

LDP VPLS using BGP-Auto Discovery

In This Chapter

This section provides information about LDP VPLS using BGP-Auto Discovery.

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Applicability

This section is applicable to all of the 7450 ESS, 7750 SR and 7710 SR series and was tested on release SR OS 12.0.R5. There are no pre-requisites for this configuration.

Summary

MPLS-based Virtual Private LAN Services (VPLS) may have many different provisioning models to allow the signaling of pseudowires between PE routers containing VPLS instances.

Network Management System (NMS) provisioning using LDP signaling is a well understood method of provisioning of Layer 2 VPLS services as is described in RFC 4762. This relies on the provisioning of pseudowires between VPLS instances using Label Distribution Protocol (LDP) signaling with a common virtual circuit (VC) identifier within the label mapping message to instantiate pseudowires.

Border Gateway Protocol (BGP) Auto Discovery (RFC 6074) is an alternative method of provisioning of Layer 2 Provider Edge routers containing VPLS service instances to those described above where PEs in a common VPLS instance are automatically discovered using BGP Auto Discovery (BGP-AD) techniques.

Each PE router advertises the presence of VPLS instances to other PE routers using defined parameters within a BGP update message.

LDP is used as the pseudowire signaling protocol and relies on the auto-discovery of VPLS endpoints to instantiate pseudowires instead of manually provisioning virtual circuits. Locally configured parameters, along with BGP learned parameters, are used to determine local and remote VPLS endpoints, which are used by LDP to signal service labels to peer routers.

Knowledge of BGP-Auto-discovery RFC 6074 architecture and functionality, RFC 4447 Pseudo-wire Set-up using Label Distribution Protocol is assumed throughout this section, as well as knowledge of Multi-Protocol BGP (MP-BGP).

Overview

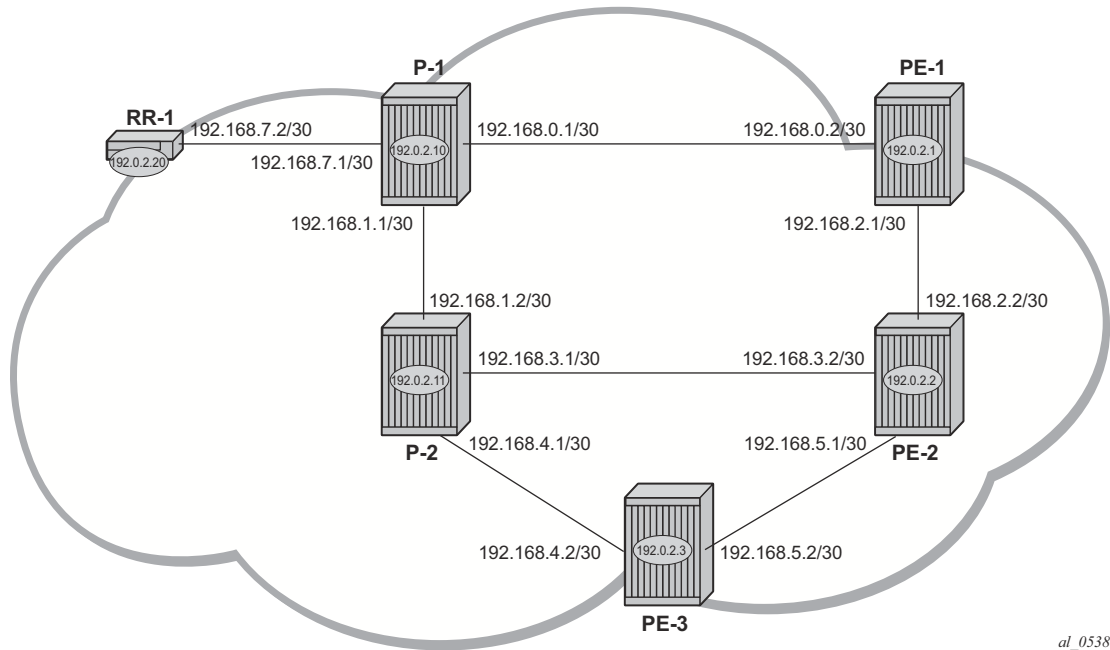


Figure 57: Network Topology

The network topology is displayed in [Figure 57](#). The setup uses six 7750/7450/7710 Service Router (SR) nodes located in the same Autonomous System (AS). There are three PEs and RR-1 will act as a Route Reflector for the AS. The Provider Edge routers are all VPLS aware; The Provider (P) routers are VPLS unaware and do not take part in the BGP process. A full mesh VPLS between PE-1, PE-2 and PE-3 is described.

The following configuration tasks should be completed as a pre-requisite:

- ISIS or OSPF should be enabled on all network interfaces between each of the PE/P routers and route reflector.
- MPLS should be configured on all interfaces between PE and P routers; MPLS is not required between P-1 and RR-1.
- LDP should be configured on interfaces between PE and P routers. It is not required between P-1 and RR-1.
- RSVP protocol is disabled by default, so the RSVP protocol should be enabled.

BGP-AD

In this architecture a VPLS service is a collection of local VPLS Instances present on a number of PEs in a provider network. In this context, VPLS-aware devices are PE routers. Each VPLS instance has a unique identifier known as the VPLS identifier (VPLS-id). All PEs that have this VPLS instance present will have a common VPLS-id configured.

Each VPLS instance within a PE contains a Virtual Switching Instance (VSI). The VPLS attachment circuits and pseudowires are associated with the VSI. Each VSI within a given VPLS has a unique identifier called the VSI identifier (VSI-id) and is a concatenation of the VPLS-id plus an IP address, usually the system IP address.

The PEs communicate with each other at the control plane level by means of BGP updates containing BGP Layer 2 Network Layer Reachability Information (NLRI). Each update contains enough information for a PE to determine the presence of other local VPLS instances on peering PEs. In turn, this allows peer PE routers to setup pseudowire connectivity using LDP signaling for data flow between peers containing a local VPLS within the same VPLS instances.

Each update contains parameters usually associated with Multi-Protocol BGP updates:

- NLRI encoded as route-target (usually the VPLS-id) and PE system address
- Next-Hop — The system IP address of the sending PE router.
- Extended communities — Contains the route target extended community and the VPLS-id as community values.

Each VPLS instance is configured with import and export route target extended communities to create the required pseudowire topology by controlling the distribution of each NLRI.

The purpose of this section is to describe the provisioning of a VPLS instance across three PE routers. A full mesh of pseudowires interconnects the VSI of each PE within the VPLS instance. A single attachment circuit is also configured on each VSI.

Configuration

The first step is to configure an MP-iBGP session using the L2VPN address family between each of the PEs and the route reflector.

The configuration for PE-1 is:

```
configure
  router
    bgp
      group "internal"
        family l2-vpn
        type internal
        peer-as 65536
        neighbor 192.0.2.20
      exit
    exit
  no shutdown
exit
```

The configuration for the other PE nodes is identical. The IP addresses can be derived from [Figure 57](#).

The configuration for route reflector RR-1 is:

```
configure
  router
    bgp
      cluster 1.1.1.1
      group rr_internal
        family l2-vpn
        type internal
        peer-as 65536
        neighbor 192.0.2.1
      exit
      neighbor 192.0.2.2
      exit
      neighbor 192.0.2.3
      exit
    exit
  no shutdown
exit
```

On PE-1, verify that the BGP session with RR-1 is established with address family l2-vpn capability negotiated:

```
A:PE-1# show router bgp neighbor 192.0.2.20
=====
BGP Neighbor
=====
-----
Peer   : 192.0.2.20
```

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Group : internal

```

-----
Peer AS          : 65536          Peer Port       : 179
Peer Address     : 192.0.2.20
Local AS        : 65536          Local Port      : 49519
Local Address    : 192.0.2.1
Peer Type       : Internal
State           : Established    Last State      : Active
Last Event      : recvKeepAlive
Last Error     : Unrecognized Error
Local Family    : L2-VPN
Remote Family   : L2-VPN
Hold Time       : 90             Keep Alive      : 30
Min Hold Time   : 0
Active Hold Time : 90           Active Keep Alive : 30
Cluster Id      : None
Preference      : 170           Num of Update Flaps : 0
Recd. Paths     : 19
IPv4 Recd. Prefixes : 0       IPv4 Active Prefixes : 0
IPv4 Suppressed Pfxs : 0       VPN-IPv4 Suppr. Pfxs : 0
VPN-IPv4 Recd. Pfxs : 0       VPN-IPv4 Active Pfxs : 0
Mc IPv4 Recd. Pfxs. : 0       Mc IPv4 Active Pfxs. : 0
Mc IPv4 Suppr. Pfxs : 0       IPv6 Suppressed Pfxs : 0
IPv6 Recd. Prefixes : 0       IPv6 Active Prefixes : 0
VPN-IPv6 Recd. Pfxs : 0       VPN-IPv6 Active Pfxs : 0
VPN-IPv6 Suppr. Pfxs : 0
Mc IPv6 Recd. Pfxs. : 0       Mc IPv6 Active Pfxs. : 0
Mc IPv6 Suppr. Pfxs : 0       L2-VPN Suppr. Pfxs  : 0
L2-VPN Recd. Pfxs  : 19       L2-VPN Active Pfxs  : 13
MVPN-IPv4 Suppr. Pfxs : 0       MVPN-IPv4 Recd. Pfxs : 0
MVPN-IPv4 Active Pfxs : 0       MDT-SAFI Suppr. Pfxs : 0
MDT-SAFI Recd. Pfxs : 0       MDT-SAFI Active Pfxs : 0
Flow-IPv4 Suppr. Pfxs : 0       Flow-IPv4 Recd. Pfxs : 0
Flow-IPv4 Active Pfxs : 0       Rte-Tgt Suppr. Pfxs : 0
Rte-Tgt Recd. Pfxs : 0       Rte-Tgt Active Pfxs : 0
Backup IPv4 Pfxs   : 0       Backup IPv6 Pfxs    : 0
Mc Vpn Ipv4 Recd. Pf* : 0     Mc Vpn Ipv4 Active P* : 0
Backup Vpn IPv4 Pfxs : 0     Backup Vpn IPv6 Pfxs : 0
Input Queue        : 0       Output Queue        : 0
i/p Messages       : 110      o/p Messages        : 95
i/p Octets         : 3980     o/p Octets          : 2258
i/p Updates        : 21       o/p Updates         : 6
MVPN-IPv6 Suppr. Pfxs : 0     MVPN-IPv6 Recd. Pfxs : 0
MVPN-IPv6 Active Pfxs : 0
Flow-IPv6 Suppr. Pfxs : 0     Flow-IPv6 Recd. Pfxs : 0
Flow-IPv6 Active Pfxs : 0
Evpn Suppr. Pfxs  : 0       Evpn Recd. Pfxs    : 0
Evpn Active Pfxs  : 0
TTL Security       : Disabled   Min TTL Value       : n/a
Graceful Restart   : Disabled   Stale Routes Time   : n/a
Restart Time       : n/a
Advertise Inactive : Disabled   Peer Tracking       : Disabled
Advertise Label    : None
Auth key chain     : n/a
Disable Cap Nego   : Disabled   Bfd Enabled         : Disabled
Flowspec Validate  : Disabled   Default Route Tgt   : Disabled
Aigp Metric        : Disabled   Split Horizon       : Disabled
Damp Peer Oscillatio* : Disabled  Update Errors       : 0
GR Notification    : Disabled   Fault Tolerance     : Disabled
  
```

Configuration

```
Rem Idle Hold Time      : 00h00m00s
Next-Hop Unchanged     : None
L2 VPN Cisco Interop   : Disabled
Local Capability        : RtRefresh MPBGP 4byte ASN
Remote Capability       : RtRefresh MPBGP 4byte ASN
Local AddPath Capabi*  : Disabled
Remote AddPath Capab*  : Send - None
                       : Receive - None
Import Policy           : None Specified / Inherited
Export Policy           : None Specified / Inherited
```

```
Origin Validation      : N/A
```

```
-----
Neighbors : 1
=====
```

* indicates that the corresponding row element may have been truncated.

```
A:PE-1#
```

On RR-1, show that BGP sessions with each PE are established, and have correctly negotiated the l2-vpn address family capability.

```
A:RR-1# show router bgp summary
```

```
=====
BGP Router ID:192.0.2.20      AS:65536      Local AS:65536
=====
BGP Admin State      : Up          BGP Oper State      : Up
Total Peer Groups    : 1           Total Peers         : 3
Total BGP Paths      : 26         Total Path Memory   : 4984
Total IPv4 Remote Rts : 0         Total IPv4 Rem. Active Rts : 0
Total McIPv4 Remote Rts : 0       Total McIPv4 Rem. Active Rts: 0
Total McIPv6 Remote Rts : 0       Total McIPv6 Rem. Active Rts: 0
Total IPv6 Remote Rts : 0         Total IPv6 Rem. Active Rts : 0
Total IPv4 Backup Rts : 0         Total IPv6 Backup Rts  : 0

Total Supressed Rts  : 0           Total Hist. Rts     : 0
Total Decay Rts      : 0

Total VPN Peer Groups : 0         Total VPN Peers     : 0
Total VPN Local Rts   : 0
Total VPN-IPv4 Rem. Rts : 0       Total VPN-IPv4 Rem. Act. Rts: 0
Total VPN-IPv6 Rem. Rts : 0       Total VPN-IPv6 Rem. Act. Rts: 0
Total VPN-IPv4 Bkup Rts : 0       Total VPN-IPv6 Bkup Rts  : 0

Total VPN Supp. Rts   : 0         Total VPN Hist. Rts : 0
Total VPN Decay Rts   : 0

Total L2-VPN Rem. Rts : 22        Total L2VPN Rem. Act. Rts : 0
Total MVPN-IPv4 Rem Rts : 0       Total MVPN-IPv4 Rem Act Rts : 0
Total MDT-SAFI Rem Rts : 0         Total MDT-SAFI Rem Act Rts : 0
Total MSPW Rem Rts    : 0         Total MSPW Rem Act Rts    : 0
Total RouteTgt Rem Rts : 0         Total RouteTgt Rem Act Rts : 0
Total McVpnIPv4 Rem Rts : 0       Total McVpnIPv4 Rem Act Rts : 0
Total MVPN-IPv6 Rem Rts : 0       Total MVPN-IPv6 Rem Act Rts : 0
Total EVPN Rem Rts    : 0         Total EVPN Rem Act Rts    : 0
Total FlowIpv4 Rem Rts : 0         Total FlowIpv4 Rem Act Rts : 0
Total FlowIpv6 Rem Rts : 0         Total FlowIpv6 Rem Act Rts : 0
```



```

=====
BGP Summary
=====
Neighbor
          AS PktRcvd InQ  Up/Down  State|Rcv/Act/Sent (Addr Family)
          PktSent OutQ
-----
192.0.2.1
          65536    96   0 00h43m38s 6/0/22 (L2VPN)
          111     0
192.0.2.2
          65536   100  0 00h44m20s 9/0/22 (L2VPN)
          113     0
192.0.2.3
          65536    97   0 00h43m47s 7/0/22 (L2VPN)
          112     0
-----
A:RR-1#

```

A full mesh of RSVP Label Switched Paths (LSPs) is configured between the PE routers. For reference, the MPLS interface configuration and LSPs for PE-1 to PE-2 and PE-3 is:

```

A:PE-1# configure router mpls
      interface "system"
        no shutdown
      exit
      interface "int-PE-1-P-1"
        no shutdown
      exit
      interface "int-PE-1-PE-2"
        no shutdown
      exit
      path "loose"
        no shutdown
      exit
      lsp "LSP-PE-1-PE-2"
        to 192.0.2.2
        primary "loose"
        exit
        no shutdown
      exit
      lsp "LSP-PE-1-PE-3"
        to 192.0.2.3
        primary "loose"
        exit
        no shutdown
      exit
      no shutdown

```

VPLS PE Configuration

Pseudowire-Templates

Pseudowire templates are used by BGP to dynamically instantiate Service Distribution Point (SDP) bindings, for a given service they are used to signal the egress service de-multiplexor labels used by remote PEs to reach the local PE.

The template determines the signaling parameters of the pseudowire, control word presence, plus other usage characteristics such as Split Horizon Groups, MAC-pinning, filters, etc.

The MPLS transport tunnel between PE routers can be signaled using either LDP or RSVP.

LDP based pseudowires can be automatically instantiated. RSVP based SDPs have to be pre-provisioned.

Pseudowire Templates for Auto-SDP Creation using LDP

In order to use an LDP transport tunnel for data flow between PEs, it is necessary for link layer LDP to be configured between all PEs/Ps so that a transport label for each PE's system interface address is available. Using this mechanism SDPs can be auto-instantiated with SDP ids starting at 17407. Any subsequent SDPs created use SDP-ids decrementing from this value.

A pseudowire template is required which may contain a split-horizon group. Each SDP created with this template is contained within the configured split horizon group so that traffic cannot be forwarded between them.

```
A:PE-1# configure service
      pw-template 1 create
          split-horizon-group "vpls-shg"
      exit
exit
```

A pseudowire template can also be created that does not contain a split-horizon group. The split horizon group can then be specified when the pw-template is included within the service.

```
A:PE-1# configure service
      pw-template 2 create
      exit
```

Pseudowire Templates for Provisioned SDPs using RSVP

To use an RSVP tunnel as transport between PEs, it is necessary to bind the RSVP LSPs to the SDPs between each PE.

SDP creation from PE-1 to PE-2:

```
A:PE-1# configure service sdp 43 mpls create
      far-end 192.0.2.2
      lsp "LSP-PE-1-PE-2"
      keep-alive
      shutdown
      exit
      no shutdown
```

To create an SDP within a service that uses the RSVP transport tunnel, a pseudowire template is required that has the **use-provisioned-sdp** parameter.

```
A:PE-1# configure service
      pw-template 3 use-provisioned-sdp create
      exit
      exit
```

VPLS BGP-AD using Auto-Provisioned SDPs

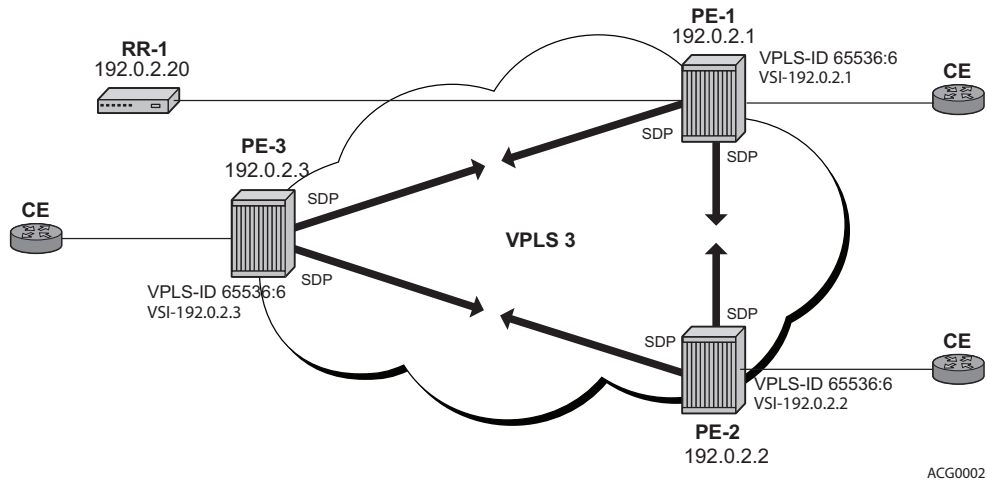


Figure 58: VPLS Instance with Auto-Provisioned SDPs

Figure 58 shows a schematic of a VPLS instance where the SDPs are auto-provisioned. SDPs are instantiated by a PE router using LDP signaling upon receipt of BGP Auto-discovery (BGP-AD) updates from peer PE routers.

PE-1 Configuration:

The following output shows the configuration required for a VPLS service using a pseudowire template configured for auto-provisioning of SDPs.

```
A:PE-1# configure service vpls 3 customer 1 create
      bgp
        route-distinguisher 65536:3
        route-target export target:65536:3 import target:65536:3
        pw-template-binding 2 split-horizon-group "vpls-shg"
          import-rt "target:65536:3"
        exit
      exit
    bgp-ad
      vpls-id 65536:3
      vsi-id
        prefix 192.0.2.1
      exit
    no shutdown
  exit
  stp
    shutdown
  exit
  sap 1/1/4:3.0 create
  exit
  no shutdown
```

Within the **bgp** context, the pseudowire template is referenced which can be linked to a split-horizon-group and an import route-target, if required.

Within the **bgp-ad** context, the signaling parameters are configured. These are two parameters used by each PE to determine the presence of a given VPLS instance on a PE router. In turn, these are translated into endpoint identifiers for LDP signaling of pseudowires. As previously discussed, these parameters are:

- VPLS-id - a unique identifier of the VPLS instance. Each PE that is a member of a VPLS must share the same VPLS-id. This is inserted as an extended community value in the format AS:n. In this case, the VPLS-id for VPLS 3 is 65536:3. This is a mandatory parameter and if it is not configured it is not possible to enable bgp-ad using no shutdown.
- Virtual Switching Instance (VSI) prefix — This identifies a specific instance of the VPLS. This must be unique within the VPLS instance, and is encoded using the 4 byte dotted decimal notation. Generally the system address is used as the VSI prefix. If this parameter is not configured, then the system address is used automatically.

The VPLS-id and VSI prefix for VPLS 3 on each PE is shown in [Figure 58](#).

The VPLS-id and VSI prefix are concatenated to form a unique VSI-id. In this case, PE-1 has a VSI-id of 65536:3:192.0.2.1. This uniquely identifies the VPLS instance on each individual PE and is advertised as an L2 VPN BGP update.

A BGP-AD update is transmitted to all other PEs via the Route Reflector as follows:

```
A:PE-1# show router bgp routes l2-vpn rd 65536:3 hunt
<snipped>
-----
RIB Out Entries
-----
Route Type      : AutoDiscovery
Route Dist.     : 65536:3
Prefix          : 192.0.2.1
Nexthop         : 192.0.2.1
To              : 192.0.2.20
Res. Nexthop    : n/a
Local Pref.     : 100
Aggregator AS  : None
Atomic Aggr.   : Not Atomic
AIGP Metric     : None
Connector       : None
Community       : target:65536:3 l2-vpn/vrf-imp:65536:3
Cluster         : No Cluster Members
Originator Id   : None
Origin          : IGP
AS-Path         : No As-Path
Route Tag       : 0
Neighbor-AS     : N/A
Orig Validation : N/A
Source Class    : 0
Interface Name  : NotAvailable
Aggregator     : None
MED            : 0
Peer Router Id  : 192.0.2.20
Dest Class     : 0
-----
```

VPLS PE Configuration

```
Routes : 4
```

```
=====
```

```
A:PE-1#
```

The BGP update shown above is transmitted by PE-1 and has route type Auto Discovery.

In this L2 VPN update, the VPLS-id is encoded as the L2VPN extended community.

The VSI is seen as the prefix. This combination forms the VSI-id and uniquely identifies the VPLS instance within this PE router.

The nexthop is also encoded as the local system IP address, which allows remote PEs to identify a suitable transport tunnel to PE-1 and for the targeted-LDP peer for instantiating the SDP.

As can be seen within the update, the VPLS-id is also used to determine the route target extended community and the route distinguisher.

PE-2 Configuration

On PE-2 create a VPLS Service using pseudowire template 1, with VPLS-id 65536:3 and VSI-id prefix 192.0.2.2 (system IP address).

```
A:PE2# configure service
      vpls 3 customer 1 create
        bgp
          route-distinguisher 65536:3
          route-target export target:65536:3 import target:65536:3
          pw-template-binding 2 split-horizon-group "vpls-shg"
                                import-rt "target:65536:3"
        exit
      exit
    bgp-ad
      vpls-id 65536:3
      vsi-id
        prefix 192.0.2.2
      exit
    no shutdown
  exit
  stp
    shutdown
  exit
  sap 1/1/4:3.0 create
  exit
  no shutdown
exit
```

PE-3 Configuration

Create a VPLS Instance on PE-3: VPLS-id is the same as that of PE-1 and PE-2, with VSI-id of 192.0.2.3 (system IP address).

```
A:PE3# configure service
      vpls 3 customer 1 create
        bgp
          route-distinguisher 65536:3
          route-target export target:65536:3 import target:65536:3
          pw-template-binding 2 split-horizon-group "vpls-shg"
                                import-rt "target:65536:3"
        exit
      exit
    bgp-ad
      vpls-id 65536:3
      vsi-id
        prefix 192.0.2.3
      exit
    no shutdown
  exit
  stp
    shutdown
  exit
  sap 1/1/4:3.0 create
  exit
  no shutdown
exit
```

PE-1 Service Operation Verification

Verify that the service is operationally up on PE-1.

```
A:PE-1# show service id 3 base
=====
Service Basic Information
=====
Service Id       : 3                Vpn Id           : 0
Service Type    : VPLS
Name            : (Not Specified)
Description     : (Not Specified)
Customer Id     : 1                Creation Origin  : manual
Last Status Change: 11/04/2014 12:04:11
Last Mgmt Change  : 11/04/2014 12:07:22
Etree Mode      : Disabled
Admin State     : Up                Oper State       : Up
MTU             : 1514              Def. Mesh VC Id : 3
SAP Count       : 1                SDP Bind Count  : 2
Snd Flush on Fail : Disabled        Host Conn Verify : Disabled
Propagate MacFlush: Disabled        Per Svc Hashing  : Disabled
Allow IP Intf Bind: Disabled
Def. Gateway IP  : None
Def. Gateway MAC : None
Temp Flood Time  : Disabled        Temp Flood       : Inactive
Temp Flood Chg Cnt: 0
VSD Domain      : <none>
```

VPLS PE Configuration

```
-----  
Service Access & Destination Points  
-----  
Identifier                                     Type           AdmMTU  OprMTU  Adm  Opr  
-----  
sap:1/1/4:3.0                                qinq           1522    1522    Up   Up  
sdp:17405:4294967291 SB(192.0.2.3)  BgpAd         0       1556    Up   Up  
sdp:17407:4294967295 SB(192.0.2.2)  BgpAd         0       1556    Up   Up  
=====
```

A:PE-1#

As seen from the output, the service is operationally up, with the SAPs and SDPs also up. The **SB** flag indicates that the SDP is of type spoke BGP.

BGP is used to discover the VPLS endpoints and exchange network reachability information. LDP is used to signal the pseudowires between the PEs.

LDP signaling occurs when each PE has discovered the endpoints of the VPLS instance. This compares with the use of the provisioned virtual-circuit IDs used in an NMS provisioned VPLS instances as per RFC 4762.

Verification of the ability of PE-1 to reach the other PE routers with VSIs within the VPLS instance can be seen from the Layer 2 routing table as follows:

```
*A:PE-1# show service l2-route-table bgp-ad  
-----  
Services: L2 Route Information - Summary  
-----  
Svc Id    L2-Routes (RD-Prefix)           Next Hop      Origin  
          Sdp Bind Id                    PW Temp Id  
-----  
3         *65536:3-192.0.2.2              192.0.2.2    BGP-L2  
          17407:4294967295                2  
3         *65536:3-192.0.2.3              192.0.2.3    BGP-L2  
          17405:4294967291                2  
-----  
No. of L2 Route Entries: 2  
-----  
*A:PE-1#
```

This output shows the presence of the signaled pseudowire SDPs. SDPs from PE-1 to PE-2 and PE-3 are signaled using LDP Forwarding Equivalence Class (FEC) Element 129.

Each PE router uses targeted LDP to signal the local and remote endpoints. If there is an endpoint match, then SDPs are instantiated. This compares with the use of LDP for NMS provisioned SDPs, which uses virtual-circuit IDs to signal pseudowires using LDP FEC Element 128.

In order to signal the SDPs, the following parameters are required:

1. Attachment Group Identifier (AGI): this is used to carry the VPLS-id of the local PE router VPLS instance. The VPLS-id must be the same for all PEs in the same VPLS instance.
2. Source Attachment Individual Identifier (SAII) and Target Attachment Individual Identifier (TAII): These use AII type 1 (RFC 4446) and are used to carry the NRLI (VSI-id minus the RD) of the remote PE router VPLS instance.

The AGI for each PE must be identical. SAI and TAI must be different.

The following shows the service LDP bindings for VPLS 3 on PE-1:

```
*A:PE-1# show router ldp bindings service-id 3
=====
LDP LSR ID: 192.0.2.1
=====
Legend: U - Label In Use, N - Label Not In Use, W - Label Withdrawn
       S - Status Signaled Up, D - Status Signaled Down
       E - Epipe Service, V - VPLS Service, M - Mirror Service
       A - Apipe Service, F - Fpipe Service, I - IES Service, R - VPRN service
       P - Ipipe Service, WP - Label Withdraw Pending, C - Cpipe Service
       BU - Alternate For Fast Re-Route, TLV - (Type, Length: Value)
=====
LDP Service FEC 128 Bindings
=====
Type   VCId      SvcId      SDPIId    Peer          IngLbl  EgrLbl  LMTU RMTU
-----
No Matching Entries Found
=====

LDP Service FEC 129 Bindings
=====
AGI                               SAII
Type                               TAII
                               Peer          IngLbl  EgrLbl  LMTU RMTU
-----
1,8:020A000100000003             192.0.2.1
V-Eth                             192.0.2.2
                               17407    192.0.2.2    131032U 131020S 1500 1500

1,8:020A000100000003             192.0.2.1
V-Eth                             192.0.2.3
                               17405    192.0.2.3    131030U 131030S 1500 1500

-----
No. of FEC 129s: 2
=====
*A:PE-1#
```

This shows the two T-LDP bindings for PE-1 towards PE-2 and PE-3 for VPLS 3.

The AGI entry 1, 8:020A000100000003 is the direct encoding from the AGI TLV within the TLD FEC 129 Element as described by the following:

VPLS PE Configuration

type 1, length 8, Variable (VPLS-id) 020A000100000003 = 65536:3

SAII — Local system IP address 192.0.2.1

TAII — Remote system IP address 192.0.2.2 or 192.0.2.3

The ingress and egress labels can also be seen from the SDP bindings from the service:

```
*A:PE-1# show service id 3 sdp
=====
Services: Service Destination Points
=====
SdpId          Type Far End addr   Adm   Opr      I.Lbl   E.Lbl
-----
17405:4294967291 Bgp* 192.0.2.3      Up    Up       131030  131030
17407:4294967295 Bgp* 192.0.2.2      Up    Up       131032  131020
-----
Number of SDPs : 2
-----
* indicates that the corresponding row element may have been truncated.
*A:PE-1#
```

The SDPs are auto-provisioned SDPs, like SDP 17386 towards PE-2 and 17385 towards PE-3. The label bindings from the SDP and LDP binding outputs are identical.

PE-2 Service Operation Verification

For completeness, verify the service is operationally up on PE-2.

```
*A:PE-2# show service id 3 base
=====
Service Basic Information
=====
Service Id       : 3                Vpn Id          : 0
Service Type    : VPLS
Name            : (Not Specified)
Description     : (Not Specified)
Customer Id     : 1                Creation Origin  : manual
Last Status Change: 11/04/2014 12:04:34
Last Mgmt Change : 11/04/2014 12:07:21
Etree Mode     : Disabled
Admin State     : Up               Oper State      : Up
MTU             : 1514             Def. Mesh VC Id : 3
SAP Count      : 1               SDP Bind Count  : 2
Snd Flush on Fail : Disabled      Host Conn Verify : Disabled
Propagate MacFlush: Disabled      Per Svc Hashing  : Disabled
Allow IP Intf Bind: Disabled
Def. Gateway IP : None
Def. Gateway MAC : None
Temp Flood Time : Disabled        Temp Flood      : Inactive
Temp Flood Chg Cnt: 0
VSD Domain     : <none>
```

```
-----
Service Access & Destination Points
-----
Identifier                                     Type          AdmMTU  OprMTU  Adm  Opr
-----
sap:1/1/4:3.0                                 qinq          1522    1522    Up   Up
sdp:17405:4294967290 SB(192.0.2.1)           BgpAd         0       1556    Up   Up
sdp:17407:4294967295 SB(192.0.2.3)           BgpAd         0       1556    Up   Up
=====
```

*A:PE-2#

```
*A:PE-2# show service l2-route-table bgp-ad
```

```
-----
Services: L2 Route Information - Summary
-----
Svc Id   L2-Routes (RD-Prefix)                Next Hop          Origin
          Sdp Bind Id                      PW Temp Id
-----
3        *65536:3-192.0.2.1                    192.0.2.1        BGP-L2
          17405:4294967290                    2
3        *65536:3-192.0.2.3                    192.0.2.3        BGP-L2
          17407:4294967295                    2
-----
```

```
No. of L2 Route Entries: 2
```

*A:PE-2#

LDP VPLS using BGP-Auto Discovery

```

*A:PE-2# show router ldp bindings service-id 3
=====
LDP LSR ID: 192.0.2.2
=====
Legend: U - Label In Use, N - Label Not In Use, W - Label Withdrawn
        S - Status Signaled Up, D - Status Signaled Down
        E - Epipe Service, V - VPLS Service, M - Mirror Service
        A - Apipe Service, F - Fpipe Service, I - IES Service, R - VPRN service
        P - Ipipe Service, WP - Label Withdraw Pending, C - Cpipe Service
        BU - Alternate For Fast Re-Route, TLV - (Type, Length: Value)
=====
LDP Service FEC 128 Bindings
=====
Type   VCId       SvcId       SDPIId      Peer          IngLbl  EgrLbl  LMTU  RMTU
-----
No Matching Entries Found
=====
LDP Service FEC 129 Bindings
=====
AGI                                     SAII
Type          SvcId       SDPIId      Peer          IngLbl  EgrLbl  LMTU  RMTU
-----
1,8:020A000100000003                192.0.2.2
                                      192.0.2.1
V-Eth         3           17405      192.0.2.1      131020U 131032S 1500 1500
1,8:020A000100000003                192.0.2.2
                                      192.0.2.3
V-Eth         3           17407      192.0.2.3      131022U 131032S 1500 1500
-----
No. of FEC 129s: 2
=====
*A:PE-2#

*A:PE-2# show service id 3 sdp
=====
Services: Service Destination Points
=====
SdpId          Type Far End addr   Adm   Opr       I.Lbl   E.Lbl
-----
17405:4294967290 Bgp* 192.0.2.1      Up    Up        131020  131032
17407:4294967295 Bgp* 192.0.2.3      Up    Up        131022  131032
-----
Number of SDPs : 2
=====
* indicates that the corresponding row element may have been truncated.
*A:PE-2#

```

PE-3 Service Operation Verification

Verify service is operationally up on PE-3.

```
*A:PE-3# show service id 3 base
=====
Service Basic Information
=====
Service Id       : 3                Vpn Id          : 0
Service Type    : VPLS
Name            : (Not Specified)
Description     : (Not Specified)
Customer Id     : 1                Creation Origin  : manual
Last Status Change: 11/04/2014 12:07:26
Last Mgmt Change : 11/04/2014 12:10:16
Etree Mode     : Disabled
Admin State    : Up                Oper State      : Up
MTU            : 1514             Def. Mesh VC Id : 3
SAP Count     : 1                SDP Bind Count  : 2
Snd Flush on Fail : Disabled      Host Conn Verify : Disabled
Propagate MacFlush: Disabled      Per Svc Hashing  : Disabled
Allow IP Intf Bind: Disabled
Def. Gateway IP : None
Def. Gateway MAC : None
Temp Flood Time : Disabled        Temp Flood      : Inactive
Temp Flood Chg Cnt: 0
VSD Domain     : <none>
```

```
-----
Service Access & Destination Points
-----
Identifier                                     Type           AdmMTU  OprMTU  Adm  Opr
-----
sap:1/1/4:3.0                                qinq           1522    1522    Up   Up
sdp:17405:4294967290 SB(192.0.2.1)          BgpAd          0        1556    Up   Up
sdp:17407:4294967295 SB(192.0.2.2)          BgpAd          0        1556    Up   Up
=====
```

```
*A:PE-3#

*A:PE-3# show service l2-route-table bgp-ad
=====
Services: L2 Route Information - Summary
=====
Svc Id   L2-Routes (RD-Prefix)                Next Hop      Origin
        Sdp Bind Id                      PW Temp Id
-----
3        *65536:3-192.0.2.1                    192.0.2.1    BGP-L2
        17405:4294967290                    2
3        *65536:3-192.0.2.2                    192.0.2.2    BGP-L2
        17407:4294967295                    2
-----
No. of L2 Route Entries: 2
=====
*A:PE-3#
```

LDP VPLS using BGP-Auto Discovery

```

*A:PE-3# show router ldp bindings service-id 3
=====
LDP LSR ID: 192.0.2.3
=====
Legend: U - Label In Use, N - Label Not In Use, W - Label Withdrawn
        S - Status Signaled Up, D - Status Signaled Down
        E - Epipe Service, V - VPLS Service, M - Mirror Service
        A - Apipe Service, F - Fpipe Service, I - IES Service, R - VPRN service
        P - Ipipe Service, WP - Label Withdraw Pending, C - Cpipe Service
        BU - Alternate For Fast Re-Route, TLV - (Type, Length: Value)
=====
LDP Service FEC 128 Bindings
=====
Type   VCId       SvcId       SDPIId      Peer          IngLbl  EgrLbl  LMTU  RMTU
-----
No Matching Entries Found
=====

LDP Service FEC 129 Bindings
=====
AGI                               SAII
Type                               TAII
Type   SvcId       SDPIId      Peer          IngLbl  EgrLbl  LMTU  RMTU
-----
1,8:020A000100000003              192.0.2.3
V-Eth          3           17405       192.0.2.1     131030U 131030S 1500 1500
1,8:020A000100000003              192.0.2.3
V-Eth          3           17407       192.0.2.2     131032U 131022S 1500 1500
-----
No. of FEC 129s: 2
=====
*A:PE-3#

*A:PE-3# show service id 3 sdp
=====
Services: Service Destination Points
=====
SdpId          Type  Far End addr  Adm   Opr    I.Lbl    E.Lbl
-----
17405:4294967290 Bgp* 192.0.2.1    Up    Up     131030   131030
17407:4294967295 Bgp* 192.0.2.2    Up    Up     131032   131022
-----
Number of SDPs : 2
=====
* indicates that the corresponding row element may have been truncated.
*A:PE-3#

```

BGP AD using Pre-Provisioned SDPs

It is possible to configure BGP-AD instances that use RSVP transport tunnels. In this case, the LSPs and SDPs must be manually created.

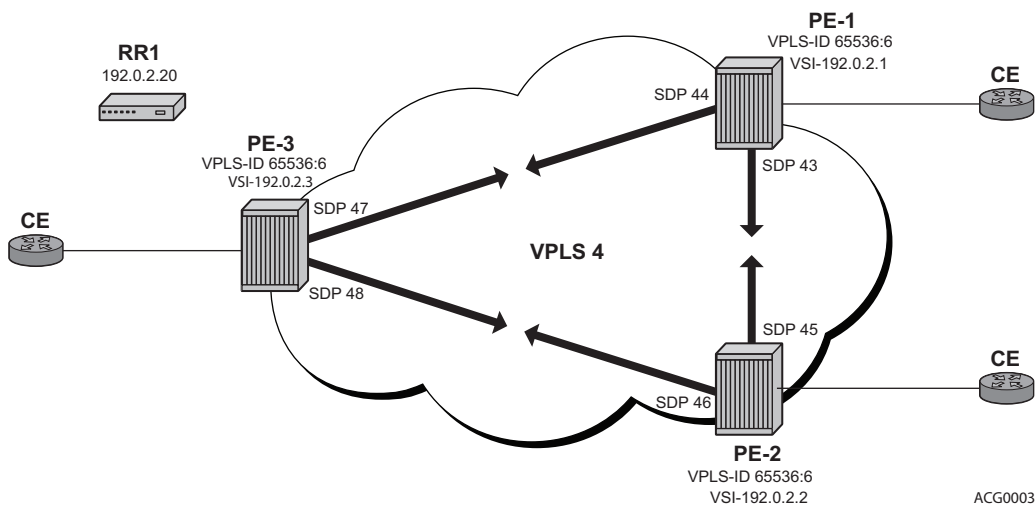


Figure 59: VPLS Instance using Pre-Provisioned SDPs

Figure 59 shows a VPLS instance configured across three Provider Edge routers as before.

The SDP configurations for the three PEs are shown below:

SDPs on PE-1

```
configure service
  sdp 43 mpls create
    far-end 192.0.2.2
    lsp "LSP-PE-1-PE-2"
    keep-alive
    shutdown
  exit
  no shutdown
exit
sdp 44 mpls create
  far-end 192.0.2.3
  lsp "LSP-PE-1-PE-3"
  keep-alive
  shutdown
exit
  no shutdown
exit
exit
```


SDPs on PE-2

```
configure service
  sdp 45 mpls create
    far-end 192.0.2.1
    lsp "LSP-PE-2-PE-1"
    keep-alive
    shutdown
  exit
  no shutdown
exit
sdp 46 mpls create
  far-end 192.0.2.3
  lsp "LSP-PE-2-PE-3"
  keep-alive
  shutdown
exit
  no shutdown
exit
exit
```

SDPs on PE-3

```
configure service
  sdp 47 mpls create
    far-end 192.0.2.1
    lsp "LSP-PE-3-PE-1"
    keep-alive
    shutdown
  exit
  no shutdown
exit
sdp 48 mpls create
  far-end 192.0.2.2
  lsp "LSP-PE-3-PE-2"
  keep-alive
  shutdown
exit
  no shutdown
exit
exit
```

VPLS PE Configuration

The pw-template that is to be used within each VPLS instance must be provisioned on all PEs and must use the keyword **use-provisioned-sdp**. The pw-template looks like:

```
A:PE-1# configure service
      pw-template 3 use-provisioned-sdp create
      exit
exit
```

This configuration must be repeated on both PE-2 and PE-3.

The following output shows the configuration required for a VPLS service using a pseudowire template configured for pre-provisioned RSVP SDPs.

```
A:PE-1# configure service vpls 4 customer 1 create
      bgp
        route-distinguisher:65536:4
        route-target export target:65536:4 import target:65536:4
        pw-template-binding 3 split-horizon-group "vpls-shg"
                               import-rt "target:65536:4"
      exit
exit
      bgp-ad
        vpls-id 65536:4
        vsi-id
          prefix 192.0.2.1
        exit
        no shutdown
exit
      stp
        shutdown
exit
      sap 1/1/4:4.0 create
exit
no shutdown
```

Similarly, on PE-2 the configuration is shown below:

```
A:PE-2# configure service vpls 4 customer 1 create
      bgp
        route-distinguisher:65536:4
        route-target export target:65536:4 import target:65536:4
        pw-template-binding 3 split-horizon-group "vpls-shg"
                               import-rt "target:65536:4"
      exit
exit
      bgp-ad
        vpls-id 65536:4
        vsi-id
          prefix 192.0.2.2
        exit
        no shutdown
exit
      stp
        shutdown
```

```

exit
sap 1/1/4:4.0 create
exit
no shutdown

```

On PE-3:

```

A:PE-3# config service vpls 4 customer 1 create
      bgp
        route-distinguisher:65536:4
        route-target export target:65536:4 import target:65536:4
        pw-template-binding 3 split-horizon-group "vpls-shg"
                               import-rt "target:65536:4"
      exit
exit
bgp-ad
  vpls-id 65536:4
  vsi-id
    prefix 192.0.2.3
  exit
  no shutdown
exit
stp
  shutdown
exit
sap 1/1/4:4.0 create
exit
no shutdown

```

Verify that the service is operationally up on PE-1.

```

*A:PE-1# show service id 4 base
=====
Service Basic Information
=====
Service Id      : 4                Vpn Id          : 0
Service Type    : VPLS
Name            : (Not Specified)
Description     : (Not Specified)
Customer Id     : 1                Creation Origin  : manual
Last Status Change: 11/04/2014 12:04:11
Last Mgmt Change  : 11/04/2014 12:54:15
Etree Mode     : Disabled
Admin State     : Up                Oper State      : Up
MTU            : 1514              Def. Mesh VC Id : 4
SAP Count      : 1                SDP Bind Count  : 2
Snd Flush on Fail : Disabled       Host Conn Verify : Disabled
Propagate MacFlush: Disabled       Per Svc Hashing  : Disabled
Allow IP Intf Bind: Disabled
Def. Gateway IP : None
Def. Gateway MAC : None
Temp Flood Time : Disabled         Temp Flood      : Inactive
Temp Flood Chg Cnt: 0
VSD Domain     : <none>
=====
Service Access & Destination Points

```

VPLS PE Configuration

```

-----
Identifier                               Type           AdmMTU  OprMTU  Adm  Opr
-----
sap:1/1/4:4.0                           qinq          1522    1522    Up   Up
sdp:43:4294967284 S(192.0.2.2)           BgpAd         0       1556    Up   Up
sdp:44:4294967285 S(192.0.2.3)           BgpAd         0       1556    Up   Up
=====
*A:PE-1#

```

Note that the SDP identifiers are the pre-provisioned SDPs, i.e. SDP 43 and 44.

For completeness, verify the service is operationally up on PE-2.

```

*A:PE-2# show service id 4 base
=====
Service Basic Information
=====
Service Id       : 4                Vpn Id           : 0
Service Type    : VPLS
Name             : (Not Specified)
Description     : (Not Specified)
Customer Id     : 1                Creation Origin  : manual
Last Status Change: 11/04/2014 12:04:34
Last Mgmt Change  : 11/04/2014 12:54:08
Etree Mode     : Disabled
Admin State     : Up                Oper State       : Up
MTU             : 1514             Def. Mesh VC Id : 4
SAP Count      : 1                SDP Bind Count  : 2
Snd Flush on Fail : Disabled        Host Conn Verify : Disabled
Propagate MacFlush: Disabled        Per Svc Hashing  : Disabled
Allow IP Intf Bind: Disabled
Def. Gateway IP : None
Def. Gateway MAC : None
Temp Flood Time : Disabled        Temp Flood       : Inactive
Temp Flood Chg Cnt: 0
VSD Domain     : <none>
=====
Service Access & Destination Points
-----
Identifier                               Type           AdmMTU  OprMTU  Adm  Opr
-----
sap:1/1/4:4.0                           qinq          1522    1522    Up   Up
sdp:45:4294967284 S(192.0.2.1)           BgpAd         0       1556    Up   Up
sdp:46:4294967285 S(192.0.2.3)           BgpAd         0       1556    Up   Up
=====
*A:PE-2#

```

Verify service is operational on PE-3.

```

*A:PE-3# show service id 4 base
=====
Service Basic Information
=====
Service Id       : 4                Vpn Id           : 0
Service Type    : VPLS
Name             : (Not Specified)

```

LDP VPLS using BGP-Auto Discovery

```

Description      : (Not Specified)
Customer Id      : 1                Creation Origin   : manual
Last Status Change: 11/04/2014 12:07:26
Last Mgmt Change  : 11/04/2014 12:56:35
Etree Mode       : Disabled
Admin State      : Up                Oper State        : Up
MTU              : 1514              Def. Mesh VC Id   : 4
SAP Count        : 1                SDP Bind Count    : 2
Snd Flush on Fail : Disabled         Host Conn Verify  : Disabled
Propagate MacFlush: Disabled         Per Svc Hashing   : Disabled
Allow IP Intf Bind: Disabled
Def. Gateway IP   : None
Def. Gateway MAC  : None
Temp Flood Time   : Disabled         Temp Flood        : Inactive
Temp Flood Chg Cnt: 0
VSD Domain        : <none>
  
```

 Service Access & Destination Points

Identifier	Type	AdmMTU	OprMTU	Adm	Opr
sap:1/1/4:4.0	qinq	1522	1522	Up	Up
sdp:47:4294967284 S(192.0.2.1)	BgpAd	0	1556	Up	Up
sdp:48:4294967285 S(192.0.2.2)	BgpAd	0	1556	Up	Up

=====

*A:PE-3#

Conclusion

BGP-Auto discovery coupled with LDP pseudowire signaling allows the delivery of L2 VPN services to customers where BGP is commonly used. This example shows the configuration of BGP-Auto discovery together with the associated show outputs which can be used for verification and troubleshooting.