



# MPLS Support on UPF

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## Feature Summary and Revision History

### Summary Data

*Table 1: Summary Data*

Applicable Product (s) or Functional Area	5G-UPF
Applicable Platforms	VPC-SI
Feature Default Setting	Disabled – Configuration Required
Related Changes in this Release	Not Applicable
Related Documentation	<i>UCC 5G UPF Configuration and Administration Guide</i>

### Revision History

Revision Details	Release
Added MPLS support over the N6 interface.	2023.01.0
First introduced.	2022.04.0

## Feature Description

In UPF, the boxer supports MPLS on the existing platforms (VPC-DI and ASR 5500) to switch MPLS traffic using VPP as the data plane forwarder. This feature supports MPLS on the N6 interface using VPP for 5G deployments.

In ASR 5500, the NP4c network processor generates and processes MPLS traffic. In VPC-DI, IFTask generates and processes MPLS traffic.

VPC-SI uses VPP as the data plane forwarder. VPP supports and provides multiple data plane features that include the MPLS stack as a separate graph node. VPP encapsulates and decapsulates subscriber traffic with MPLS labels. This feature helps to differentiate between different customer VRFs and support many corporate APNs having different addressing models and requirements.

UPF supports the following functionalities for MPLS:

- Uses the VPP MPLS stack to send the MPLS labeled packet.
- Uses the VPP MPLS stack to process the incoming labeled MPLS packet.
- Uses only MP-BGP as the label distribution protocol.
- VPPCTL CLI commands display the FTN, FIB, and ILM tables that are in VPP, for debugging and comparing values with boxer configuration.

## How it Works

This section briefly describes how the MPLS Support for UPF works.

The VPP forwarder provides its own MPLS stack, which supports all existing functionalities for MPLS packet processing. The VPP MPLS stack is configured with the appropriate FTN (FEC To NHLFE), forwarding information base (FIB), and incoming label map (ILM) tables. This generates the MPLS packet on the egress with the correct MPLS header. It also processes the incoming MPLS packet and switches the packet based on the incoming label to the appropriate VRF table.

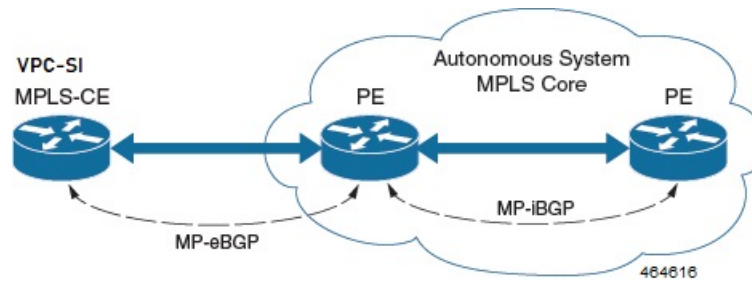
VPC-SI also supports VPNv6 as described in RFC 4659 – *BGP-MPLS IP Virtual Private Network (VPN) Extension for IPv6 VPN*.

## MPLS-CE Connected to PE

The VPC-SI functions as an MPLS-CE (Customer Edge) network element connected to a Provider Edge (PE) Label Edge Router (LER), which in turn connects to the MPLS core as per RFC 4364.

The following figure illustrates the MPLS-CE to PE connection:

Figure 1: VPC-SI MPLS-CE to PE



The MPLS-CE functions like a PE router within its own Autonomous System (AS). It maintains Virtual Routing and Forwarding (VRF) routes and exchanges VPN route information with the PE through an MP-eBGP (Multi Protocol external BGP) session.

The PE is also configured with VRFs and exchanges VPN routes with other PEs in its AS through MP-iBGP (Multi Protocol internal BGP) connection and MPLS-CE through an MP-eBGP connection.

The EBGP connection allows the PE to change next-hop IP addresses and labels in the routes learnt from IBGP peers before advertising them to the MPLS-CE. The MPLS-CE uses only MP-eBGP to advertise and learn routes. Label Distribution Protocol (LDP) and Resource Reservation Protocol (RSVP) are not required because of direct-connect EBGP peering. The MPLS-CE pushes or pops a single label (learnt over the MP-eBGP connection) to or from the PE.

## Sample Configuration

The following is a sample configuration to configure the basic MPLS feature on UPF:

```
context ISP
  ip vrf MPN00001
    ip maximum-routes 100
  #exit
mpls bgp forwarding
router bgp 64455
  neighbor 172.31.35.29 remote-as 65200
  neighbor 172.31.35.29 timers keepalive-interval 60 holdtime-interval 300
  neighbor 172.31.35.29 update-source 172.31.35.4
  neighbor 172.31.35.29 fall-over bfd
  neighbor 172.31.35.29 srp-activated-soft-clear
  address-family ipv4
    redistribute connected
    redistribute static
  #exit
  address-family vpnv4
    neighbor 172.31.35.29 activate
    neighbor 172.31.35.29 send-community extended
  #exit
  address-family vpnv6
    neighbor 172.31.35.29 activate
    neighbor 172.31.35.29 send-community extended
  #exit
  address-family ipv6
    redistribute connected
    redistribute static
  #exit
  ip vrf MPN00001
    route-distinguisher 64455 11100001
    route-target both 64455 11100001
```

```

#exit
address-family ipv4 vrf MPN00001
  redistribute connected
#exit
address-family ipv6 vrf MPN00001
  redistribute connected
#exit
interface N6-11
  ip address 172.31.35.4 255.255.255.224
  ip mtu 1504
  bfd interval 999 min_rx 999 multiplier 3
#exit
interface N6-12
  ip address 172.31.35.35 255.255.255.224
  ip mtu 1504
  bfd interval 999 min_rx 999 multiplier 3
#exit
interface loop_MPN00001 loopback
  ip vrf forwarding MPN00001
  ip address 2.2.4.2 255.255.255.255
#exit

```

## VPN-related CLI Commands

UPF supports the VPN-related features and functions across several CLI command modes. The following tables identify commands associated with configuration and monitoring of VPN-related functions.

**Table 2: VPN-Related Configuration Commands**

CLI Mode	Command	Description
BGP Address-Family (IPv4/IPv6) Configuration Mode	<b>neighbor <i>ip_address</i> activate</b>	Enables the exchange of routing information with a peer router.
BGP Address-Family (IPv4/IPv6) Configuration Mode	<b>neighbor <i>ip_address</i> send community { both   extended   standard }</b>	Sends the community attributes to a peer router (neighbor).
BGP Address-Family (IPv4/IPv6) Configuration Mode	<b>redistribute connected</b>	Redistributes routes into BGP from another protocol as BGP neighbors.
BGP Address-Family (VPNv4) Configuration Mode	<b>neighbor <i>ip_address</i> activate</b>	Enables the exchange of routing information with a peer router.
BGP Address-Family (VPNv4) Configuration Mode	<b>neighbor <i>ip_address</i> send community { both   extended   standard }</b>	Sends the extended-community attribute to a peer router. In VPN, route-distinguisher and route-target are encoded in the BGP extended-community. This command sends BGP routes with the extended community to a neighbor.
BGP Address-Family (VRF) Configuration Mode	<b>neighbor <i>ip_address</i> activate</b>	Enables the exchange of routing information with a peer router.

CLI Mode	Command	Description
BGP Address-Family (VRF) Configuration Mode	<b>neighbor</b> <i>ip_address</i> <b>send community</b> { <b>both</b>   <b>extended</b>   <b>standard</b> }	Sends the extended-community attribute to a peer router. In VPN, route-distinguisher and route-target are encoded in the BGP extended-community. This command sends BGP routes with the extended community to a neighbor.
BGP Address-Family (VRF) Configuration Mode	<b>redistribute connected</b>	Redistributes routes into BGP from another protocol as BGP neighbors.
BGP Configuration Mode	<b>address-family</b> { <b>ipv4 vrf</b> <i>vrf_name</i>   <b>vpn4</b> }	Enables the exchange of IPv4 VRF routing information. There is a different mode for each address-family.
BGP Configuration Mode	<b>address-family</b> { <b>ipv6 vrf</b> <i>vrf_name</i>   <b>vpn6</b> }	Configures a VPNv6 address family and IPv6 VRF routing in BGP.
BGP Configuration Mode	<b>ip vrf</b> <i>vrf_name</i>	Adds a VRF to BGP and switches to the VRF Configuration mode to allow configuration of BGP attributes for the VRF.
BGP IP VRF Configuration Mode	<b>route-distinguisher</b> { <i>as_value</i>   <i>ip_address</i> } <i>rd_value</i>	Assigns a Route Distinguisher (RD) for the VRF. The RD value must be a unique value on the router for each VRF.
BGP IP VRF Configuration Mode	<b>route-target</b> { <b>both</b>   <b>import</b>   <b>export</b> } { <i>as_value</i>   <i>ip_address</i> } <i>rd_value</i>	Adds a list of import and export route-target extended communities to the VRF.
Context Configuration Mode	<b>ip pool</b> <i>pool_name</i> <i>addr_range</i> <b>vrf</b> <i>vrf_name</i> [ <b>mpls-label input</b> <i>inlabel1</i> <b>output</b> <i>outlabel1</i> <i>outlabel2</i> ]	Configures a pool into the specified VRF. Specify this command with the Next-Hop parameter. <i>inlabel1</i> is the MPLS label that identifies inbound traffic destined for this pool. <i>outlabel1</i> and <i>outlabel2</i> specify the MPLS labels to be added to packets sent for subscribers from this pool.
Context Configuration Mode	<b>ip vrf</b> <i>vrf_name</i>	Creates a VRF and assigns a VRF-ID. A VRF is created in the router.

CLI Mode	Command	Description
Context Configuration Mode	<b>ipv6 pool</b> <i>pool_name</i> <b>vrf</b> <i>vrf_name</i>	Associates the pool with that VRF.  <b>Note:</b> By default the configured IPv6 pool is associated with the global routing domain.
Context Configuration Mode	<b>mpls bgp forwarding</b>	Globally enables MPLS Border Gateway Protocol (BGP) forwarding.
Context Configuration Mode	<b>mpls exp</b> <i>value</i>	Sets the default behavior as Best Effort using a zero value in the 3-bit MPLS EXP header. This value applies to all the VRFs in the context. The default behavior is to copy the DSCP value of mobile subscriber traffic to the EXP header, if there is no explicit configuration for DSCP to EXP (via the <b>mpls map-dscp-to-exp dscp n exp m</b> command).  <b>mpls exp</b> disables the default behavior and sets the EXP value to the configured <i>value</i> .
Context Configuration Mode	<b>mpls ip</b>	Globally enables the MPLS forwarding of IPv4 packets along normally routed paths.
Context Configuration Mode	<b>radius change-authorize-nas-ip</b> <i>ip_address</i> { <b>encrypted</b>   <b>key</b> } <i>value</i> <b>port</b> <i>port_num</i> <b>mpls input</b> <i>inlabel</i> <b>output</b> <i>outlabel1</i> <i>outlabel2</i>	Configures COA traffic to use the specified MPLS labels. <i>inlabel</i> identifies the inbound COA traffic. <i>outlabel1</i> and <i>outlabel2</i> specify the MPLS labels to add to the COA response. <i>outlabel1</i> is the inner output label and <i>outlabel2</i> is the outer output label.
Ethernet Interface Configuration Mode	<b>mpls ip</b>	Enables dynamic MPLS forwarding of IP packets on this interface.
Exec Mode	<b>clear ip bgp peer</b>	Clears BGP sessions.

Table 3: VPN-Related Monitoring Commands

CLI Mode	Command	Description
Exec Mode show Commands	<b>show ip bgp neighbors</b>	Displays information regarding BGP neighbors.

CLI Mode	Command	Description
Exec Mode show Commands	<b>show ip bgp vpnv4 { all   route-distinguisher   vrf }</b>	Displays all VPNv4 routing data, routing data for a VRF or a route-distinguisher.
Exec Mode show Commands	<b>show ip bgp vpnv6</b>	Displays contents of VPNv6 routing table.
Exec Mode show Commands	<b>show ip bgp vpnv6 { all   route-distinguisher   vrf }</b>	Displays all VPNv6 routing data, routing data for a VRF or a route-distinguisher.
Exec Mode show Commands	<b>show ip fib table-id table_id</b>	Displays information for FIB table.
Exec Mode show Commands	<b>show ip pool</b>	Displays pool details including the configured VRF.
Exec Mode show Commands	<b>show mpls cross-connect</b>	Displays MPLS cross-connect information. MPLS tunnel cross-connects between interfaces and Label-Switched Paths (LSPs). LSP connects two distant interface circuits of the same type through MPLS tunnels.
Exec Mode show Commands	<b>show mpls fib table table_id</b>	Displays MPLS forwarding information base (FIB) table information.
Exec Mode show Commands	<b>show mpls ftn [ vrf vrf_name ]</b>	Displays MPLS FEC-to-NHLFE (FTN) table information.
Exec Mode show Commands	<b>show mpls ftn [ vrf vrf_name ]</b>	Displays the contents of the MPLS FTN table for a specified VRF.
Exec Mode show Commands	<b>show mpls ilm [ all   label label_value ]</b>	Displays MPLS Incoming Label Map (ILM) table information.
Exec Mode show Commands	<b>show mpls nexthop-label-forwarding-entry</b>	Displays MPLS Next-Hop Label Forwarding Entry (NHLFE) table information.

## Monitoring and Troubleshooting

This section provides information regarding the CLI command to monitor and troubleshoot the feature.

### Show Commands and Outputs

This section provides information regarding show commands and their outputs in support of this feature.

## show mpls ftn vpp

The output of this CLI command contains the "vpp" field for the MPLS Support on UPF feature.

This field displays the configured VPP dataplane values in the VPP dataplane forwarder. Use this command for debugging purposes.

- vpp
  - all-vrf
  - summary
  - vrf