MPLS Traffic Engineering with OSPF

« IP L2 VPN with L2TPv3 (/workbook/view/service-provider-v4/task/ip-l2-vpn-with-l2tpv3-Mjk0Nw%3D%3D) | MPLS Traffic Engineering with IS-IS (/workbook/view/service-provider-v4/task/mpls-traffic-engineering-with-is-is-Mjg4MA%3D%3D) »

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Note:

Initial Configuration & Diagrams: Load the initial configuration files for the section named **MPLS TE with OSPF**, 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

- R2 and XR1 are preconfigured as PE routers for the MPLS L3VPN customer routers R1 and XR2, respectively. However, the core of the Service Provider network is not running LDP.
- Configure the core of the Service Provider network to support MPLS TE tunnels as follows:
  - Enable MPLS TE support for the OSPF area 0 core.
  - Set the OSPF MPLS TE Router-ID to be the Loopback0 interfaces.
  - Enable support for RSVP and MPLS TE on all transit interfaces running OSPF in the core.
- Configure an MPLS TE tunnel from R2 to XR1 as follows:
  - Unnumber the tunnel to R2’s Loopback0 interface.
  - Set the tunnel destination as XR1’s Loopback0 interface.
  - Set the tunnel’s path option to dynamic.
  - Configure Autoroute Announce on the tunnel so that the OSPF core can use it for dynamic routing.
- Configure an MPLS TE tunnel from XR1 to R2 as follows:
  - Unnumber the tunnel to XR1’s Loopback0 interface.
  - Set the tunnel destination as R2’s Loopback0 interface.
  - Set the tunnel’s path option to dynamic.
  - Configure Autoroute Announce on the tunnel so that the OSPF core can use it for dynamic routing.
- When complete, the following reachability should be achieved:
  - R1 and XR2 should have full IP reachability to each other, and a traceroute should indicate that their L3VPN tunnel is transiting over the MPLS TE tunnels in the core of the SP network.

Configuration

Click to *collapse*

```
R2:
mpls traffic-eng tunnels
!
interface Tunnel0
 ip unnumbered Loopback0
 tunnel mode mpls traffic-eng
 tunnel destination 19.19.19.19
 tunnel mpls traffic-eng autoroute announce
 tunnel mpls traffic-eng path-option 10 dynamic
!
interface GigabitEthernet1.23
 mpls traffic-eng tunnels
  ip rsvp bandwidth
!
interface GigabitEthernet1.24
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
router ospf 1
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng area 0

R3:
mpls traffic-eng tunnels
!
interface GigabitEthernet1.23
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
interface GigabitEthernet1.34
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
interface GigabitEthernet1.36
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
router ospf 1
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng area 0

R4:
mpls traffic-eng tunnels
!
interface GigabitEthernet1.24
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
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 ospf 1
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng area 0

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
!
interface GigabitEthernet1.519
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
router ospf 1
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng area 0

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
!
interface GigabitEthernet1.619
 mpls traffic-eng tunnels
 ip rsvp bandwidth
!
router ospf 1
 mpls traffic-eng router-id Loopback0
 mpls traffic-eng area 0

XR1:
```

```
interface tunnel-te0
 ipv4 unnumbered Loopback0
 autoroute announce
 destination 2.2.2.2
 path-option 1 dynamic
!
router ospf 1
 area 0
  mpls traffic-eng
 !
 mpls traffic-eng router-id Loopback0
!
rsvp
 interface GigabitEthernet0/0/0/0.519
 !
 interface GigabitEthernet0/0/0/0.619
 !
mpls traffic-eng
 interface GigabitEthernet0/0/0/0.519
 !
 interface GigabitEthernet0/0/0/0.619
 !
mpls ldp
```


Verification

Traditional routing only takes link costs into account when selecting a best path towards each destination. This decision is done on a hop by hop basis. Making routing decisions on information other than destination address can normally be solved using Policy Based Routing (PBR). However, this would have to be configured on a hop by hop basis throughout the core and edge of the network, which can lead to an operational nightmare. MPLS Traffic Engineering solves the problem of providing a more granular traffic forwarding model, by allowing customizable forwarding paths to be established based on criteria other than link costs/metrics.

Picture a scenario where a customer has two sites using a L3VPN service from the Service Provider. The customer sends two types of traffic between the sites, Voice/Video and normal bulk data. Based on normal routing, the PE router connected to the customer CE would select a single LSP to send traffic to the other site (another PE). This means that all traffic between the two PEs will take the same path through the MPLS core network. In order to provider SLAs to the customer for the voice/video traffic, MPLS Traffic Engineering can be used to find a the best path through the network for each traffic class, based on criteria other than link cost/metric. Voice traffic can use an LSP with the least amount of delay (shortest fiber length for example), and bulk data traffic can follow the default path.

The example outlined in this task shows the minimum configuration needed to build two basic MPLS TE tunnels between the PE routers of the Service Provider's network. Additionally in this case, the TE tunnels replace the need for Label Distribution Protocol (LDP) in the SP core. Instead of automatically allocating a label value for each route advertised via IGP, MPLS TE only allocates labels for destinations that have a TE tunnel built toward them. This is why two tunnels are needed in this example; the first tunnel is unidirectional from R2 to XR1, which allocates the transport label to get to XR1, and the second tunnel is unidirectional from XR1 back to R2, which allocates the transport label to get to R2.

Note an important caveat of IOS XR here: Even though LDP is not used for label distribution, the command `mpls ldp` must be entered globally to allow the forwarding of MPLS-labeled packets. Without this, the MPLS TE tunnels will form and labels will be allocated for the tunnel endpoints, but the end customer traffic will not actually be able to use the tunnels. This is a rather obscure problem, though, because typically the SP core network would be running LDP already to service L3VPN or L2VPN customers, and then run MPLS TE on top of this. It only becomes a problem in this example because LDP is not already running in the SP core.

The issue can be verified by looking at the LFIB on XR1. Notice that the entry shows up as "unresolved". As soon as 'mpls ldp' is enabled, the LFIB entry gets resolved as becomes usable for forwarding.

```
RP/0/0/CPU0:XR1#show cef vrf VPN_A 1.1.1.1 detail
Sun May 17 23:51:10.597 UTC
1.1.1.1/32, version 6, internal 0x14004001 0x0 (ptr 0xa0ec2974) [1], 0x0 (0x0), 0x208 (0xa13f62d0)
 Updated May 17 23:37:42.052
 Prefix Len 32, traffic index 0, precedence n/a, priority 3
  gateway array (0xa0d47568) reference count 2, flags 0x403a, source rib (6), 0 backups
              [1 type 1 flags 0x148089 (0xa141026c) ext 0x0 (0x0)]
  LW-LDI[type=0, refc=0, ptr=0x0, sh-ldi=0x0]
   via 2.2.2.2, 0 dependencies, recursive [flags 0x6000]
    path-idx 0 NHID 0x0 [0xa0c28204 0x0]
    next hop VRF - 'default', table - 0xe0000000
     unresolved
      labels imposed {16}


    Load distribution: 0 (refcount 1)

    Hash  OK  Interface                 Address
    0     Y   Unknown                    drop

RP/0/0/CPU0:XR1#conf t
Sun May 17 23:53:08.668 UTC
RP/0/0/CPU0:XR1(config)#mpls ldp
RP/0/0/CPU0:XR1(config-ldp)#commit
Sun May 17 23:53:13.008 UTC
RP/0/0/CPU0:XR1(config-ldp)#end
RP/0/0/CPU0:XR1#show cef vrf VPN_A 1.1.1.1 detail
Sun May 17 23:53:21.088 UTC
1.1.1.1/32, version 6, internal 0x14004001 0x0 (ptr 0xa0ec2974) [1], 0x0 (0x0), 0x208 (0xa13f62d0)
 Updated May 17 23:37:42.052
 Prefix Len 32, traffic index 0, precedence n/a, priority 3
  gateway array (0xa0d47568) reference count 2, flags 0x4038, source rib (6), 0 backups
              [1 type 1 flags 0x40089 (0xa141026c) ext 0x0 (0x0)]
  LW-LDI[type=0, refc=0, ptr=0x0, sh-ldi=0x0]
   via 2.2.2.2, 3 dependencies, recursive [flags 0x6000]
    path-idx 0 NHID 0x0 [0xa145e9f4 0x0]
    next hop VRF - 'default', table - 0xe0000000
    next hop 2.2.2.2 via 16016/0/21
     next hop 2.2.2.2/32 tt0          labels imposed {ImplNull 16}


    Load distribution: 0 (refcount 1)

    Hash  OK  Interface                 Address
    0     Y   Unknown                    16016/0
```

The final verification of this task is to check whether the customer sites have reachability to each other. The end result is just like a normal MPLS L3VPN. The customer sites see no difference between the transport labels being allocated via MPLS TE vs. being allocated via LDP.

```
R1#traceroute 20.20.20.20 source lo0


Type escape sequence to abort.

Tracing the route to 20.20.20.20

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

  1 10.1.2.2 4 msec 1 msec 1 msec

  2  20.2.4.4 [MPLS: Labels 16/16014 Exp 0] 11 msec 8 msec 4 msec

  3  20.4.5.5 [MPLS: Labels 16/16014 Exp 0] 4 msec 16 msec 20 msec

  4 20.5.19.19 20 msec 12 msec 14 msec

  5 10.19.20.20 18 msec *  11 msec


RP/0/0/CPU0:XR2#traceroute 1.1.1.1 source 20.20.20.20
```

Sun May 17 23:58:51.765 UTC

Type escape sequence to abort. Tracing the route to 1.1.1.1

```
1  10.19.20.19 9 msec  0 msec  0 msec

2   20.6.19.6 [MPLS: Labels 16/19 Exp 0] 9 msec  0 msec  0 msec

3   20.3.6.3 [MPLS: Labels 16/19 Exp 0] 0 msec  0 msec  0 msec

4  10.1.2.2 [MPLS: Label 19 Exp 0] 0 msec  0 msec  9 msec

5  10.1.2.1 9 msec  *  9 msec
```

In the above output, we see that a two-label stack is used in the core for forwarding the L3VPN customer's traffic. From R1 to XR2, bottom label 16014 is the VPN label that was allocated by the VPNv4 process of R2, whereas the top label is is the transport label that was allocated by RSVP for the MPLS TE tunnel. Likewise, on the way back from XR2 to R1, the bottom label is the VPNv4 BGP-derived label, whereas the top label is the MPLS TE label.

The details of the MPLS TE tunnels can be verified on both the head end and the tail end, as seen below.

```
R2#show mpls traffic-eng tunnels detail

P2P TUNNELS/LSPs:

Name: R2_t0                               (Tunnel0) Destination: 19.19.19.19
  Status:
    Admin: up         Oper: up     Path: valid       Signalling: connected
    path option 10, type dynamic (Basis for Setup, path weight 3)

  Config Parameters:
    Bandwidth: 0        kbps (Global)  Priority: 7  7   Affinity: 0x0/0xFFFF
    Metric Type: TE (default)
    AutoRoute: enabled  LockDown: disabled Loadshare: 0 [0] bw-based
    auto-bw: disabled
  Active Path Option Parameters:
    State: dynamic path option 10 is active
    BandwidthOverride: disabled  LockDown: disabled  Verbatim: disabled


  InLabel  :  -
  OutLabel : GigabitEthernet1.24, 16
  Next Hop : 20.2.4.4
  RSVP Signalling Info:
       Src 2.2.2.2, Dst 19.19.19.19 , Tun_Id 0, Tun_Instance 30
    RSVP Path Info:
      My Address: 20.2.4.2
      Explicit Route: 20.2.4.4 20.4.5.4 20.4.5.5 20.5.19.5
                      20.5.19.19 19.19.19.19
      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=0 kbits
  History:
    Tunnel:
      Time since created: 20 minutes, 58 seconds
      Time since path change: 14 minutes, 53 seconds
      Number of LSP IDs (Tun_Instances) used: 30
    Current LSP: [ID: 30]
      Uptime: 14 minutes, 53 seconds
    Prior LSP: [ID: 29]
      ID: path option unknown
      Removal Trigger: path error

LSP Tunnel XR1_t0 is signalled, connection is up
  InLabel  : GigabitEthernet1.23, implicit-null
  Prev Hop : 20.2.3.3
  OutLabel :  -
  RSVP Signalling Info:
       Src 19.19.19.19, Dst 2.2.2.2 , Tun_Id 0, Tun_Instance 2
    RSVP Path Info:
      My Address: 2.2.2.2
      Explicit Route:  NONE
```

```
      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=0 kbits


P2MP TUNNELS:


P2MP SUB-LSPS:
```

In the above output, R2 has state for two separate TE tunnels. The first is the local tunnel to XR1 (R2_t0); R2 is the head end (the originator) of the tunnel. The second is the remote tunnel from XR1 (XR1_t0); R2 is the tail end (the destination).

The important aspects of the above output are that the tunnel is up, that the path is valid, and that signaling is connected. This means that whichever path option was chosen (such as dynamic, explicit, or verbatim) was acceptable, and that RSVP was able to send the PATH messages and get the RESV message responses to actually build the tunnel. Additionally, we see the label value that R2 uses for the top of the stack for traffic routed out the tunnel, and the resulting path that the dynamic path option computed.

For the second tunnel output, we can tell that R2 is the tail because the label value is implicit NULL, and the destination is the local address 2.2.2.2.

Note that neither of these tunnels has asked for additional path requirements such as bandwidth values, affinity bits, fast reroute protection, etc. All of these features are optional parameters of the tunnels and are not required for the most basic design.

Likewise, in the below output we see that XR1 is the head end for a tunnel going to R2, and the tail end for a tunnel coming from R2.

```
RP/0/0/CPU0:XR1#show mpls traffic-eng tunnels detail
Mon May 18 00:28:52.062 UTC



Name: tunnel-te0  Destination: 2.2.2.2
  Signalled-Name: XR1_t0
  Status:
    Admin:    up Oper:   up   Path:  valid   Signalling: connected


    path option 10,  type dynamic  (Basis for Setup, path weight 3)
    G-PID: 0x0800 (derived from egress interface properties)
    Bandwidth Requested: 0 kbps  CT0
    Creation Time: Sun May 17 23:48:38 2015 (00:40:14 ago)
  Config Parameters:
    Bandwidth:        0 kbps (CT0) Priority:  7  7 Affinity: 0x0/0xffff
    Metric Type: TE (default)
    Hop-limit: disabled
    AutoRoute:  enabled  LockDown: disabled   Policy class: not set
    Forward class: 0 (default)
    Forwarding-Adjacency: disabled
    Loadshare:          0 equal loadshares
    Auto-bw: disabled
    Fast Reroute: Disabled, Protection Desired: None
    Path Protection: Not Enabled
    BFD Fast Detection: Disabled
    Reoptimization after affinity failure: Enabled
    Soft Preemption: Disabled
  SNMP Index: 11
  History:
    Tunnel has been up for: 00:40:14 (since Sun May 17 23:48:38 UTC 2015)
    Current LSP:
      Uptime: 00:40:14 (since Sun May 17 23:48:38 UTC 2015)
  Current LSP Info:
    Instance: 2, Signaling Area: OSPF 1 area 0
    Uptime: 00:40:14 (since Sun May 17 23:48:38 UTC 2015)
    Outgoing Interface: GigabitEthernet0/0/0/0.619, Outgoing Label: 16
    Router-IDs: local      19.19.19.19
                downstream 6.6.6.6
    Soft Preemption: None
    Path Info:
      Outgoing:
        Explicit Route:
          Strict, 20.6.19.6
          Strict, 20.3.6.6
          Strict, 20.3.6.3
          Strict, 20.2.3.3
          Strict, 20.2.3.2
          Strict, 2.2.2.2


      Record Route: Disabled
      Tspec: avg rate=0 kbits, burst=1000 bytes, peak rate=0 kbits
      Session Attributes: Local Prot: Not Set, Node Prot: Not Set, BW Prot: Not Set
                          Soft Preemption Desired: Not Set
```

```
    Resv Info: None
      Record Route: Disabled
      Resv Info:
        Record Route: Disabled
        Fspec: avg rate=0 kbits, burst=1000 bytes, peak rate=0 kbits


 LSP Tunnel 2.2.2.2 0 [30] is signalled, connection is up
   Tunnel Name: R2_t0 Tunnel Role: Tail
   InLabel: GigabitEthernet0/0/0/0.519, implicit-null
  Signalling Info:
     Src 2.2.2.2 Dst 19.19.19.19 , Tun ID 0, Tun Inst 30, Ext ID 2.2.2.2
    Router-IDs: upstream   5.5.5.5
                local      19.19.19.19
    Bandwidth: 0 kbps (CT0) Priority:  7  7 DSTE-class: 0
    Soft Preemption: None
    Path Info:
      Incoming Address: 20.5.19.19
      Incoming:
      Explicit Route:
        Strict, 20.5.19.19
        Strict, 19.19.19.19


      Record Route: Disabled
      Tspec: avg rate=0 kbits, burst=1000 bytes, peak rate=0 kbits
      Session Attributes: Local Prot: Not Set, Node Prot: Not Set, BW Prot: Not Set
                          Soft Preemption Desired: Not Set
Resv Info: None
  Record Route: Disabled
  Resv Info:
    Record Route: Disabled
    Fspec: avg rate=0 kbits, burst=1000 bytes, peak rate=0 kbits
Displayed 1 (of 1) heads, 0 (of 0) midpoints, 1 (of 1) tails
Displayed 1 up, 0 down, 0 recovering, 0 recovered heads
```

Again, the important information that `show mpls traffic-eng tunnels detail` gives us is that the tunnel is up, the path calculation is valid, and RSVP successfully made the reservation and label allocation. Here we see that the label value 16 was allocated, and the next-hop of the tunnel is R6. The path information shows the specific end-to-end path of the tunnel, which in this case is XR1 to R6 to R3 to R2.

For the second tunnel, XR1 knows that it is the tail (destination) of the tunnel, and is advertising label value implicit null, because the destination is connected.

Devices in the core of the network, or what is considered the midpoints of the tunnel, should also know about the end-to-end signaling, as seen below.

```
R3#show mpls traffic-eng tunnels detail

P2P TUNNELS/LSPs:

 LSP Tunnel XR1_t0 is signalled, connection is up
   InLabel  : GigabitEthernet1.36, 16
  Prev Hop : 20.3.6.6
   OutLabel : GigabitEthernet1.23, implicit-null
  Next Hop : 20.2.3.2
  RSVP Signalling Info:
       Src 19.19.19.19, Dst 2.2.2.2 , Tun_Id 0, Tun_Instance 2
    RSVP Path Info:
      My Address: 20.2.3.3
      Explicit Route: 20.2.3.2 2.2.2.2
      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=0 kbits

P2MP TUNNELS:

P2MP SUB-LSPS:

R4#show mpls traffic-eng tunnels detail

P2P TUNNELS/LSPs:

 LSP Tunnel R2_t0 is signalled, connection is up
   InLabel  : GigabitEthernet1.24, 16
  Prev Hop : 20.2.4.2
   OutLabel : GigabitEthernet1.45, 16
  Next Hop : 20.4.5.5
  RSVP Signalling Info:
       Src 2.2.2.2, Dst 19.19.19.19 , Tun_Id 0, Tun_Instance 30
    RSVP Path Info:
      My Address: 20.4.5.4
      Explicit Route: 20.4.5.5 20.5.19.5 20.5.19.19 19.19.19.19
      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=0 kbits

P2MP TUNNELS:

P2MP SUB-LSPS:
```


The above output tells us that R3 is a midpoint for a tunnel that is coming from XR1 and going to R2. R3 is the penultimate (next to last) hop for the tunnel, because the outgoing label is implicit null. Likewise, R4 is a midpoint for the tunnel coming from R2 and going to XR1. Just like in the previous L3VPN and L2VPN examples we saw, the core of the SP network does not care what kind of traffic transits over the tunnel. It only cares about moving traffic from the tunnel head end to the tail end. As long as the LSP for the transport label is end to end (that is, the TE tunnel is up), it doesn't need to know about the final end customer traffic.

Another key requirement of establishing the MPLS TE tunnels is that the core of the network agrees on the traffic engineering topology. In this example, the TE topology is calculated based on the OSPF topology, but additional attributes such as the TE metrics, available link bandwidth, reservable link bandwidth, etc. make up what is considered the Constrained topology. These additional attributes are then used to run the Constrained Shortest Path First (CSPF) calculation, to result in the Constrained Shortest Path Tree (CSPT). The idea behind this calculation as compared to a normal SPF calculation is to take other attributes into account besides link costs when calculating the paths. MPLS TE allows considering additional attributes such as amount of already reserved bandwidth on a link, attribute flags configured on each link, or an additional metric value (TE Metric).

A link state routing protocol is needed for proper operation and flooding of MPLS TE resource information. Specifically, OSPF uses the Opaque LSAs to flood this information - LSA Type 9, 10, and 11. The following information is flooded by the IGP once MPLS TE extensions have been enabled:

CONTENTS

- Interface address
- Neighbor address
- Physical bandwidth
- Maximum reservable bandwidth
- Unreserved bandwidth
- TE metric
- Administrative group

An additional database is build by the IGP, called the Traffic Engineering Database (TED). The TED is consulted by the head end routers when computing CSPF during the tunnel building process. Once the CSPF is computed at the head end, signaling takes place via RSVP PATH and RESV messages.

The Opaque LSAs can be inspected from the OSPF database.

```
R3#show ip ospf database

            OSPF Router with ID (3.3.3.3) (Process ID 1)

                Router Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Link count
2.2.2.2         2.2.2.2         743         0x80000008 0x00C5BB 3
3.3.3.3         3.3.3.3         2002        0x80000007 0x00FD21 4
4.4.4.4         4.4.4.4         1965        0x80000006 0x007E3A 5
5.5.5.5         5.5.5.5         2009        0x80000007 0x008938 4
6.6.6.6         6.6.6.6         11          0x80000007 0x005106 5
19.19.19.19     19.19.19.19     3           0x80000005 0x005FCA 3

                Net Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum
20.2.3.3        3.3.3.3         2002        0x80000003 0x00AF4C
20.2.4.4        4.4.4.4         1965        0x80000003 0x009E53
20.3.4.4        4.4.4.4         1965        0x80000003 0x00C428
20.3.6.6        6.6.6.6         11          0x80000004 0x00A037
20.4.5.5        5.5.5.5         2009        0x80000003 0x00D904
20.4.6.6        6.6.6.6         11          0x80000004 0x00C60C
20.5.6.6        6.6.6.6         11          0x80000004 0x00ECE0
20.5.19.19      19.19.19.19     2022        0x80000003 0x00F15A
20.6.19.19      19.19.19.19     2021        0x80000003 0x00083F

                Type-10 Opaque Link Area Link States (Area 0)

Link ID         ADV Router      Age         Seq#       Checksum Opaque ID
1.0.0.0         2.2.2.2         1750        0x80000003 0x0058C7 0
1.0.0.0         3.3.3.3         1503        0x80000003 0x005CBB 0
1.0.0.0         4.4.4.4         1702        0x80000003 0x0060AF 0
1.0.0.0         5.5.5.5         1493        0x80000003 0x0064A3 0
1.0.0.0         6.6.6.6         1508        0x80000003 0x006897 0
1.0.0.0         19.19.19.19     1529        0x80000003 0x009CFA 0
1.0.0.6         2.2.2.2         1750        0x80000004 0x00E4E7 6
1.0.0.6         3.3.3.3         1503        0x80000003 0x00E6E1 6
1.0.0.6         4.4.4.4         1702        0x80000003 0x002F91 6
1.0.0.6         5.5.5.5         1493        0x80000003 0x00D7DC 6
1.0.0.6         6.6.6.6         1509        0x80000003 0x00EFBE 6
1.0.0.7         2.2.2.2         1503        0x80000004 0x0023A5 7
1.0.0.7         3.3.3.3         1503        0x80000003 0x00556D 7
1.0.0.7         4.4.4.4         1702        0x80000003 0x005568 7
1.0.0.7         5.5.5.5         1493        0x80000003 0x004668 7
1.0.0.7         6.6.6.6         1509        0x80000003 0x001695 7
1.0.0.8         3.3.3.3         1503        0x80000003 0x00DBDF 8
1.0.0.8         4.4.4.4         1702        0x80000003 0x00C3F3 8
1.0.0.8         5.5.5.5         1494        0x80000003 0x00E79E 8
1.0.0.8         6.6.6.6         1509        0x80000003 0x003C6C 8
1.0.0.8         19.19.19.19     1529        0x80000004 0x00CF83 8
1.0.0.9         4.4.4.4         1703        0x80000003 0x0002B1 9
1.0.0.9         6.6.6.6         1510        0x80000003 0x000E70 9
```

CONTENTS

```
1.0.0.9         19.19.19.19     1528        0x80000004 0x00F55A 9



R3#show ip ospf database opaque-area adv-router 3.3.3.3

            OSPF Router with ID (3.3.3.3) (Process ID 1)

                Type-10 Opaque Link Area Link States (Area 0)
```

```
  LS age: 1571
  Options: (No TOS-capability, DC)
  LS Type: Opaque Area Link
  Link State ID: 1.0.0.0
  Opaque Type: 1
  Opaque ID: 0
  Advertising Router: 3.3.3.3
  LS Seq Number: 80000003
  Checksum: 0x5CBB
  Length: 28
  Fragment number : 0

    MPLS TE router ID : 3.3.3.3

    Number of Links : 0

  LS age: 1571
  Options: (No TOS-capability, DC)
  LS Type: Opaque Area Link
  Link State ID: 1.0.0.6
  Opaque Type: 1
  Opaque ID: 6
  Advertising Router: 3.3.3.3
  LS Seq Number: 80000003
  Checksum: 0xE6E1
  Length: 124
  Fragment number : 6

    Link connected to Broadcast network
      Link ID : 20.2.3.3
       Interface Address : 20.2.3.3
       Admin Metric : 1
       Maximum bandwidth : 125000000
       Maximum reservable bandwidth : 93750000
      Number of Priority : 8
      Priority 0 : 93750000     Priority 1 : 93750000
      Priority 2 : 93750000     Priority 3 : 93750000
      Priority 4 : 93750000     Priority 5 : 93750000
      Priority 6 : 93750000     Priority 7 : 93750000
       Affinity Bit : 0x0
       IGP Metric : 1

    Number of Links : 1

  LS age: 1571
```


CONTENTS ›

```
Options: (No TOS-capability, DC)
LS Type: Opaque Area Link
Link State ID: 1.0.0.7
Opaque Type: 1
Opaque ID: 7
Advertising Router: 3.3.3.3
LS Seq Number: 80000003
Checksum: 0x556D
Length: 124
Fragment number : 7

  Link connected to Broadcast network
    Link ID : 20.3.4.4
    Interface Address : 20.3.4.3
    Admin Metric : 1
    Maximum bandwidth : 125000000
    Maximum reservable bandwidth : 93750000
    Number of Priority : 8
    Priority 0 : 93750000     Priority 1 : 93750000
    Priority 2 : 93750000     Priority 3 : 93750000
    Priority 4 : 93750000     Priority 5 : 93750000
    Priority 6 : 93750000     Priority 7 : 93750000
    Affinity Bit : 0x0
    IGP Metric : 1

  Number of Links : 1

LS age: 1571
Options: (No TOS-capability, DC)
LS Type: Opaque Area Link
Link State ID: 1.0.0.8
Opaque Type: 1
Opaque ID: 8
Advertising Router: 3.3.3.3
LS Seq Number: 80000003
Checksum: 0xDBDF
Length: 124
Fragment number : 8

  Link connected to Broadcast network
    Link ID : 20.3.6.6
    Interface Address : 20.3.6.3
    Admin Metric : 1
    Maximum bandwidth : 125000000
    Maximum reservable bandwidth : 93750000
    Number of Priority : 8
    Priority 0 : 93750000     Priority 1 : 93750000
    Priority 2 : 93750000     Priority 3 : 93750000
    Priority 4 : 93750000     Priority 5 : 93750000
    Priority 6 : 93750000     Priority 7 : 93750000
    Affinity Bit : 0x0
    IGP Metric : 1

  Number of Links : 1
```


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The below output of `show mpls traffic-eng topology` is similar to what `show ip ospf database` or `show isis database detail` would convey, but it also shows the additional attributes for the CSPF calculation. The IGP IDs are the nodes in the MPLS TE topology graph, similar to what the OSPF Type 1 Router LSA is used to advertise.

CONTENTS

```
R3#show mpls traffic-eng topology
My_System_id: 3.3.3.3 (ospf 1  area 0)

Signalling error holddown: 10 sec Global Link Generation 31

 IGP Id: 2.2.2.2, MPLS TE Id:2.2.2.2 Router Node  (ospf 1  area 0)
      link[0]: Broadcast, DR: 20.2.3.3, nbr_node_id:2, gen:16
      frag_id: 6, Intf Address: 20.2.3.2
      TE metric: 1, IGP metric: 1, 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: 20.2.4.4, nbr_node_id:3, gen:16
      frag_id: 7, Intf Address: 20.2.4.2
      TE metric: 1, IGP metric: 1, 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

 IGP Id: 3.3.3.3, MPLS TE Id:3.3.3.3 Router Node  (ospf 1  area 0)
      link[0]: Broadcast, DR: 20.2.3.3, nbr_node_id:2, gen:18
      frag_id: 6, Intf Address: 20.2.3.3
      TE metric: 1, IGP metric: 1, 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: 20.3.4.4, nbr_node_id:4, gen:18
  frag_id: 7, Intf Address: 20.3.4.3
  TE metric: 1, IGP metric: 1, 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[2]: Broadcast, DR: 20.3.6.6, nbr_node_id:5, gen:18
  frag_id: 8, Intf Address: 20.3.6.3
  TE metric: 1, IGP metric: 1, 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
```

```
IGP Id: 4.4.4.4, MPLS TE Id:4.4.4.4 Router Node  (ospf 1  area 0)
     link[0]: Broadcast, DR: 20.4.6.6, nbr_node_id:7, gen:22
     frag_id: 9, Intf Address: 20.4.6.4
     TE metric: 1, IGP metric: 1, 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: 20.4.5.5, nbr_node_id:6, gen:22
     frag_id: 8, Intf Address: 20.4.5.4
     TE metric: 1, IGP metric: 1, 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[2]: Broadcast, DR: 20.3.4.4, nbr_node_id:4, gen:22
     frag_id: 7, Intf Address: 20.3.4.4
     TE metric: 1, IGP metric: 1, 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[3]: Broadcast, DR: 20.2.4.4, nbr_node_id:3, gen:22
      frag_id: 6, Intf Address: 20.2.4.4
      TE metric: 1, IGP metric: 1, 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

 IGP Id: 5.5.5.5, MPLS TE Id:5.5.5.5 Router Node  (ospf 1  area 0)
      link[0]: Broadcast, DR: 20.5.19.19, nbr_node_id:9, gen:25
      frag_id: 8, Intf Address: 20.5.19.5
      TE metric: 1, IGP metric: 1, 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: 20.5.6.6, nbr_node_id:8, gen:25
      frag_id: 7, Intf Address: 20.5.6.5
      TE metric: 1, IGP metric: 1, attribute flags: 0x0
      SRLGs: None
      physical_bw: 1000000 (kbps), max_reservable_bw_global: 750000 (kbps)
      max_reservable_bw_sub: 0 (kbps)
```

CONTENTS

```
                      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[2]: Broadcast, DR: 20.4.5.5, nbr_node_id:6, gen:25
    frag_id: 6, Intf Address: 20.4.5.5
    TE metric: 1, IGP metric: 1, 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

IGP Id: 6.6.6.6, MPLS TE Id:6.6.6.6 Router Node  (ospf 1  area 0)
    link[0]: Broadcast, DR: 20.6.19.19, nbr_node_id:10, gen:29
    frag_id: 9, Intf Address: 20.6.19.6
    TE metric: 1, IGP metric: 1, 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
```

CONTENTS

```
  link[1]: Broadcast, DR: 20.5.6.6, nbr_node_id:8, gen:29
  frag_id: 8, Intf Address: 20.5.6.6
  TE metric: 1, IGP metric: 1, 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[2]: Broadcast, DR: 20.4.6.6, nbr_node_id:7, gen:29
  frag_id: 7, Intf Address: 20.4.6.6
  TE metric: 1, IGP metric: 1, 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[3]: Broadcast, DR: 20.3.6.6, nbr_node_id:5, gen:29
  frag_id: 6, Intf Address: 20.3.6.6
  TE metric: 1, IGP metric: 1, 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


 IGP Id: 19.19.19.19, MPLS TE Id:19.19.19.19 Router Node  (ospf 1  area 0)

      link[0]: Broadcast, DR: 20.5.19.19, nbr_node_id:9, gen:31

      frag_id: 8, Intf Address: 20.5.19.19

      TE metric: 1, IGP metric: 1, 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: 20.6.19.19, nbr_node_id:10, gen:31

      frag_id: 9, Intf Address: 20.6.19.19

      TE metric: 1, IGP metric: 1, 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


IGP Id: 20.2.3.3, Network Node  (ospf 1  area 0)

      link[0]: Broadcast, Nbr IGP Id: 3.3.3.3, nbr_node_id:1, gen:4


      link[1]: Broadcast, Nbr IGP Id: 2.2.2.2, nbr_node_id:11, gen:4


IGP Id: 20.2.4.4, Network Node  (ospf 1  area 0)
```

CONTENTS

```
      link[0]: Broadcast, Nbr IGP Id: 4.4.4.4, nbr_node_id:12, gen:5


      link[1]: Broadcast, Nbr IGP Id: 2.2.2.2, nbr_node_id:11, gen:5


IGP Id: 20.3.4.4, Network Node  (ospf 1  area 0)
      link[0]: Broadcast, Nbr IGP Id: 4.4.4.4, nbr_node_id:12, gen:6


      link[1]: Broadcast, Nbr IGP Id: 3.3.3.3, nbr_node_id:1, gen:6


IGP Id: 20.3.6.6, Network Node  (ospf 1  area 0)
      link[0]: Broadcast, Nbr IGP Id: 6.6.6.6, nbr_node_id:14, gen:7


      link[1]: Broadcast, Nbr IGP Id: 3.3.3.3, nbr_node_id:1, gen:7


IGP Id: 20.4.5.5, Network Node  (ospf 1  area 0)
      link[0]: Broadcast, Nbr IGP Id: 5.5.5.5, nbr_node_id:13, gen:8


      link[1]: Broadcast, Nbr IGP Id: 4.4.4.4, nbr_node_id:12, gen:8


IGP Id: 20.4.6.6, Network Node  (ospf 1  area 0)
      link[0]: Broadcast, Nbr IGP Id: 6.6.6.6, nbr_node_id:14, gen:9


      link[1]: Broadcast, Nbr IGP Id: 4.4.4.4, nbr_node_id:12, gen:9


IGP Id: 20.5.6.6, Network Node  (ospf 1  area 0)
      link[0]: Broadcast, Nbr IGP Id: 6.6.6.6, nbr_node_id:14, gen:10


      link[1]: Broadcast, Nbr IGP Id: 5.5.5.5, nbr_node_id:13, gen:10


IGP Id: 20.5.19.19, Network Node  (ospf 1  area 0)
      link[0]: Broadcast, Nbr IGP Id: 5.5.5.5, nbr_node_id:13, gen:11


      link[1]: Broadcast, Nbr IGP Id: 19.19.19.19, nbr_node_id:15, gen:11


IGP Id: 20.6.19.19, Network Node  (ospf 1  area 0)
      link[0]: Broadcast, Nbr IGP Id: 6.6.6.6, nbr_node_id:14, gen:12


      link[1]: Broadcast, Nbr IGP Id: 19.19.19.19, nbr_node_id:15, gen:12
```

« IP L2 VPN with L2TPv3 (/workbook/view/service-provider-v4/task/ip-l2-vpn-with-l2tpv3-Mjk0Nw%3D%3D) | MPLS Traffic Engineering with IS-IS (/workbook/view/service-provider-v4/task/mpls-traffic-engineering-with-is-is-Mjg4MA%3D%3D) »