

Carrier Supporting Carrier IP VPNs

In This Chapter

This section provides information about carrier supporting carrier IP VPN configurations.

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Applicability

This example is applicable to the following platforms: 7950 XRS, 7750 SR-7/12, 7450 ESS-6/7/12 and 7450 SR-c4/c12.

When a 7450 operating in mixed-mode, a 7750, or a 7950 is deployed as a CSC-PE (refer to [Figure 86](#)) all its network interfaces and all its CSC VPRN interfaces must be configured on FP2 or higher hardware.

The configuration in this guide was tested with release 12.0.R1.

Overview

Carrier Supporting Carrier (CSC) is a solution that allows one service provider (the Customer Carrier) to use the IP VPN service of another service provider (the Super Carrier) for some or all of its backbone transport. RFC 4364 defines a Carrier Supporting Carrier solution for BGP/MPLS IP VPNs that uses MPLS at the interconnection points between the two service providers to provide a scalable and secure solution.

A simplified CSC network topology is shown in Figure 86. A CSC deployment involves the following types of devices:

CE — Customer premises equipment dedicated to one particular business/enterprise.

PE — Edge router managed and operated by the Customer Carrier that connects to CEs to provide business VPN or Internet services.

CSC-CE — Peering router managed and operated by the Customer Carrier that is connected to CSC-PEs for purposes of using the associated CSC IP VPN services for backbone transport. The CSC-CE may attach directly to CEs if it is also configured to be a PE for business VPN services.

CSC-PE — A PE router managed and operated by the Super Carrier that supports one or more CSC IP VPN services possibly in addition to other traditional PE services.

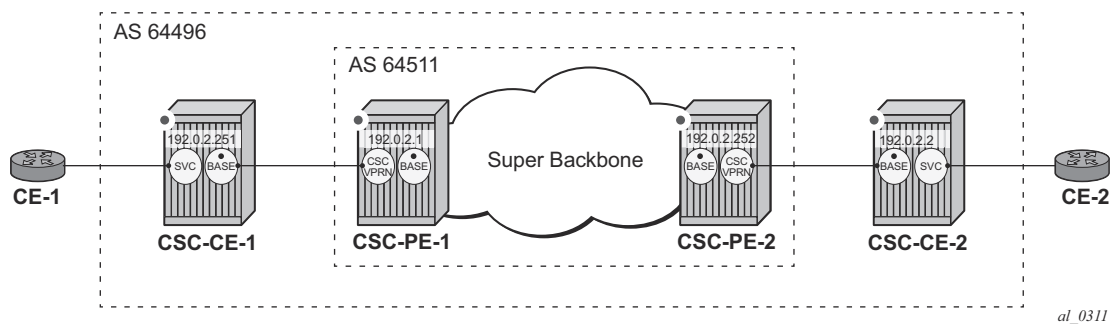


Figure 86: CSC Network Topology

In the CSC solution the CSC-CE and CSC-PE are directly connected by a link that supports MPLS. The CSC-CE distributes an MPLS label for every /32 IPv4 prefix it and any downstream PE uses as a BGP next-hop in routes associated with services offered by the Customer Carrier. Note that BGP **must be used** as the label distribution protocol between CSC-CE and CSC-PE if the latter device is a 7x50. Typically the Customer Carrier and Super Carrier operate as two different Autonomous Systems (AS) and therefore BGP, more specifically EBGP, is the best label distribution protocol even if other options are available. The BGP session between CSC-CE and CSC-PE must be single-hop EBGP (or IBGP) if either device is a 7x50.

In a 7x50 CSC-PE the interface to a CSC-CE is a special type of IP/MPLS interface that belongs to a VPRN configured for CSC mode. This special type of interface is called a CSC VPRN interface throughout the remainder of this example. The CSC VPRN interface has many of the same characteristics as a network interface of the base router but its association with a VRF ensures that the traffic and control plane routes of the Customer Carrier are kept separate from other services.

When a 7x50 CSC-PE receives a labelled-IPv4 route (with label L1, next-hop N1) from a CSC-CE BGP peer the following actions take place in the CSC-PE:

1. The BGP route is installed into the routing table of the CSC VPRN (assuming the BGP route is the best route to the destination).
2. If the BGP route matches the VRF export policy it is advertised to core MP-BGP peers as a VPN-IPv4 route. The advertised label value is changed to L2.
3. BGP programs the line cards with an MPLS forwarding entry that swaps L2 for L1 and sends the MPLS packet over the CSC VPRN interface associated with next-hop N1.

When a 7x50 CSC-PE receives a VPN-IPv4 route (with label L2, next-hop N2) the following actions take place in the CSC-PE:

1. If the VPN-IPv4 route matches the VRF import policy of a CSC VPRN it is installed into the routing table of that CSC VPRN.
2. If the imported (BGP-VPN) route matches the BGP export policy associated with a CSC-CE BGP peer it is advertised to that peer as a labelled-IPv4 route. The advertised label value is changed to L3.
3. BGP programs the line cards with an MPLS forwarding entry that swaps L3 for L2 and sends the packet inside the MPLS tunnel to next-hop N2.

Once a CSC-CE has learned a labelled-IPv4 route for a remote CSC-CE and vice versa the two CSC-CEs can setup a BGP session between themselves and exchange VPN routes over this session if they are both PEs with services. Typically this BGP session will be an IBGP session because the local and remote CSC-CEs belong to the same Autonomous System (AS). The Layer 2 VPN and Layer 3 VPN routes exchanged by the CSC-CEs are resolved by the labelled-IPv4 routes they have for each other's /32 IPv4 address.

Configuration

This section will walk through the steps to configure the CSC solution shown in [Figure 86](#). Note that the IPv4 addresses in [Figure 86](#) are the system IP addresses of the routers.

Step 1. Configure CSC-CE-1.

This example assumes that CSC-CE-1 is a PE router with Layer 2 and Layer 3 VPN services that must extend across the CSC VPN service; assume that there are no further downstream PEs in AS 64496. The configuration of one such Layer 3 VPN service in CSC-CE-1 is shown below:

```
A:csc-ce-1>config>service>vprn# info
-----
route-distinguisher 64496:1
auto-bind mpls
vrf-target target:64496:1
...
no shutdown
-----
A:csc-ce-1>config>service>vprn#
```

For brevity the above configuration sample omits commands related to SAP IP interfaces, spoke-SDP IP interfaces, PE-CE routing protocols, QoS, IP filters, etc.

The base routing instance of the CSC-CE should be configured with the appropriate router-ID and autonomous-system number and the system interface should be given an IPv4 address (usually the same as the router-id). The interface to CSC-PE-1 should then be created and configured. The base router configuration of CSC-CE-1 is shown below:

```
*A:csc-ce-1>config>router# info
-----
#-----
echo "IP Configuration"
#-----
interface "int-csc-ce-1-to-csc-pe-1"
address 192.168.0.1/30
port 1/1/2
no shutdown
exit
interface "system"
address 192.0.2.1/32
no shutdown
exit
autonomous-system 64496
router-id 192.0.2.1
-----
*A:csc-ce-1>config>router#
```

BGP should be configured as the control plane protocol running on the interface to CSC-PE-1, as shown below:

```
*A:csc-ce-1>config>router>bgp# info
-----
      group "csc-pe"
        peer-as 64511
        neighbor 192.168.0.2
          family ipv4
            export "static-to-bgp"
            advertise-label ipv4
            split-horizon
        exit
      exit
      no shutdown
-----
*A:csc-ce-1>config>router>bgp#
```

Note the following about the BGP configuration of CSC-CE-1:

- The peer type is EBGp (**peer-as** is different from the locally configured **autonomous-system**)
- The transport for the EBGp session is IPv4 (the **neighbor** address is an IPv4 address)
- The **advertise-label ipv4** command causes MP-BGP negotiation of the address family for AFI=1 and SAFI=4 (IPv4 NLRI with MPLS labels), as can be observed from the following debug trace (using the command **debug router bgp open**) of the OPEN message from CSC-CE-1.

```
2 2014/04/01 08:35:44.15 EST MINOR: DEBUG #2001 Base BGP
"BGP: OPEN
Peer 1: 192.168.0.2 - Received BGP OPEN: Version 4
  AS Num 64511: Holdtime 90: BGP_ID 192.0.2.251: Opt Length 16
  Opt Para: Type CAPABILITY: Length = 14: Data:
    Cap_Code MP-BGP: Length 4
      Bytes: 0x0 0x1 0x0 0x4
    Cap_Code ROUTE-REFRESH: Length 0
    Cap_Code 4-OCTET-ASN: Length 4
      Bytes: 0x0 0x0 0xfb 0xff
"
```

- The **split-horizon** command is optional. It prevents a best BGP route from the CSC-PE peer from being re-advertised back to that peer.
- The **export** command applies a BGP export policy to the session. The configuration of the policy is shown below:

```
*A:csc-ce-1>config>router>policy-options# info
-----
      prefix-list "system-ip"
        prefix 192.0.2.1/32 exact
      exit
      policy-statement "static-to-bgp"
        entry 10
-----
```

```

        from
            protocol direct
            prefix-list "system-ip"
        exit
        action accept
        exit
    exit
    default-action reject
    exit
-----
*A:csc-ce-1>config>router>policy-options#

```

The effect of the BGP export policy is to advertise the system IP address of CSC-CE-1 as a labelled-IPv4 BGP route towards the CSC-PE(s).

Step 2. Configure CSC service on CSC-PE-1.

CSC-PE-1 must be configured with a VPRN in **carrier-carrier-vpn** mode in order to provide CSC service to CSC-CE-1. The entire configuration of the VPRN is shown below:

```

A:csc-pe-1>config>service>vprn# info
-----
    carrier-carrier-vpn
    router-id 192.0.2.251
    autonomous-system 64511
    route-distinguisher 64511:1
    auto-bind mpls
    vrf-target target:64511:1
    network-interface "csc-pe-1-to-csc-ce-1" create
        address 192.168.0.2/30
        port 1/1/1
        no shutdown
    exit
    bgp
        group "csc-ce"
            as-override
            export "bgp-vpn-routes"
            peer-as 64496
            neighbor 192.168.0.1
                family ipv4
                advertise-label ipv4
                split-horizon
            exit
        exit
        no shutdown
    exit
    no shutdown
-----
A:csc-pe-1>config>service>vprn#

```

Note the following about the VPRN configuration of CSC-PE-1:

- The **carrier-carrier-vpn** command is mandatory. It cannot be configured if the VPRN currently has any SAP or spoke-SDP access interfaces configured; they must first be shutdown if necessary and then deleted.

```
*A:csc-pe-1>config>service>vprn# carrier-carrier-vpn
INFO: PIP #1195 Cannot toggle carrier-carrier-vpn - service interfaces present
*A:csc-pe-1>config>service>vprn#
```

- The **auto-bind** command should be set appropriately for the type of transport desired to other CSC-PEs, but note that GRE is not supported.

```
A:csc-pe-1>config>service>vprn# auto-bind gre
MINOR: SVCMMGR #1538 auto-bind config not supported - carrier-carrier vprn
A:csc-pe-1>config>service>vprn#
```

- The interface to CSC-CE-1 must be a **network-interface**. A **network-interface** can be associated with an entire Ethernet port (as shown in the example above), a VLAN sub-interface of an Ethernet port, an entire LAG or a VLAN sub-interface of a LAG. In all cases the associated Ethernet ports must be configured in network or hybrid mode and must reside on FP2 or higher based cards/systems.

Note the following about the BGP configuration of the CSC VPRN service in CSC-PE-1:

- The peer type is EBGP (**peer-as** is different from the locally configured **autonomous-system**).
- The transport for the EBGP session is IPv4 (the **neighbor** address is an IPv4 address).
- The **advertise-label ipv4** command causes MP-BGP negotiation of the address family for AFI=1 and SAFI=4 (IPv4 NLRI with MPLS labels).
- The **split-horizon** command is optional. It prevents a best BGP route from the CSC-CE peer from being re-advertised back to that peer.
- The **as-override** command replaces CSC-CE-1's AS number (64496) with CSC-PE-1's AS number (64511) in the AS_PATH attribute of routes advertised to CSC-CE-1. Without this configuration CSC-CE-1 may reject routes originated by CSC-CE-2 as invalid due to an AS-path loop.
- The **export** command applies a BGP export policy to the session. The configuration of the policy is shown below:

```
*A:csc-pe-1>config>router>policy-options# info
-----
      policy-statement "bgp-vpn-routes"
        entry 10
          from
            protocol bgp-vpn
          exit
          action accept
          exit
```



```

        exit
        default-action reject
    exit
-----
*A:csc-pe-1>config>router>policy-options#

```

The effect of the BGP export policy is to re-advertise VPN-IPv4 routes imported into the CSC VPRN (and used for forwarding) to CSC-CE-1.

Step 3. Verify exchange of routes between CSC-CE-1 and CSC-PE-1.

When Steps 1 and 2 have been completed properly CSC-CE-1 should now be advertising the labelled-IPv4 route for its system IP address to CSC-PE-1. This can be checked from the perspective of CSC-CE-1 as shown below:

```

*A:csc-ce-1# show router bgp routes 192.0.2.1/32 hunt
=====
BGP Router ID:192.0.2.1      AS:64496      Local AS:64496
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
Origin codes  : i - IGP, e - EGP, ? - incomplete, > - best, b - backup
=====
BGP IPv4 Routes
=====
RIB In Entries
-----
RIB Out Entries
-----
Network       : 192.0.2.1/32
Nexthop       : 192.168.0.1
Path Id       : None
To            : 192.168.0.2
Res. Nexthop  : n/a
Local Pref.   : n/a
Aggregator AS : None
Atomic Aggr.  : Not Atomic
AIGP Metric   : None
Connector     : None
Community     : No Community Members
Cluster       : No Cluster Members
Originator Id : None
IPv4 Label    : 262142
Origin        : IGP
AS-Path       : 64496
Neighbor-AS   : 64496
Peer Router Id : 192.0.2.251
-----
Routes : 1
=====
*A:csc-ce-1#

```

Note that CSC-CE-1 has advertised a label value of 262142 with the prefix.

The following output shows the received route from the perspective of CSC-PE-1:

```
*A:csc-pe-1# show router 1 bgp routes 192.0.2.1/32 hunt
=====
BGP Router ID:192.0.2.251      AS:64511      Local AS:64511
=====
Legend -
Status codes : u - used, s - suppressed, h - history, d - decayed, * - valid
Origin codes : i - IGP, e - EGP, ? - incomplete, > - best, b - backup
=====
BGP IPv4 Routes
=====
RIB In Entries
-----
Network      : 192.0.2.1/32
Nexthop      : 192.168.0.1
Path Id      : None
From         : 192.168.0.1
Res. Nexthop : 192.168.0.1
Local Pref.  : None
Aggregator AS : None
Atomic Aggr. : Not Atomic
AIGP Metric  : None
Connector    : None
Community    : No Community Members
Cluster      : No Cluster Members
Originator Id : None
Fwd Class    : None
IPv4 Label   : 262142
Flags        : Used Valid Best IGP
Route Source : External
AS-Path      : 64496
Neighbor-AS  : 64496
-----
RIB Out Entries
-----
Routes : 1
=====
*A:csc-pe-1#
```

Step 4. Configure core connectivity for CSC-PE-1.

The next step is to configure the base router instance of CSC-PE-1 so that it can exchange VPN-IPv4 routes with CSC-PE-2 (and potentially other CSC-PEs). At a minimum this requires:

- Router-id and autonomous-system configuration.
- Network interface creation and configuration, including assignment of an IPv4 address to the system interface.
- Configuration of the IGP protocol. In this example IS-IS is used.
- Configuration of the LDP protocol (optional).
- Configuration of RSVP LSPs used to reach remote CSC-PE devices (optional).
- Configuration of the BGP protocol.

These elements of the base router configuration of CSC-PE-1 are shown below:

```
*A:csc-pe-1>config>router# info
-----
#-----
echo "IP Configuration"
#-----
        interface "csc-pe-1-to-csc-pe-2"
            address 192.168.1.1/30
            port 1/1/2
            no shutdown
        exit
        interface "system"
            address 192.0.2.251/32
            no shutdown
        exit
        autonomous-system 64511
        router-id 192.0.2.251
#-----
echo "ISIS Configuration"
#-----
        isis
            level-capability level-2
            area-id 49.01
            level 2
                wide-metrics-only
            exit
            interface "system"
                level-capability level-2
                passive
                no shutdown
            exit
            interface "csc-pe-1-to-csc-pe-2"
                level-capability level-2
                interface-type point-to-point
                level 2
                    metric 100
                exit
                no shutdown
```

Configuration

```
        exit
        no shutdown
    exit
#-----
echo "LDP Configuration"
#-----
    ldp
        interface-parameters
            interface "csc-pe-1-to-csc-pe-2"
            exit
        exit
        targeted-session
        exit
        no shutdown
    exit
#-----
echo "BGP Configuration"
#-----
    bgp
        group "core"
            peer-as 64511
            neighbor 192.0.2.252
                family vpn-ipv4
            exit
        exit
        no shutdown
    exit
-----
*A:csc-pe-1>config>router#
```

Note the following about the BGP configuration of the base router in CSC-PE-1:

- The peer type is IBGP (**peer-as** is the same as the locally configured **autonomous-system**).
- The transport for the IBGP session is IPv4 (the **neighbor** address is an IPv4 address).
- The **family vpn-ipv4** command causes MP-BGP negotiation of the address family for AFI=1 and SAFI=128, as can be observed from the following debug trace of the OPEN message from CSC-PE-1.

```
12 2014/04/01 09:34:48.64 EST MINOR: DEBUG #2001 Base BGP
"BGP: OPEN
Peer 1: 192.0.2.252 - Send (Active) BGP OPEN: Version 4
  AS Num 64511: Holdtime 90: BGP_ID 192.0.2.251: Opt Length 16
  Opt Para: Type CAPABILITY: Length = 14: Data:
    Cap_Code MP-BGP: Length 4
      Bytes: 0x0 0x1 0x0 0x80
    Cap_Code ROUTE-REFRESH: Length 0
    Cap_Code 4-OCTET-ASN: Length 4
      Bytes: 0x0 0x0 0xfb 0xff
"
```

Step 5. Configure core connectivity for CSC-PE-2

The next step is to configure the base router instance of CSC-PE-2 so that it can exchange VPN-IPv4 routes with CSC-PE-1 (and potentially other CSC-PEs). At a minimum this requires:

- Router-id and autonomous-system configuration.
- Network interface creation and configuration, including assignment of an IPv4 address to the system interface.
- Configuration of the IGP protocol. In this example IS-IS is used.
- Configuration of the LDP protocol (optional).
- Configuration of RSVP LSPs used to reach remote CSC-PE devices (optional).
- Configuration of the BGP protocol.

These elements of the base router configuration of CSC-PE-2 are shown below:

```
A:csc-pe-2>config>router# info
-----
#-----
echo "IP Configuration"
#-----
        interface "csc-pe-2-to-csc-pe-1"
            address 192.168.1.2/30
            port 1/1/2
            no shutdown
        exit
        interface "system"
            address 192.0.2.252/32
            no shutdown
        exit
        autonomous-system 64511
        router-id 192.0.2.252
#-----
echo "ISIS Configuration"
#-----
        isis
            level-capability level-2
            area-id 49.01
            level 2
                wide-metrics-only
            exit
            interface "system"
                level-capability level-2
                passive
                no shutdown
            exit
            interface "csc-pe-2-to-csc-pe-1"
                level-capability level-2
                interface-type point-to-point
                level 2
                    metric 100
                exit
                no shutdown
```

Configuration

```
        exit
        no shutdown
    exit
#-----
echo "LDP Configuration"
#-----
    ldp
        interface-parameters
            interface "csc-pe-2-to-csc-pe-1"
            exit
        exit
        targeted-session
        exit
        no shutdown
    exit
#-----
echo "BGP Configuration"
#-----
    bgp
        group "core"
            cluster 192.0.2.252
            peer-as 64511
            neighbor 192.0.2.251
                family vpn-ipv4
                split-horizon
            exit
        exit
        no shutdown
    exit
#-----
A:csc-pe-2>config>router#
```

Note the following about the BGP configuration of the base router in CSC-PE-2:

- The peer type is IBGP (**peer-as** is the same as the locally configured **autonomous-system**).
- The transport for the IBGP session is IPv4 (the **neighbor** address is an IPv4 address).
- The **family vpn-ipv4** command causes MP-BGP negotiation of the address family for AFI=1 and SAFI=128.
- The **cluster** command configures CSC-PE-2 as a route reflector for clients in the BGP group called “core”. This is not required and in a more typical deployment the route reflector would be a separate router from any CSC-PE.

Step 6. Configure CSC service on CSC-PE-2.

CSC-PE-2 must be configured with a VPRN in **carrier-carrier-vpn** mode in order to provide CSC service to CSC-CE-2. The entire configuration of the VPRN is shown below:

```
A:csc-pe-2>config>service>vprn# info
-----
carrier-carrier-vpn
router-id 192.0.2.252
autonomous-system 64511
route-distinguisher 64511:2
auto-bind mpls
vrf-target target:64511:1
network-interface "csc-pe-2-to-csc-ce-2" create
  address 192.168.2.1/30
  port 1/1/3
  no shutdown
exit
bgp
  group "csc-ce"
    as-override
    export "bgp-vpn-routes"
    peer-as 64496
    neighbor 192.168.2.2
      family ipv4
      advertise-label ipv4
      split-horizon
    exit
  exit
  no shutdown
exit
no shutdown
-----
A:csc-pe-2>config>service>vprn#
```

Note the following about the VPRN configuration of CSC-PE-2:

- The **carrier-carrier-vpn** command is mandatory. It cannot be configured if the VPRN currently has any SAP or spoke-SDP “access” interfaces configured; they must first be shutdown if necessary and then deleted.
- The **auto-bind** command should be set appropriately for the type of transport desired to other CSC-PEs, but note that GRE is not supported.
- The interface to CSC-CE-2 must be a **network-interface**. A **network-interface** can be associated with an entire Ethernet port (as shown in the example above), a VLAN sub-interface of an Ethernet port, an entire LAG or a VLAN sub-interface of a LAG. In all cases the associated Ethernet ports must be configured in network or hybrid mode and must reside on FP2 or higher based cards/systems.

Note the following about the BGP configuration of the CSC VPRN service in CSC-PE-2:

- The peer type is EBGP (**peer-as** is different from the locally configured **autonomous-system**).
- The transport for the EBGP session is IPv4 (the **neighbor** address is an IPv4 address).
- The **advertise-label ipv4** command causes MP-BGP negotiation of the address family for AFI=1 and SAFI=4 (IPv4 NLRI with MPLS labels).
- The **split-horizon** command is optional. It prevents a best BGP route from the CSC-CE peer from being re-advertised back to that peer.
- The **as-override** command replaces CSC-CE-2's AS number (64496) with CSC-PE-2's AS number (64511) in the AS_PATH attribute of routes advertised to CSC-CE-2. Without this configuration CSC-CE-2 may reject routes originated by CSC-CE-1 as invalid due to an AS-path loop.
- The **export** command applies a BGP export policy to the session. The configuration of the policy is shown below:

```
*A:csc-pe-2>config>router>policy-options# info
-----
    policy-statement "bgp-vpn-routes"
      entry 10
        from
          protocol bgp-vpn
        exit
        action accept
        exit
      exit
      default-action reject
    exit
-----
*A:csc-pe-2>config>router>policy-options#
```

The effect of the BGP export policy is to re-advertise VPN-IPv4 routes imported into the CSC VPRN (and used for forwarding) to CSC-CE-2.

Step 7. Verify exchange of routes between CSC-PE-1 and CSC-PE-2.

When the preceding steps have been completed properly CSC-PE-1 should now be advertising the labelled-IPv4 route for 192.0.2.1/32 (the system IP address of CSC-CE-1) to CSC-PE-2. This can be checked from the perspective of CSC-PE-1 as shown below:

```
*A:csc-pe-1# show router bgp routes vpn-ipv4 192.0.2.1/32 hunt
=====
BGP Router ID:192.0.2.251      AS:64511      Local AS:64511
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
Origin codes  : i - IGP, e - EGP, ? - incomplete, > - best, b - backup
=====
BGP VPN-IPv4 Routes
=====
RIB In Entries
-----
RIB Out Entries
-----
Network       : 192.0.2.1/32
Nexthop       : 192.0.2.251
Route Dist.   : 64511:1          VPN Label     : 262140
Path Id       : None
To            : 192.0.2.252
Res. Nexthop  : n/a
Local Pref.   : 100
Aggregator AS : None           Interface Name : NotAvailable
Atomic Aggr.  : Not Atomic     Aggregator    : None
AIGP Metric   : None          MED           : None
Connector     : None
Community     : target:64511:1
Cluster       : No Cluster Members
Originator Id : None          Peer Router Id : 192.0.2.252
Origin        : IGP
AS-Path       : 64496
Neighbor-AS   : 64496
=====
Routes : 1
=====
*A:csc-pe-1#
```

Note that CSC-PE-1 has advertised a label value of 262140 with the prefix.

The following output shows the received route from the perspective of CSC-PE-2:

```
A:csc-pe-2# show router bgp routes vpn-ipv4 192.0.2.1/32 hunt
=====
BGP Router ID:192.0.2.252      AS:64511      Local AS:64511
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
Origin codes  : i - IGP, e - EGP, ? - incomplete, > - best, b - backup
```

Configuration

```
=====
BGP VPN-IPv4 Routes
=====
-----
RIB In Entries
-----
Network       : 192.0.2.1/32
NextHop       : 192.0.2.251
Route Dist.   : 64511:1           VPN Label      : 262140
Path Id       : None
From          : 192.0.2.251
Res. NextHop  : n/a
Local Pref.   : 100               Interface Name : csc-pe-2-to-csc-pe-1
Aggregator AS : None             Aggregator    : None
Atomic Aggr.  : Not Atomic       MED           : None
AIGP Metric   : None
Connector     : None
Community     : target:64511:1
Cluster       : No Cluster Members
Originator Id : None             Peer Router Id : 192.0.2.251
Fwd Class     : None             Priority       : None
Flags         : Used Valid Best IGP
Route Source  : Internal
AS-Path       : 64496
Neighbor-AS   : 64496
VPRN Imported : 1
-----
RIB Out Entries
-----
-----
Routes : 1
=====
A:csc-pe-2#
```

Also note the label swap entries that BGP programmed in the line cards of CSC-PE-1 based on the received labelled-IPv4 route from CSC-CE-1 (Label Origin = ExtCarCarVpn) and the advertised VPN-IPv4 route to CSC-PE-2:

```
*A:csc-pe-1# show router bgp inter-as-label
=====
BGP Inter-AS labels
=====
NextHop                Received      Advertised    Label
                        Label         Label         Origin
-----
192.168.0.1            262142      262140       ExtCarCarVpn
-----
Total Labels allocated: 1
=====
*A:csc-pe-1#
```

Step 8. Configure CSC-CE-2.

This example assumes that CSC-CE-2 is a PE router with Layer 2 and Layer 3 VPN services that must extend across the CSC VPN service. The configuration of one such Layer 3 VPN service in CSC-CE-2 is shown below:

```
A:csc-ce-2>config>service>vprn# info
-----
route-distinguisher 64496:2
auto-bind mpls
vrf-target target:64496:1
...
no shutdown
-----
A:csc-ce-2>config>service>vprn#
```

For brevity, the above configuration sample omits commands related to SAP IP interfaces, spoke-SDP IP interfaces, PE-CE routing protocols, QoS, IP filters, etc.

The base routing instance of CSC-CE-2 should be configured with the appropriate router-ID and autonomous-system number and the system interface should be given an IPv4 address (usually the same as the router-id). The interface to CSC-PE-2 should then be created and configured. The base router configuration of CSC-CE-2 is shown below:

```
A:csc-ce-2>config>router# info
-----
#-----
echo "IP Configuration"
#-----
interface "int-csc-ce-2-to-csc-pe-2"
address 192.168.2.2/30
port 1/1/2
no shutdown
exit
interface "system"
address 192.0.2.2/32
no shutdown
exit
autonomous-system 64496
router-id 192.0.2.2
-----
A:csc-ce-2>config>router#
```

BGP should be configured as the control plane protocol running on the interface to CSC-PE-2 as shown below:

```
A:csc-ce-2>config>router>bgp# info
-----
group "csc-pe"
family ipv4
peer-as 64511
neighbor 192.168.2.1
```

Configuration

```
        family ipv4
        export "static-to-bgp"
        advertise-label ipv4
        split-horizon
    exit
exit
no shutdown
-----
A:csc-ce-2>config>router>bgp#
```

Note the following about the BGP configuration of CSC-CE-2:

- The peer type is EBGP (**peer-as** is different from the locally configured **autonomous-system**).
- The transport for the EBGP session is IPv4 (the **neighbor** address is an IPv4 address).
- The **advertise-label ipv4** command causes MP-BGP negotiation of the address family for AFI=1 and SAFI=4 (IPv4 NLRI with MPLS labels).
- The **split-horizon** command is optional. It prevents a best BGP route from the CSC-PE peer from being re-advertised back to that peer.
- The **export** command applies a BGP export policy to the session. The configuration of the policy is shown below:

```
A:csc-ce-2>config>router>policy-options# info
-----
    prefix-list "system-ip"
        prefix 192.0.2.2/32 exact
    exit
    policy-statement "static-to-bgp"
        entry 10
            from
                protocol direct
                prefix-list "system-ip"
            exit
            action accept
            exit
        exit
        default-action reject
    exit
-----
A:csc-ce-2>config>router>policy-options#
```

The effect of the BGP export policy is to advertise the system IP address of CSC-CE-2 as a labelled-IPv4 BGP route towards CSC-PE-2.

Step 9. Verify exchange of routes between CSC-PE-2 and CSC-CE-2.

When the preceding steps have been completed properly CSC-PE-2 should now be advertising the labelled-IPv4 route for 192.0.2.1/32 to CSC-CE-2. This can be checked from the perspective of CSC-PE-2 as shown below:

```
A:csc-pe-2# show router 1 bgp routes ipv4 192.0.2.1/32 hunt
=====
BGP Router ID:192.0.2.252      AS:64511      Local AS:64511
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
Origin codes  : i - IGP, e - EGP, ? - incomplete, > - best, b - backup
=====
BGP IPv4 Routes
=====
RIB In Entries
-----
RIB Out Entries
-----
Network       : 192.0.2.1/32
Nexthop       : 192.168.2.1
Path Id       : None
To            : 192.168.2.2
Res. Nexthop  : n/a
Local Pref.   : n/a
Aggregator AS : None
Atomic Aggr.  : Not Atomic
AIGP Metric   : None
Connector     : None
Community     : target:64511:1
Cluster       : No Cluster Members
Originator Id : None
IPv4 Label    : 262139
Origin        : IGP
AS-Path       : 64511 64511
Neighbor-AS   : 64511
Interface Name : NotAvailable
Aggregator    : None
MED           : None
Peer Router Id : 192.0.2.2

Routes : 1
=====
A:csc-pe-2#
```

Note that CSC-PE-2 has advertised a label value of 262139 with the prefix.

The following output shows the received route from the perspective of CSC-CE-2:

```
A:csc-ce-2# show router bgp routes ipv4 192.0.2.1/32 hunt
=====
BGP Router ID:192.0.2.2      AS:64496      Local AS:64496
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
Origin codes  : i - IGP, e - EGP, ? - incomplete, > - best, b - backup
```

Configuration

```
=====
BGP IPv4 Routes
=====
-----
RIB In Entries
-----
Network       : 192.0.2.1/32
NextHop       : 192.168.2.1
Path Id       : None
From          : 192.168.2.1
Res. NextHop  : 192.168.2.1
Local Pref.   : None
Aggregator AS : None
Atomic Aggr.  : Not Atomic
AIGP Metric   : None
Connector     : None
Community     : target:64511:1
Cluster       : No Cluster Members
Originator Id : None
Fwd Class     : None
IPv4 Label    : 262139
Flags         : Used Valid Best IGP
Route Source  : External
AS-Path       : 64511 64511
Neighbor-AS   : 64511
Interface Name : int-csc-ce-2-to-csc-p*
Aggregator     : None
MED            : None
Peer Router Id : 192.0.2.252
Priority       : None
-----
RIB Out Entries
-----
Routes : 1
=====
* indicates that the corresponding row element may have been truncated.
A:csc-ce-2#
```

Also note the label swap entries that BGP programmed in the line cards of CSC-PE-2 based on the received VPN-IPv4 routes from CSC-PE-1 (Label Origin = Internal) and the advertised labelled-IPv4 routes to CSC-CE-2:

```
A:csc-pe-2# show router 1 bgp inter-as-label
=====
BGP Inter-AS labels
=====
NextHop                Received      Advertised    Label
                        Label          Label         Origin
-----
192.0.2.251            262140        262139        Internal
192.0.2.251            262142        262138        Internal
-----
Total Labels allocated:  2
=====
A:csc-pe-2#
```

In the above output the first entry for NextHop 192.0.2.251 corresponds to the prefix 192.0.2.1/32; recall from Step 7 that CSC-PE-2 received the VPN-IPv4 route with label value 262140 and it can be seen from this step that it re-advertised the route to CSC-CE-2 with label value 262139.

Step 10. Setup BGP session between CSC-CE-1 AND CSC-CE-2.

The final step in the setup of the CSC solution shown in Figure 1 is the creation of a BGP session between CSC-CE-1 and CSC-CE-2 so that they can exchange routes belonging to VPN services they support. The configuration of this BGP session from the perspective of CSC-CE-1 is shown below:

```
*A:csc-ce-1>config>router>bgp# info
-----
      group "csc-ce"
        peer-as 64496
        neighbor 192.0.2.2
          family vpn-ipv4
        exit
      exit
      no shutdown
-----
*A:csc-ce-1>config>router>bgp#
```

The configuration of the BGP session from the perspective of CSC-CE-2 is very similar, as shown below.

```
A:csc-ce-2>config>router>bgp# info
-----
      group "csc-ce"
        peer-as 64496
        neighbor 192.0.2.1
          family vpn-ipv4
        exit
      exit
      no shutdown
-----
A:csc-ce-2>config>router>bgp#
```

Note the following about the configuration of the BGP session between CSC-CE-1 and CSC-CE-2:

- The peer type is IBGP (**peer-as** is the same as the locally configured **autonomous-system**).
- The transport for the IBGP session is IPv4 (the **neighbor** address is an IPv4 address).
- The **family vpn-ipv4** command causes MP-BGP negotiation of the address family for AFI=1 and SAFI=128.

Step 11. Verify exchange of routes between CSC-CE-1 and CSC-CE-2.

When the preceding steps have been completed properly CSC-PE-2 should now be able to advertise a VPN-IPv4 route for some IP prefix (for example 10.14.30.0/24) to CSC-CE-2. This can be checked from the perspective of CSC-CE-2 as shown below:

```
A:csc-ce-2# show router bgp routes vpn-ipv4 10.14.30.0/24 hunt
=====
BGP Router ID:192.0.2.2      AS:64496      Local AS:64496
=====
Legend -
Status codes  : u - used, s - suppressed, h - history, d - decayed, * - valid
Origin codes  : i - IGP, e - EGP, ? - incomplete, > - best, b - backup
=====
BGP VPN-IPv4 Routes
=====
RIB In Entries
-----
Network       : 10.14.30.0/24
Nextthop      : 192.0.2.1
Route Dist.   : 64496:1          VPN Label      : 262143
Path Id       : None
From          : 192.0.2.1
Res. Nextthop : n/a
Local Pref.   : 100              Interface Name  : NotAvailable
Aggregator AS : None            Aggregator     : None
Atomic Aggr.  : Not Atomic      MED            : None
AIGP Metric   : None
Connector     : None
Community     : target:64496:1
Cluster       : No Cluster Members
Originator Id : None            Peer Router Id  : 192.0.2.1
Fwd Class     : None            Priority        : None
Flags         : Used Valid Best IGP
Route Source  : Internal
AS-Path       : No As-Path
Neighbor-AS   : N/A
VPRN Imported : 1
-----
RIB Out Entries
-----
Routes : 1
=====
A:csc-ce-2#
```

It is also possible to check that CSC-CE-2 has properly installed the above VPN-IPv4 route into the routing table of the importing VPRN service, as shown below.

```
A:csc-ce-2# show router 1 route-table
=====
Route Table (Service: 1)
=====
Dest Prefix[Flags]                Type      Proto      Age          Pref
```



```
Next Hop[Interface Name]                               Metric
-----
10.14.30.0/24                                           Remote BGP VPN 00h03m33s 170
    192.0.2.1 (tunneled)                                0
-----
```

```
No. of Routes: 1
Flags: n = Number of times nexthop is repeated
      B = BGP backup route available
      L = LFA nexthop available
```

```
=====
A:csc-ce-2#
```

Conclusion

Carrier Supporting Carrier is a scalable and secure solution for using an infrastructure IP VPN to transport traffic between dispersed CSC-CE devices belonging to an ISP or other service provider. Many different topology models are supported by the 7x50. This guide has explored one simplified configuration that can serve as the basis for more complicated setups.