MPLS

Multiprotocol Label Switching

MPLS: A Packet forwarding technology for the next generation Internet

It is the latest technique that provides virtual path capability to packet(label) switches.

Requirements for the Next Generation Internet forwarding

- Characteristics for QoS support
  - Low latency: Low forwarding overhead.
  - Low jitter: Consistent forwarding overhead, Predictable and consistent transit time.
- Ability to distinguish “flows” or bundle of flows and route them through different routes (called traffic engineering).

Background:

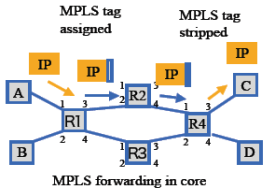
- A number of different technologies were previously deployed with essentially identical goals, such as frame relay and ATM.
- MPLS is now replacing these technologies in the marketplace, mostly because it is better aligned with current and future technology needs.

- MPLS was originally proposed by a group of engineers from CISCO Systems Inc,
- It was called "Tag Switching" when it was a Cisco proprietary proposal,
- It was renamed "Label Switching" when it was handed over to the IETF for open standardization.

- MPLS operates at an OSI Model layer that is generally considered to lie between traditional definitions of Layer 2 (data link layer) and Layer 3 (network layer), and thus is often referred to as a "Layer 2.5" protocol.

- It was designed to provide a unified data-carrying service for both circuit-based clients and packet-switching clients which provide a datagram service model.
- It can be used to carry many different kinds of traffic, including IP packets, as well as native ATM, SONET, and Ethernet frames.

MPLS core, IP interface



MPLS forwarding in core

The **External Border Gateway Protocol (EBGP)** is the core routing protocol of the Internet. It works by maintaining a table of IP networks or 'prefixes' which designate network reachability.

Hop-by-hop or source routing to establish labels

Potential advantages:

- Packet forwarding can be faster
- Can use more complex routing decisions
- Can force packets to followed a pinned route

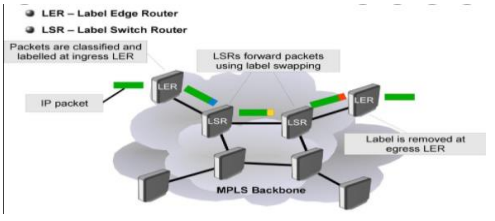
MPLS IN SUPPORT OF QOS

Two types of routers are defined in an MPLS network, namely the Label Edge Router (LER) and the Label Switch Router (LSR).

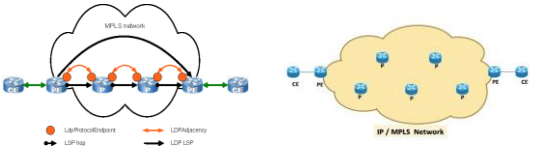
LERs reside on the edge of the MPLS network while LSRs reside in the core of the network.

When a packet enters an MPLS network, a label will be assigned to it based on the packet's Forwarding Equivalency Class (FEC).

A FEC could be the source IP address, the destination IP address



- MPLS uses an underlying routing mechanism (static route or dynamic routes set up by routing protocols)
- To identify the individual hops in the Label Switched Paths (LSPs) and; uses signaling protocols like Label Distribution Protocol (LDP).



CE - Customer Edge
PE - Provider Edge – Runs IP and MPLS
P – Runs only an MPLS

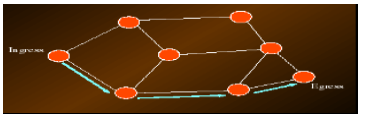
MPLS Basics:

MPLS does label switching.
Each IP flow is assigned a label.
Then these flows are sent through a predefined path called ***Label Switched Path (LSP).***
Each router forwards the packets based on the label not on Destination IP address.

Here the packets are sent from the sourse router Ingress to the Destination router Egress.
Each router in LSP adds the MPLS header to the packets and forwards it .

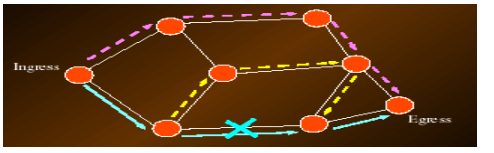
Note that the forwarding to the next route in LSP is based on label not on IP Address.

Here is a simple LSP :-

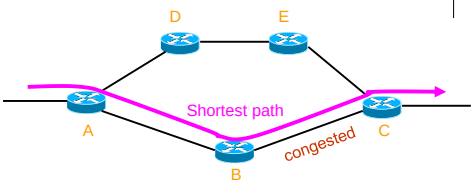


Fault Tolerance : MPLS Path Recovery

- Suppose There is a link failure ,as shown in figure, on the path from ingress router to egress router then there are 2 ways of replacing it.



Shortest Path Routing Problem



- RIP/OSPF selects A-B-C as the shortest path from A to C, although B-C is congested.

Tools to Improve the Internet

- Superior routing and forwarding
  - Multiprotocol label switching (MPLS)
    - Overcomes the IP shortest path routing problem.
    - Permits routing based on any constraints including i.e QoS.

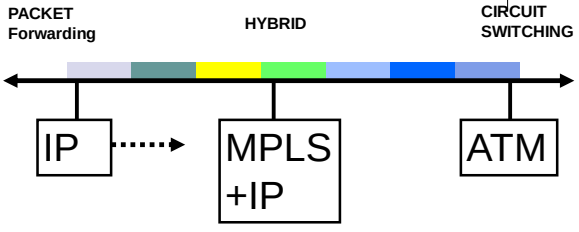
The MPLS advantages

- Provides QoS support
  - Fast, consistent forwarding.
- Provides traffic engineering support
  - Different routes can be assigned to flows at ingress routers.
- Provides multi-protocol support
  - Different protocols are only distinguished at ingress and egress routers.
  - IPv4, IPv6
  - 802.3 (Ethernet), VLAN

WHY MPLS ?

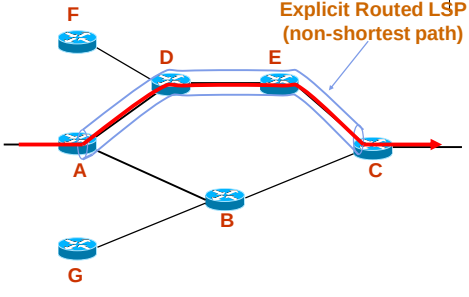
- Ultra fast forwarding
- IP Traffic Engineering
  - Constraint-based Routing
- Virtual Private Networks
  - Controllable tunneling mechanism
- Voice/Video on IP
  - Delay variation + QoS constraints

BEST OF BOTH WORLDS



- MPLS + IP form a middle ground that combines the best of IP and the best of circuit switching technologies.

Explicit Routing Using MPLS



MPLS Summary

- MPLS overcomes the shortest path routing problems.
- MPLS enables QoS routing.
- MPLS enables efficient explicit routing.

MPLS Applications

- Constraint-based routing (CR)
  - Routing based on QoS, policy, …
- Traffic Engineering (TE)
  - Routing based on optimizing usage of network resources.
- Fast protection switching
- Network-based VPN
- IP over ATM
- Controlling optical network

Conclusion

- Current IP networks don't support QoS and TE
- Intserv and Diffserv adds QoS capability
- MPLS adds the TE capability
- MPLS enables fast protection switching
- MPLS enables scalable VPN
- MPLS is the glue between IP and ATM
- MPLS is the glue between IP and optical networks.