.3.4.3 0 msec  0 msec  39 msec

 5  20.2.3.2 9 msec  *  0 msec


RP/0/0/CPU0:XR1#show mpls traffic-eng topology

Sat May 30 14:30:37.516 UTC

To be able to use this command, please enable the MPLS-TE application
```

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