Segment Routing On Demand for L2VPN/VPWS

On-Demand Next Hop (ODN) for Layer 2 Virtual Private Network (L2VPN) creates a segment routing (SR) traffic-engineering (TE) auto-tunnel and uses the auto-tunnel for pseudowire dataplane.

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Restrictions for Segment Routing On Demand Next Hop for L2VPN/VPWS

- Layer-2 VPN/VPWS (Virtual Private Wire Service) On Demand Next Hop (ODN) is not supported with pseudowire (PW) class.

- The segment routing on demand for L2VPN or VPWS is not supported for BGP signaled/ADVPSWS or Virtual Private LAN Service (VPLS).

- Only Segment-Routing TE tunnels are supported and created for L2VPN using attribute-set.

- L2VPN preferred path bandwidth related configuration does not take effect when TE attribute-set is configured.

- Only L2-VPN ODN VPWS with LDP signaling is supported.
Information About Segment Routing On Demand Next Hop for L2VPN/VPWS

On Demand Next Hop (ODN) for L2VPN creates an SR TE auto-tunnel and uses the auto-tunnel for pseudowire dataplane. The peer IP address is the destination of tunnel and TE LSP attribute determines path of the tunnel. Sometimes a pseudowire connection may need to span multiple interior gateway protocol (IGP) areas while LDP is used as signaling protocol. The pseudowire endpoint provider edge’s (PE) loopback addresses are not distributed across IGP area boundaries. In this case, one PE may not have a default route (or an exact match route) in its RIB to reach the peer PE of the pseudowire connection. Thus the pseudowire connection cannot be signaled by LDP. A new option autoroute destination is introduced under LSP attribute to address this problem. When a LSP attribute is configured using the autoroute destination command, auto-tunnel uses the LSP attribute to automatically create a static route for the tunnel destination with the auto-tunnel interface as the next hop. This static route enables LDP to establish a LDP session and exchange label mapping messages between two pseudowire endpoints.

Note
Use the autoroute destination command only to configure LSP attribute used by LDP signaled L2VPN. It is not needed for BGP signaled Layer-3 VPN ODN.

AToM Manager

Any Transport over MPLS (AToM) manager maintains a database of auto-tunnels on a pair of attribute set and peer IP addresses, the AToM manager can add or delete an SR TE auto-tunnel for a pseudowire interface (VC).

Any VC that is configured with the same attribute-set or peer uses the same auto-tunnel. An auto-tunnel can be removed from the database using TE service if an attribute set or peer pair is no longer used by any pseudowire interfaces.

Inter-Area L2VPN ODN

When LDP is used as a signaling protocol and pseudowire connection is spanned across multiple Interior Gateway Protocols (IGPs), the pseudowire endpoint PE’s loopback addresses are not distributed across IGP area boundaries. In this case, one PE may not have a default route (or an exact match route) in its RIB to reach the peer PE of the pseudowire connection. Thus the pseudowire connection cannot be signaled by LDP.

How to Configure Segment Routing On Demand Next Hop for L2VPN/VPWS

You can use either pseudowire interface command or template method to configure L2VPN/VPWS.
1. Run the following command on headend node (R1):

```bash
R1#
mpls traffic-eng auto-tunnel p2p tunnel-num min 2000 max 2002
interface GigabitEthernet0/3/1
  no ip address
  negotiation auto
  service instance 300 ethernet
  encapsulation dot1q 300
 interface pseudowire4243
  encapsulation mpls
  neighbor 56.6.6.6 300
  preferred-path segment-routing traffic-eng attribute-set L2VPNODN
 l2vpn xconnect context foobar
  member GigabitEthernet0/3/1 service-instance 300
  member pseudowire4243
 mpls traffic-eng lsp attributes L2VPNODN
  priority 7 7
  path-selection metric te
end
```

2. Run the following command at tail end (R2):

```bash
R2#
mpls traffic-eng auto-tunnel p2p tunnel-num min 2000 max 2002
interface pseudowire4243
  encapsulation mpls
  neighbor 51.1.1.1 300
  preferred-path segment-routing traffic-eng attribute-set L2VPNODN
 interface GigabitEthernet0/2/2
  no ip address
  negotiation auto
  service instance 300 ethernet
  encapsulation dot1q 300
 l2vpn xconnect context foobar
  member GigabitEthernet0/3/1 service-instance 300
  member pseudowire4243
 mpls traffic-eng lsp attributes L2VPNODN
  priority 7 7
  path-selection metric te
end
```
Configuring Segment Routing On Demand Next Hop for L2VPN/VPWS Using Template Commands

1. Run the following command at headend node (R1):

   ```
   R1# template type pseudowire test
       encapsulation mpls
       preferred-path segment-routing traffic-eng attribute-set L2VPNODN
       interface GigabitEthernet0/3/1
       no ip address
       negotiation auto
       service instance 400 ethernet
       encapsulation dot1q 400
   !
   12vpn xconnect context foobar2
       member 56.6.6.6 400 template test
       member GigabitEthernet0/3/1 service-instance 400
   ```

2. Run the following command at tail end (R2):

   ```
   R2# !
   template type pseudowire test
   encapsulation mpls
   preferred-path segment-routing traffic-eng attribute-set L2VPNODN
   !
   interface GigabitEthernet0/2/2
   no ip address
   negotiation auto
   service instance 400 ethernet
   encapsulation dot1q 400
   !
   12vpn xconnect context foobar2
   member 51.1.1.1 400 template test
   member GigabitEthernet0/2/2 service-instance 400
   !
   end
   ```

Configuring Segment Routing On Demand Next Hop for L2VPN/VPWS With Prepend Option

To control the path of LSP it is possible to enable prepend option. The prepend option is only supported with intra-area and supports labeled paths only. To enable prepend option use the following CLI:

   ```
   R1(config-lsp-attr)#path-selection segment-routing prepend
   ```
   ```
   R1(config-lsp-attr-sr-prepend)#?
   ```

Segment Routing On Demand for L2VPN/VPWS

Segment Routing On Demand for L2VPN/VPWS Using Template Commands

```
```
Configuring Preferred Path for Segment Routing On Demand Next Hop for L2VPN/VPWS

To bring down virtual circuit (VC) in case of LSP failure, which could be either because of path fail or removing a command, disable the fallback mode.

```
preferred-path segment-routing traffic-eng attribute-set L2VPNODN
disable-fallback  disable fall back to alternative route
```

Configuring Autoroute Destination for Segment Routing On Demand Next Hop for L2VPN/VPWS

For inter-area destination, IP address may not be installed at headend. You need to have destination IP address installed to enable a targeted LDP session for L2-VPN VPWS. To enable a targeted LDP session for L2VPN VPWS, configure the auto-route destination under the attribute set:

```
Device#
mpls traffic-eng lsp attributes L2VPNODN
    priority 7 7
    path-selection metric te
    pce
    autoroute destination
!
end
```

The destination address gets installed via L2-VPN ODN LSP as a static route.

Run the following commands to verify autoroute destination configuration:

```
Device#sh ip route 56.6.6.6
Routing entry for 56.6.6.6/32
     Known via "static", distance 1, metric 0 (connected)
Routing Descriptor Blocks:
    * directly connected, via Tunnel2000------------------------ L2-VPN ODN LSP
      Route metric is 0, traffic share count is 1

Device#sh mpls for 56.6.6.6
     Local Prefix Outgoing Bytes Label Outgoing Next Hop
     Label  Label or Tunnel Id Switched interface
     25     [T] Pop Label 56.6.6.6/32 0 Tu2000 point2point
```
Verifying Segment Routing On Demand Next Hop for L2VPN/VPWS

1. `sh mpls l2 vc`

```
Device# sh mpls l2 vc
Local intf  Local circuit  Dest address  VC ID  Status
----------------- ------------------------------- ----------------- --------------  
Gi0/3/1  Eth VLAN 300  56.6.6.6  300  UP
```

2. `sh mpls l2 vc detail`

```
Device# sh mpls l2 vc detail
Local interface: Gi0/3/1 up, line protocol up, Eth VLAN 300 up
  Interworking type is Ethernet
  Destination address: 56.6.6.6, VC ID: 300, VC status: up
Output interface: Tu2000, imposed label stack (23 17 20)---- 20 is the VC label assigned by R6
  Preferred path: Tunnel2000, active
  Default path: ready
  Next hop: point2point
Create time: 00:15:48, last status change time: 00:15:38
Last label FSM state change time: 00:15:38
Signaling protocol: LDP, peer 56.6.6.6 up
  Targeted Hello: 51.1.1.1 (LDP Id) -> 56.6.6.6, LDP is UP
  Graceful restart: not configured and not enabled
Non stop routing: not configured and not enabled
Status TLV support (local/remote): enabled/supported
  LDP route watch: enabled
  Label/status state machine: established, LruRru
Last local dataplane status rcvd: No fault
Last BFD dataplane status rcvd: No fault
Last BFD peer monitor status rcvd: No fault
Last local AC circuit status sent: No fault
Last local PW i/f circ status rcvd: No fault
Last local LDP TLV status sent: No fault
Last remote LDP TLV status rcvd: No fault
Last remote LDP ADJ status rcvd: No fault
MPLS VC labels: local 2032, remote 20
Group ID: local 20, remote 25
MTU: local 1500, remote 1500
Remote interface description:
  Sequencing: receive disabled, send disabled
  Control Word: On (configured: autosense)
  SSO Descriptor: 56.6.6.6/300, local label: 2032
Dataplane:
  SSM segment/switch IDs: 10198/6097 (used), PWID: 1001
VC statistics:
  transit packet totals: receive 0, send 0
  transit byte totals: receive 0, send 0
  transit packet drops: receive 0, seq error 0, send 0
```

3. `sh l2vpn atom preferred-path`

```
Device# sh l2vpn atom preferred-path
Tunnel interface  Bandwidth Tot/Avail/Resv  Peer ID  VC ID
----------------- ------------------------------- ------------  
```
4. `sh l2vpn atom vc`

```bash
Device# sh l2vpn atom vc
Interface Peer ID VC ID Type Name Status
--------- --------------- ---------- ------ ------------------------ ----------
pw4243 56.6.6.6 300 p2p foobar UP
! end
```

5. `sh mpl traffic-eng tun tun 2000`

```bash
Device# sh mpl traffic-eng tun tun 2000
Name: R1_t2000 (Tunnel2000) Destination: 56.6.6.6 Ifhandle: 0x7EE
(auto-tunnel for atom)
Status:
   Admin: up   Oper: up   Path: valid   Signalling: connected
   path option 1, (SEGMENT-ROUTING) (PCE) type dynamic (Basis for Setup, path weight 30)
Config Parameters:
   Bandwidth: 0 kbps (Global)  Priority: 7 7  Affinity: 0x0/0xFFFF
   Metric Type: TE (interface)
   Path Selection:
      Protection: any (default)
      Path-selection Tiebreaker:
         Global: not set  Tunnel Specific: not set  Effective: min-fill (default)
   Hop Limit: disabled
   Cost Limit: disabled
   Path-invalidation timeout: 10000 msec (default), Action: Tear
   AutoRoute: disabled  LockDown: disabled  Loadshare: 0 [0] bw-based
   auto-bw: disabled
   Attribute-set: L2VPNODN
   Fault-OAM: disabled, Wrap-Protection: disabled, Wrap-Capable: No
Active Path Option Parameters:
   State: dynamic path option 1 is active
   BandwidthOverride: disabled  LockDown: disabled  Verbatim: disabled
PCEP Info:
   Delegation state: Working: yes  Protect: no
   Delegation peer: 58.8.8.8
   Working Path Info:
      Request status: processed
         Created via PCRep message from PCE server: 58.8.8.8
         PCE metric: 30, type: TE
Reported paths:
   Tunnel Name: Tunnel2000_w
   LSPs:
      LSP[0]:
         source 51.1.1.1, destination 56.6.6.6, tunnel ID 2000, LSP ID 4
         State: Admin up, Operation active
         Binding SID: 20
         Setup type: SR
         Bandwidth: requested 0, used 0
         LSP object:
            PLSP-ID 0x807D0, flags: D:0 S:0 R:0 A:1 O:2
            Metric type: TE, Accumulated Metric 30
            ERO:
               SID[0]: Adj, Label 19, NAI: Local 101.104.1.1 remote 101.104.1.2
```
Verifying Segment Routing On Demand Next Hop for L2VPN/VPWS

SID[1]: Adj, Label 23, NAI: local 103.104.12.2 remote 103.104.12.1
SID[2]: Adj, Label 17, NAI: local 103.106.13.1 remote 103.106.13.2

PLSP Event History (most recent first):
Tue Jun 20 10:04:48.514: PCRpt create LSP-ID:4, SRP-ID:0, PST:1, METRIC_TYPE:2, REQ_BW:0, USED_BW:0
Tue Jun 20 10:04:48.511: PCRep RP-ID:9
Tue Jun 20 10:04:48.505: PCReq RP-ID:9, LSP-ID:4, REQ_BW:0

History:
Tunnel:
Time since created: 18 minutes, 26 seconds
Time since path change: 17 minutes, 9 seconds
Number of LSP IDs (Tun_Instances) used: 4
Current LSP: [ID: 4]
Uptime: 17 minutes, 9 seconds
Tun_Instance: 4
Segment-Routing Path Info (isis level-2)
Segment0[Link]: 101.104.1.1 - 101.104.1.2, Label: 19-------- will not be shown in sh mpls l2 vc output
Segment1[Link]: 103.104.12.2 - 103.104.12.1, Label: 23
Segment2[Link]: 103.106.13.1 - 103.106.13.2, Label: 17
!

6. sh mpls ldp discovery

Device# sh mpls ldp discovery
Local LDP Identifier:
51.1.1.1:0
Discovery Sources:
Targeted Hellos:
51.1.1.1 -> 56.6.6.6 (ldp): active/passive, xmit/recv
LDP Id: 56.6.6.6:0

7. sh mpl ldp nei

Device# shmpl ldp nei
Peer LDP Ident: 56.6.6.6:0; Local LDP Ident 51.1.1.1:0
TCP connection: 56.6.6.6.38574 - 51.1.1.1.646
State: Oper; Msgs sent/rcvd: 43/42; Downstream
Up time: 00:19:33
LDP discovery sources:
Targeted Hello 51.1.1.1 -> 56.6.6.6, active, passive
Addresses bound to peer LDP Ident:
105.106.2.2 103.106.13.2 56.6.6.6
!

8. sh int pseudowire 4243

Device# sh int pseudowire 4243
 pseudowire4243 is up
MTU 1500 bytes, BW not configured
Encapsulation mpls
Peer IP 56.6.6.6, VC ID 300
RX 0 packets 0 bytes 0 drops
TX 0 packets 0 bytes 0 drops
!

9. sh xconnect all

Device# sh xconnect all
Legend: XC ST=Xconnect State S1=Segment1 State S2=Segment2 State
Additional References for Segment Routing On Demand Next Hop for L2VPN/VPWS

Related Documents

<table>
<thead>
<tr>
<th>Related Topic</th>
<th>Document Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco IOS Commands</td>
<td>Cisco IOS Master Command List, All Releases</td>
</tr>
</tbody>
</table>

Feature Information for Segment Routing On Demand Next Hop for L2VPN/VPWS

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for Segment Routing On Demand Next Hop for L2VPN/VPWS

<table>
<thead>
<tr>
<th>Feature Name Description</th>
<th>Releases</th>
<th>Feature Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment Routing On Demand Next Hop for L2VPN/VPWS</td>
<td>Cisco IOS XE</td>
<td>ODN for L2VPN is to create a SR TE auto-tunnel and use the auto-tunnel for pseudo-wire data-plane. The peer IP address is the destination of tunnel and TE LSP attribute determines the path of the tunnel. The following commands were added or modified: sh mpls l2 vc, sh mpls l2 vc detail, sh l2vpn atom preferred-path, sh l2vpn atom vc, sh mpls traffic-eng tun tun 2000, sh mpls ldp discovery, sh mpls ldp nei, sh int pseudowire 4243, sh xconnect all.</td>
</tr>
</tbody>
</table>