Cours N°7 MPLS :

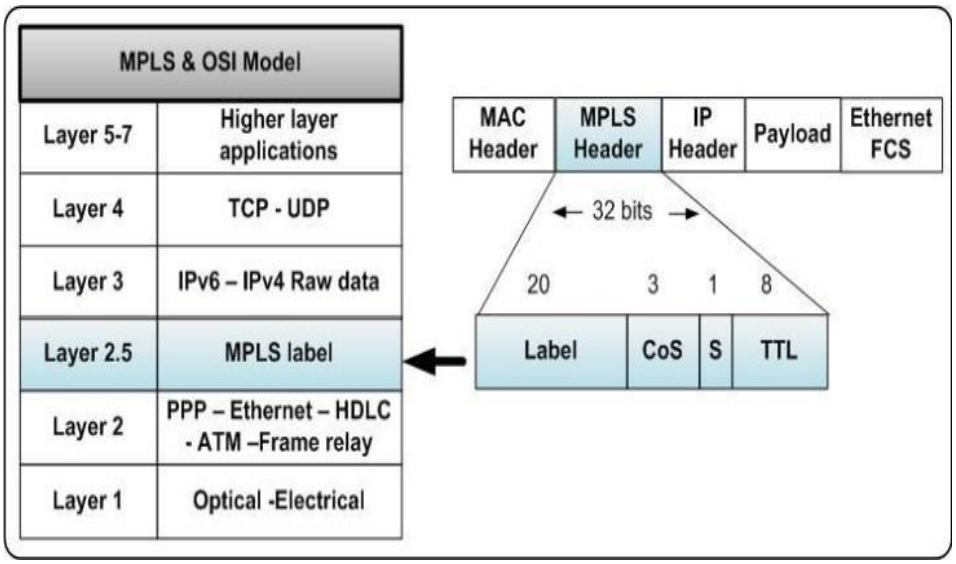
Definition

MPLS or Multi-Protocol Label Switching is a network technology that has powered enterprise networks for over three decades. Unlike other network protocols that route traffic based on source and destination address, MPLS routes traffic based on predetermined “labels”. Businesses use MPLS to connect remote branch offices that require access to data or applications that reside in the organization's data center or company head office.

There’s been some confusion about whether MPLS is a Layer 2 or Layer 3 service. But MPLS doesn’t fit neatly into the OSI seven-layer hierarchy. But if we want to classify it, we can tell it is a Layer 2.5, meaning it falls between Layer 2 (Data Link) and Layer 3 (Network) of the OSI seven-layer.

Layer 2, or the Data Link Layer, carries IP packets over simple LANs or point-to-point WANs. Layer 3, or the Network Layer, uses internet-wide addressing and routing using IP protocols. MPLS sits in between these two layers, with additional features for data transport across the network.

MPLS works by labeling data packets with a short label that is used to identify the path that the data should take. This allows for the data to be routed quickly and efficiently, and it also provides a high level of security by allowing for the creation of private networks.



What Is MPLS Used For ?

MPLS works by assigning a label to each data packet that enters the network. The label is used to identify the packet and direct it to its destination through a series of pre-determined routes. This allows for faster and more efficient routing of data packets, as well as the ability to prioritize traffic and optimize network performance.

MPLS provides enhanced security features by allowing for the creation of virtual private networks (VPNs), which enable secure communication between geographically dispersed locations. Additionally, It can be used to support quality of service (QoS) guarantees, which ensure that high-priority traffic is given priority over lower-priority traffic.

Benefits of MPLS

MPLS is a highly efficient protocol that allows for data to be routed quickly and securely. It is also very reliable, as it allows for the creation of private networks that are not affected by external traffic or congestion. However, it does not provide encryption. Although it is a VPN, it is isolated from the public internet. It also allows for Quality of Service (QoS) to be applied to data packets.

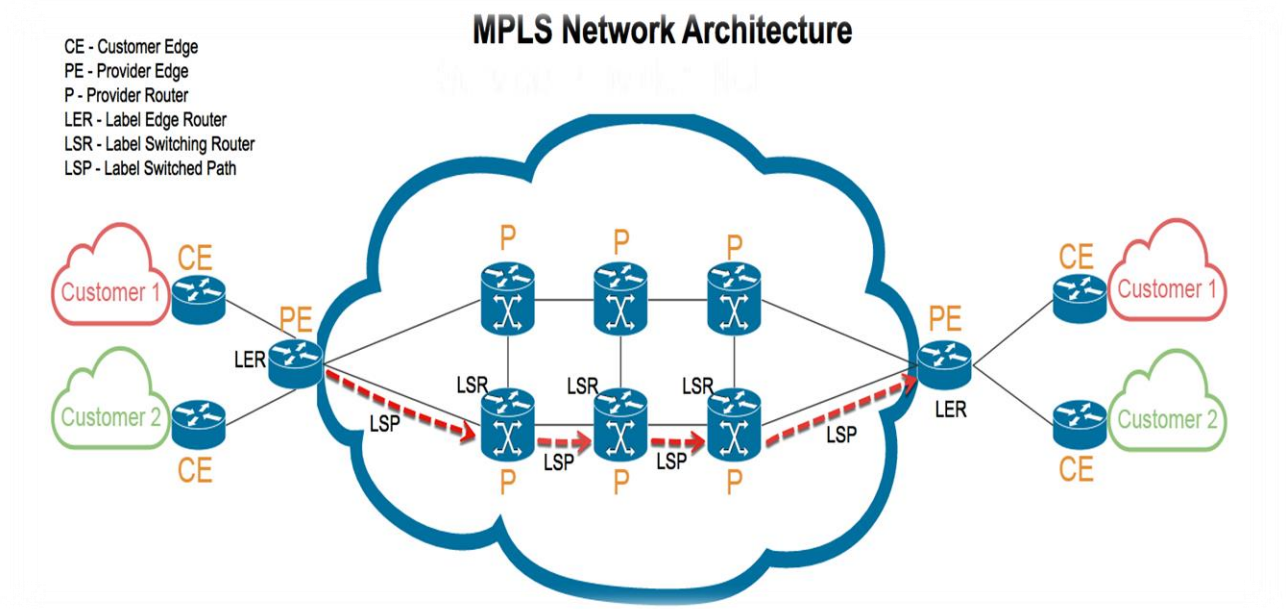
MPLS also provides a high level of scalability, as it can be used to connect different networks of any size. This makes it a great choice for large organizations that need to securely connect multiple locations.

Drawbacks of MPLS

MPLS can be expensive to implement, as it requires specialized hardware and software. Additionally, it can be difficult to troubleshoot and diagnose network issues, as the labels used to identify data packets may not be visible to the users. MPLS also requires a high level of technical expertise to configure and to maintain.

Important terms to know

Terms	Description
FEC	Forwarding Equivalence Class : A collection of packets with the same characteristics. FECs can be identified by the source address, destination address, source port, destination port, and VPN.
PE	Provider Edge : Router at edge of MPLS network that add or remove label from IP packet.
CE	Customer Edge : Router at edge of customer network that send or receive IP packet from PE.
LSR	Label Switch Router : Routers used in MPLS network that can understand labels.
Ingress LSR	LSR routers that receive IP packet from CE Routers and add MPLS header.
Intermediate LSR	LSR routers that swap label in MPLS header and assigned for forwarding labeled IP packet.
Egress LSR	LSR routers that send IP packet to CE routers and removes MPLS header.
Push, Pop and Swap	Action of addition, removal and swapping of labels by LSR respectively.

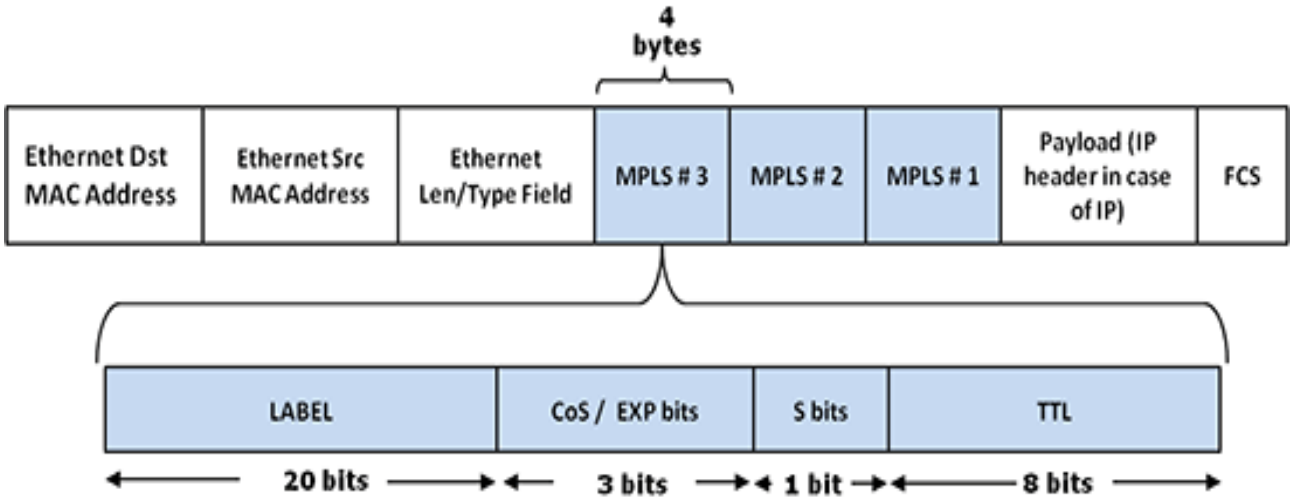


MPLS Label

A label is a short, fixed-length (4 bytes) identifier that is only locally significant. A label identifies a FEC to which a packet belongs.

Compared to an IP packet, an MPLS packet has an additional 4-bytes. The MPLS label is between the link layer header and the network layer header.

The MPLS header is divided into four parts: Label, Exp, S, TTL



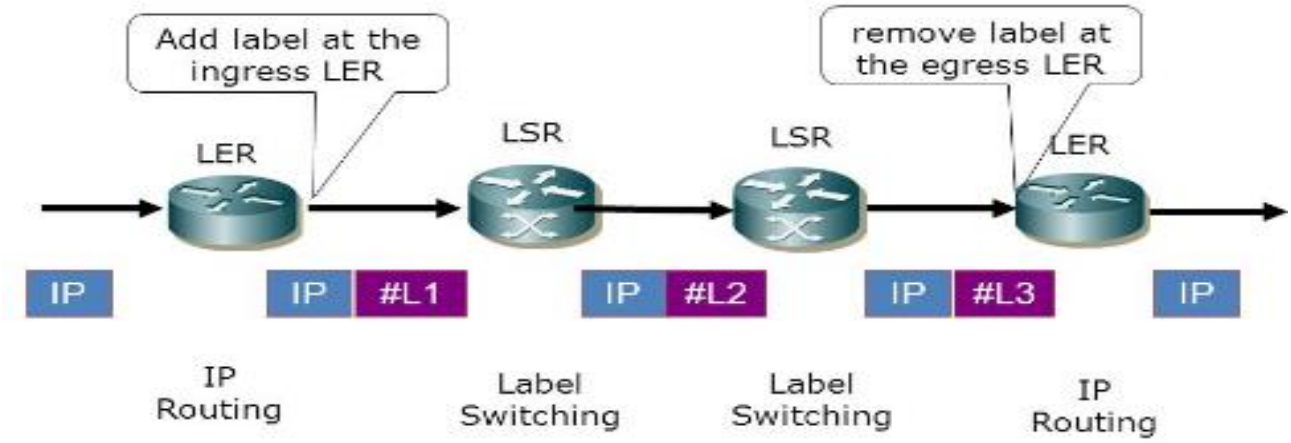
Label: 20-bit label value.

Exp: 3-bit, used as an extension value. Generally, this field is used as the class of service (CoS) field. When congestion occurs, devices prioritize packets that have a larger value in this field.

Bottom of stack (S): 1-bit value indicating the bottom of a label stack. If there is only one label remained in MPLS header, then its value is 1 otherwise 0.

TTL: Time To Live. 8-bit field is the same as the TTL field in IP packets.

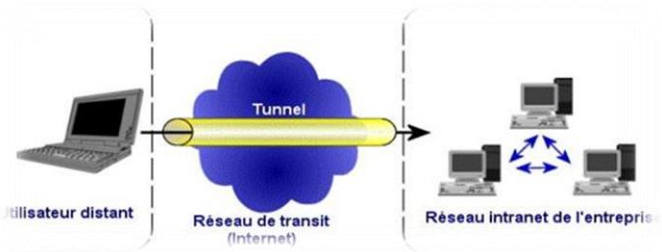
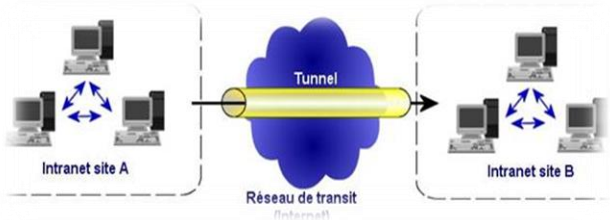
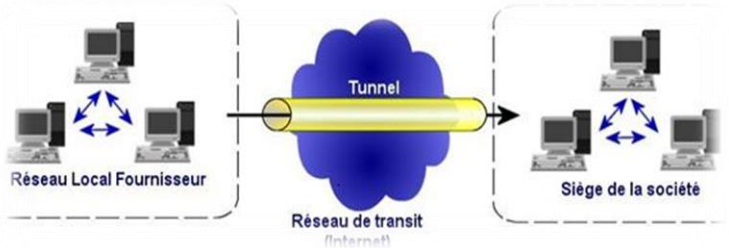
Forwarding in MPLS



PEs receive IP packet from CE and add an MPLS header in between layer 3 and layer 2. This feature allows LSRs to support receiving packets containing frames from different layer 2 protocols, that's why it is called multi-protocol.

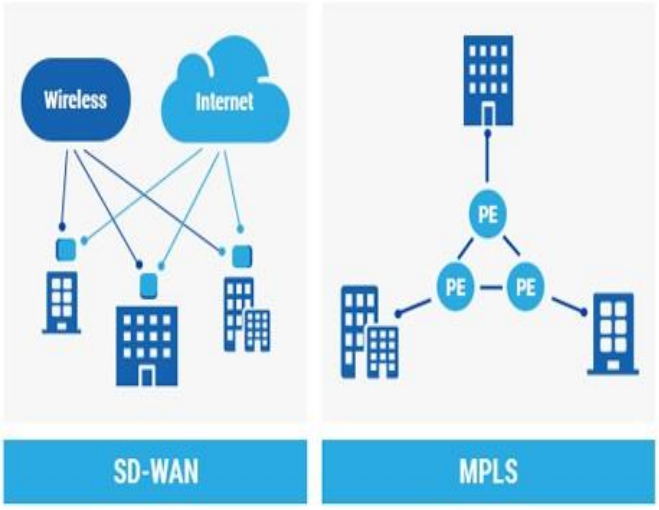
MPLS forwarding is based on label attached to IP packet. This label attachment is regulated by protocol called Label Distribution Protocol (LDP).

MPLS vs VPN

Remote User	
Intranet	
Extranet	

Parameters	VPN	MPLS
OSI Layer	Works on up to Layer 7	Works between Layer 2 and Layer 3
Encryption	Use encryption	Do not need encryption
Cost	Low	High
Traffic Prioritization	Not possible	Possible
Multicast Support	Not supported on IPsec VPN	Support multicast traffic
Target Customers	Suitable for small to medium sized enterprises	Suitable for large-size enterprises
Cloud Based Services	A wide range of Cloud-based services are available for customers over the Internet using VPN-based connectivity	Limited availability of Cloud-based services for customers over MPLS

MPLS vs SD-WAN



SD-WAN (Software-Defined Wide Area Network) is a technology that uses software to dynamically manage and optimize network connectivity across multiple sites, leveraging various transport methods like broadband, cellular, and MPLS to improve performance, reliability, and cost-effectiveness.

MPLS networks require meticulous route configuration and inflexible circuit setup, making modifications challenging. However, once deployed, these networks provide reliable, high-performance routing for time-sensitive traffic. While many network professionals view MPLS and SD-WAN as competing technologies, SD-WAN offers a more cost-effective alternative to MPLS, with significantly lower deployment and operational expenses.

	MPLS	SD-WAN
Medium	Hardware	Software
Type of Network	Dedicated hardline	Virtual network
Data	High speed at a price but lower data loss.	Cost-effective but can suffer from network congestion and packet loss.
ISP Transport types	Limited	Limitless, including MPLS