



## 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/ADVPWS 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 can not 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 a session and exchange label mapping messages between two pseudowire endpoints.



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**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.

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### 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 can not 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.

## Configuring Segment Routing On Demand Next Hop for L2VPN/VPWS Using Pseudowire Interface Commands

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

```
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):

```
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
!
l2vpn 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
!
l2vpn 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 label prepend commands:
  exit      Exist from segment-routing prepend config mode
  index     Specify the next entry index to add, edit or delete
  list      List all prepend entries
  no        Delete a specific entry index
R1(config-lsp-attr-sr-prepend)#index ?
```

```
<1-10>  Entry index number
last-hop  Indicates the end of label list
next-label Specify the next MPLS label in the path
```



**Note** If last-hop option indicates tail end node. If this option is only used no control on LSP path can be done.

## 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      Outgoing      Prefix          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 56.6.6.6:0 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: Not sent
  Last BFD peer monitor status rcvd: No fault
  Last local AC circuit 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
```

```

-----
-----
-----
Tunnel2000                                     56.6.6.6
 300
!
end

```

#### 4. sh l2vpn atom vc

```

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

```

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

```

```

        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
    !
end

```

## 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 mpls ldp nei

```

Device# sh mpls 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

```





