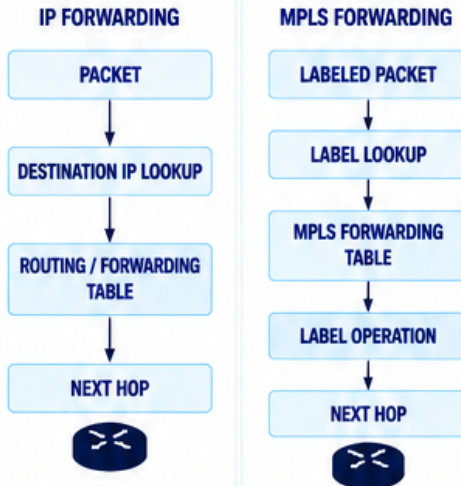


MPLS QUICK FACTS

Feature	MPLS
 Full Name	Multiprotocol Label Switching
 Main Idea	Label-Based Forwarding
 Traffic Group	FEC
 Forwarding Path	LSP
 Edge Router	LER
 Core Router	LSR
 Label Entry	32 Bits

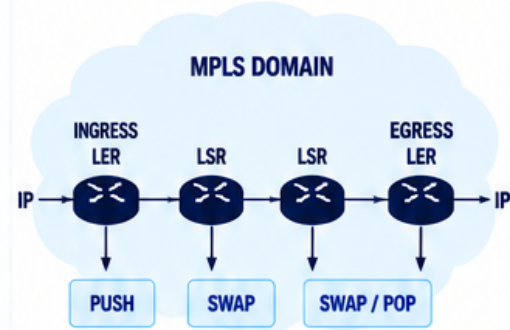
MPLS forwards packets across an MPLS domain using short labels rather than relying only on an IP lookup at every hop.

IP FORWARDING vs MPLS FORWARDING



Inside the MPLS domain, labeled packets are normally forwarded according to their labels.

MPLS DOMAIN



The ingress LER adds MPLS forwarding information. Intermediate LSRs switch labels. The label is removed before or at the egress, depending on the forwarding behavior.

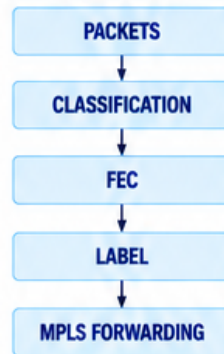
LER vs LSR

Device	Function
Ingress LER	Classifies Traffic & Pushes Label
LSR	Swaps / Forwards Labels
Egress LER	Removes Label & Forwards Packet



FORWARDING EQUIVALENCE CLASS (FEC)

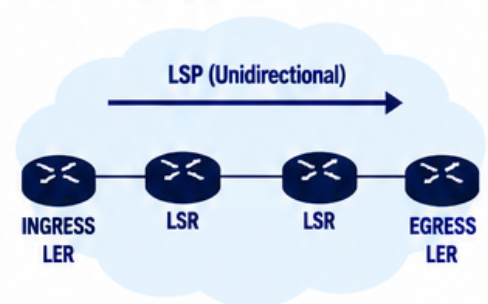
A Forwarding Equivalence Class (FEC) is a group of packets that receive equivalent forwarding treatment.



At the ingress, packets are classified into a FEC and mapped to appropriate label forwarding information.

LABEL SWITCHED PATH (LSP)

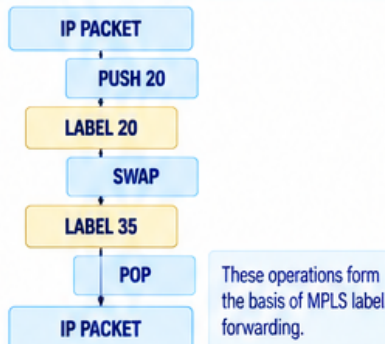
A Label Switched Path (LSP) is the path followed by labeled traffic through an MPLS network.



An LSP is unidirectional. Traffic in the opposite direction uses a separately established forwarding path.

MPLS LABEL OPERATIONS

Operation	Function
PUSH	Add Label
SWAP	Replace Top Label
POP	Remove Top Label



MPLS LABEL STACK ENTRY

Each MPLS label stack entry is 32 bits.

	20 BITS	3 BITS	1 BIT	8 BITS
	LABEL	TC	S	TTL
Field	Size	Function		
Label	20 bits	Label Value		
TC	3 bits	Traffic Class		
S	1 bit	Bottom of Stack		
TTL	8 bits	Time to Live		

The label stack entry is inserted between the Layer 2 header and the carried network-layer packet.

LABEL STACK

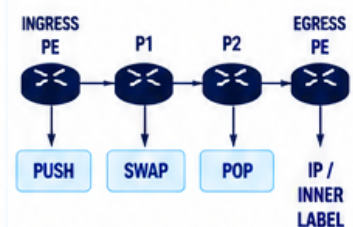
MPLS supports multiple labels on the same packet.



The router processes the top label first. The S bit identifies whether a label is the bottom label in the MPLS label stack. Multiple labels are important for services such as MPLS VPNs.

PENULTIMATE HOP POPPING

The router immediately before the egress can remove the transport label.



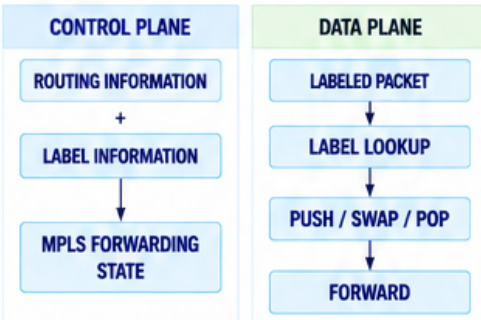
This behavior is known as Penultimate Hop Popping (PHP). It can reduce label-processing work at the egress router.

MPLS FORWARDING FLOW



MPLS CONTROL & DATA PLANE

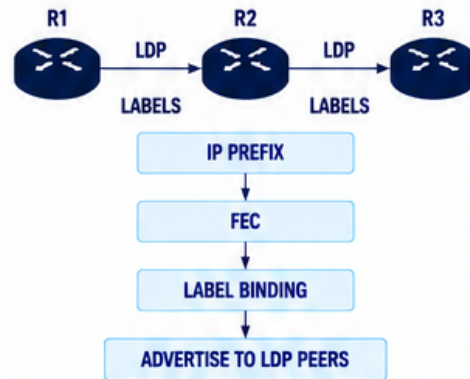
MPLS requires forwarding information to be established before labeled traffic can cross the network.



The control plane builds the information used by the MPLS data plane.

LABEL DISTRIBUTION PROTOCOL (LDP)

LDP is commonly used to distribute labels for IGP-learned prefixes.



Routers advertise label bindings to LDP peers. LDP commonly follows the path selected by the underlying IGP.

IGP + LDP

The IGP and LDP perform different jobs.

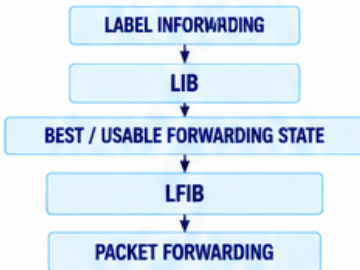
Protocol / Function	Purpose
OSPF / IS-IS	Determine IP Reachability & Best Paths
LDP	Distribute Label Bindings
MPLS Data Plane	Forward Labeled Packets



The IGP establishes reachability; LDP distributes labels associated with FECs.

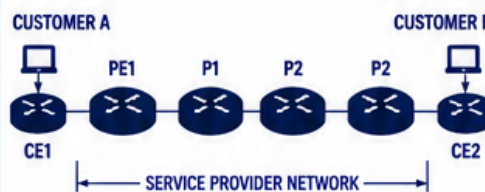
LIB vs LFIB

Table	Purpose
LIB	Label Information Base
LFIB	Label Forwarding Information Base



The LIB contains label bindings learned or generated by the router. The LFIB contains the label forwarding information used in the data plane.

MPLS SERVICE PROVIDER ROUTERS

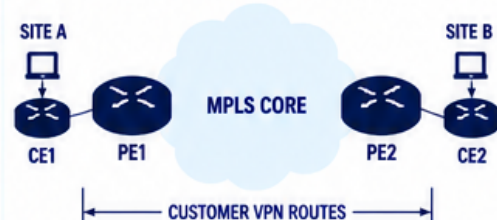


Router	Role
CE	Customer Edge
PE	Provider Edge
P	Provider Core

CE routers connect customer networks to the provider. PE routers provide customer-facing MPLS services. P routers primarily provide transport across the MPLS core.

MPLS L3VPN CONCEPT

MPLS L3VPN allows a service provider to carry separate customer Layer 3 routing information across a shared MPLS backbone.

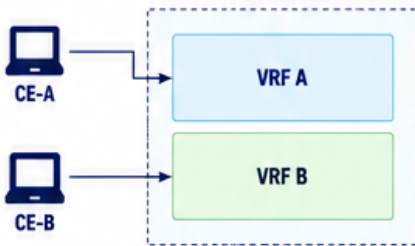


PE routers maintain customer-specific routing information. Core P routers do not need to maintain individual customer VPN routes.

VRF (VIRTUAL ROUTING AND FORWARDING)

A VRF provides a separate routing context on a PE router.

PE ROUTER



Different customers can use overlapping IP address spaces because their routes are maintained in separate VRFs.

RD vs RT

RD and RT have different purposes in MPLS L3VPN.

Feature	Purpose
RD	Makes VPN Routes Unique
RT	Controls VPN Route Import / Export

RD

IPv4 PREFIX

UNIQUE VPNv4 ROUTE

RT

VPN ROUTE

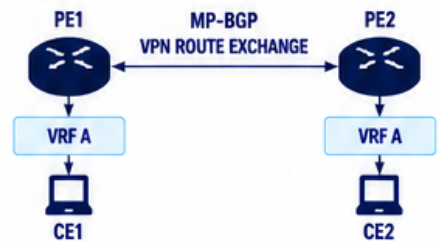
IMPORT / EXPORT POLICY

VRF

RD = Route Distinguisher
RT = Route Target
An RD provides uniqueness; it does not itself determine which VRFs receive a route.

MP-BGP IN MPLS L3VPN

MP-BGP is used between PE routers to exchange VPN routing information.



MP-BGP carries VPN routes and associated VPN information between provider edge routers. The MPLS core then provides transport between the PE routers.

TWO-LABEL FORWARDING

MPLS L3VPN traffic commonly uses a label stack.

TRANSPORT LABEL	Label	Purpose
VPN LABEL	Outer / Transport Label	Reach Remote PE
IP PACKET	Inner / VPN Label	Identify VPN Forwarding Context

Core P routers generally forward using the outer transport label without needing customer VPN routes.

MPLS L3VPN FLOW



MPLS APPLICATIONS

Application	Purpose
MPLS L3VPN	Layer 3 VPN Services
MPLS L2VPN	Layer 2 VPN Services
Traffic Engineering	Traffic Path Engineering
QoS Integration	Differentiated Traffic Treatment

MPLS provides forwarding and service separation mechanisms, but MPLS itself does not encrypt customer traffic. Encryption, when required, must be provided separately.