



Multiprotocol Label Switching

JATIN BHALLA

Student, MCA, Guru Gobind Singh Indraprastha University (GGSIPU), Delhi, India

Abstract— the extensive growth of the Internet and the advent of sophisticated services require an epoch-making change. As an alternative that can take in it, MPLS was proposed. Recently, many efforts and activities on MPLS have already been initiated, which prompt the necessity of MPLS simulator that can evaluate and analyze newly proposed MPLS techniques. This paper describes design, implementation, and capability of a MPLS which is performed on OPNET simulator, which suppose label swapping operation, LDP, CR-LDP, and various sorts of label distribution function. It enables researchers to simulate how a UP is established and terminated, and how the labeled packets act on the LSP. In order to show MPLS simulator's capability, the basic MPLS function defined in MPLS standards is simulated;

Label distribution schemes, flow aggregation, ER-LSP, and LSP Tunnel. The results are evaluated and analyzed, and their behaviors are shown by means of graphical manner.

Index Terms—

Multiprotocol label switching (MPLS)

Label switch router (LSR)

Label edge router (LER or edge LSR)

Label Distribution Protocol (LDP)

Label switch path (LSP)

I. INTRODUCTION

The demand of multimedia services is rising excessively all over the world, so traffic engineering (TE) has been appeared as a great solution which provides better management of bandwidth and service requirements for big public Internet networks. Traditional IP forwarding depends on the destination address in IP header of each packet which involves many drawbacks. In order to overcome the flaws in the traditional IP networks, IETF (Internet Engineering Task Force) has developed the MPLS (Multiprotocol Label Switching) which uses label technique for forwarding packets. Traffic engineering through MPLS provides a mechanism to forward data packets by selecting best path while utilizing the network resources efficiently. Traditional IP model use to follow shortest path whereas MPLS model follow efficient path which reduces a problem of congestion.

Drawbacks of Traditional IP routing:

- All devices in the network use routing protocol to distribute routing information.
- All the packets in the network are forwarded using destination address only regardless of the routing protocols the router uses.
- Each router in the network performs routing lookups. Every router makes independent decision while forwarding packet.
- Unlike IP, MPLS reduces the number of routing lookups, changes the criteria of forwarding and

eliminates the need to run the routing protocol on each router.

II. MPLS

Multiprotocol Label Switching (MPLS) is a forwarding technique in telecommunications networks that forwards packets from one node to the next node on the basis of short labels attached in packets instead of looking long IP addresses at every router. This helps in reducing core routers' time which do not need complex routing table lookups. The label determines virtual switching paths between distant nodes rather than end points. Hence it increases data transfer speed significantly.

MPLS is best described as a "layer 2.5 networking protocol", because it is located between layer 2 and layer 3 of OSI model, providing essential features for the data transfer across the network

MPLS is known as "Multiprotocol" as it can work with various network protocols. MPLS supports variety of access technologies, which includes ATM, Frame Relay etc.

MPLS is best described as a "layer 2.5 networking protocol", because it is located between layer 2 and layer 3 of OSI model, providing essential features for the data transfer across the network.

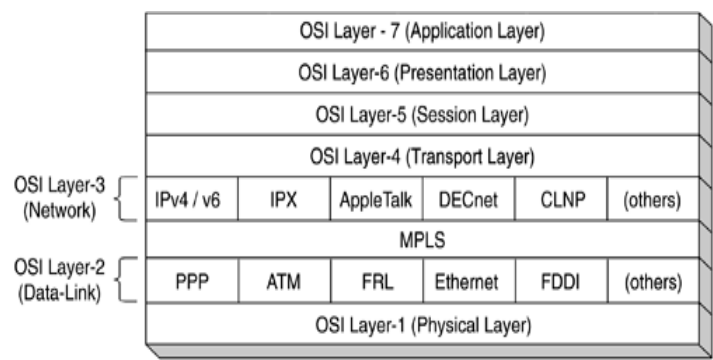


Fig 1. Position of MPLS in OSI Mode

III. FEATURES OF MPLS

Traffic Engineering - handling traffic by choosing efficient link along with efficient use of resources.

Class of Service - differentiated type of services are supported over an MPLS network

Virtual private Networks - VPN is a private connection over a shared network



Scalability-MPLS network is scalable to support growing requirements

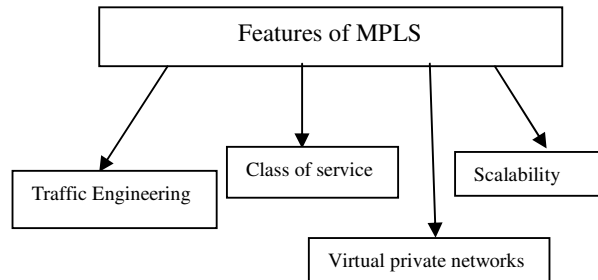


Fig 2. Features of MPLS

IV. METHODOLOGY

When an unlabelled packet enters the ingress router and needs to be passed on to an MPLS tunnel, the router first determines the forwarding equivalence class (FEC) for the packet and then inserts one or more labels in the packet's newly created MPLS header. The packet is then passed on to the next hop router for this tunnel. The MPLS Header is added between the network header and data link layer header of the OSI model. When a labelled packet is received by an MPLS router, the topmost label is examined. Based on the contents of the label a *swap*, *push* (*impose*) or *pop* (*dispose*) operation is performed on the packet's label stack. Routers can have prebuilt lookup tables that tell them which kind of operation to do based on the topmost label of the incoming packet so they can process the packet very quickly.

In a *swap* operation the label is swapped with a new label, and the packet is forwarded along the path associated with the new label.

In a *push* operation a new label is pushed on top of the existing label, effectively "encapsulating" the packet in another layer of MPLS.

In a *pop* operation the label is removed from the packet, which may reveal an inner label below. This process is called "decapsulation". If the popped label was the last on the label stack, the packet "leaves" the MPLS tunnel. This is usually done by the egress router. During these operations, the contents of the packet below the MPLS Label stack are not examined. Indeed transit routers typically need only to examine the topmost label on the stack. The forwarding of the packet is done based on the contents of the labels, which allows "protocol- independent packet forwarding" that does not need to look at a protocol-dependent routing table and avoids the expensive IP longest prefix match at each hop. At the egress router, when the last label has been popped, only the payload remains. This can be an IP packet, or any of a number of other kinds of payload packet. The egress router

must therefore have routing information for the packet's payload, since it must forward it without the help of label lookup tables. An MPLS transit router has no such requirement.

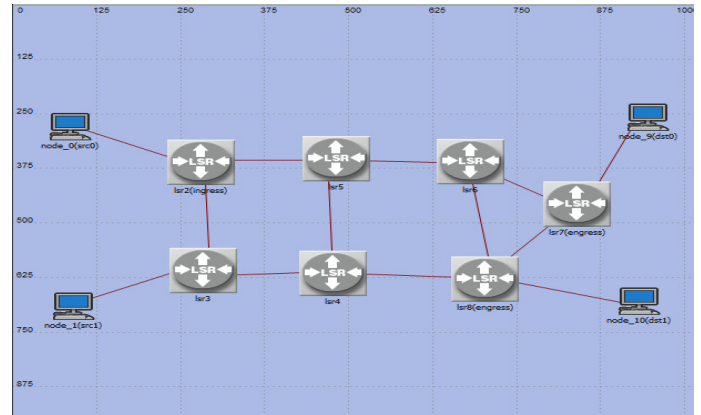


Fig 3.Design for MPLS

Node, Node1, Node9, and Node10 are IP nodes, and the others are MPLS nodes. SrcO agent attached to Node0 sends packets toward DstO agent attached to Node9. Src1 agent attached to Node1 sends packets toward Dst1 agent attached to Node10. Under the packet forwarding scheme based on shortest path, packets from SrcO are delivered along LSR 2-5-6-7, and packets from Src1 are delivered along LSR 2-3-4-8.

V. TRAFFIC ENGINEERING IN MPLS

Traffic Engineering is defined as way of spreading the traffic flow through the network, taking into account the availability of resources and the current and expected traffic. It also helps service provider to make the optimal utilization of available resources.

In traditional IP network, routing protocols are used to create routing tables, using which the path having the least cost is found out with algorithms like Open Shortest Path First i.e. OSPF. This technique has following challenges:

1. Shortest path (with least cost) is over-utilized leading to congestion in the network while the other paths are under-utilized.
2. Load sharing cannot be achieved in case of IP network.
3. Routing lookups are performed at every router which is an overhead and time consuming.

But MPLS does not direct the data on the basis of destination address in IP header. Instead, it routes data according to the label attached in a packet. So with MPLS TE network, resources utilization can be made efficient by directing



packets on less congested path or under-utilized path rather than the shortest path used in routing protocols. These new paths are created manually or through some signaling protocols and are called as Traffic tunnels or LSP tunnels.

Advantages of TE

1. Minimization of network congestion by Load sharing.
2. Fast re-routing- shifting traffic to preconfigured backup tunnels in case of link/node failure.
3. Maximum utilization of available resources. No link is over or under-utilized.

VI. OPNET SIMULATION

Simulation Tool

OPNET Model Configuration Objects The network components as used in this project work from OPNET library include:

ethernet_wkstn: Ethernet workstation OPNET element is used to simulate the network users

ethernet_server: Ethernet server provided in OPNET is used to simulate the service server in the network. It contains one Ethernet connection to the switch.

Application Config: This element is used to tell OPNET which application is going to be modeled upon the underlying network.

Profile Config: Profiles describe the activity patterns of a user or group of users in terms of the applications used over a period of (simulation) time. There can be several different profiles running on a given network under observation.

mpls_config_object: Configuring MPLS FEC and Traffic Trunk is done under this element configuration. The configured specification is used at the Ingress Edge router to direct the traffic flows and assign different LSP to different application traffic.

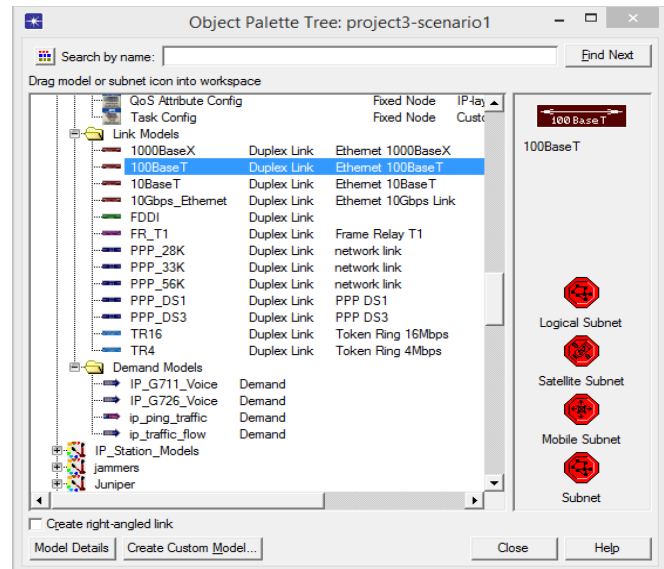


Fig 4.Tools for designing

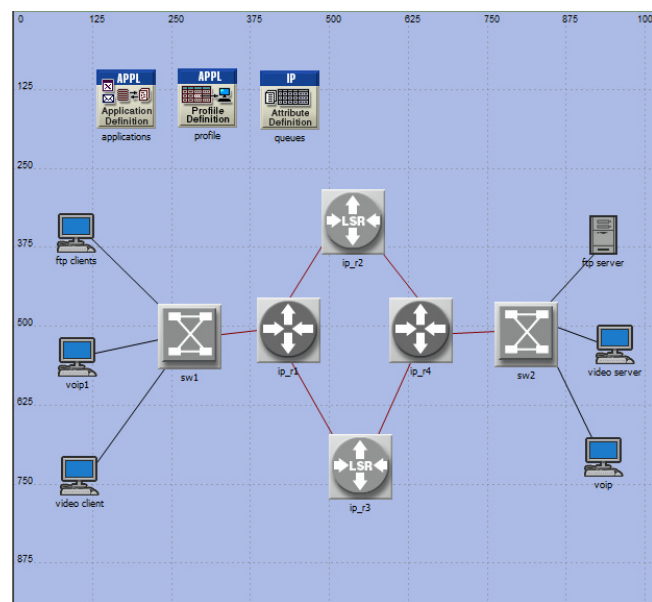


Fig 5. IP simulation without TE

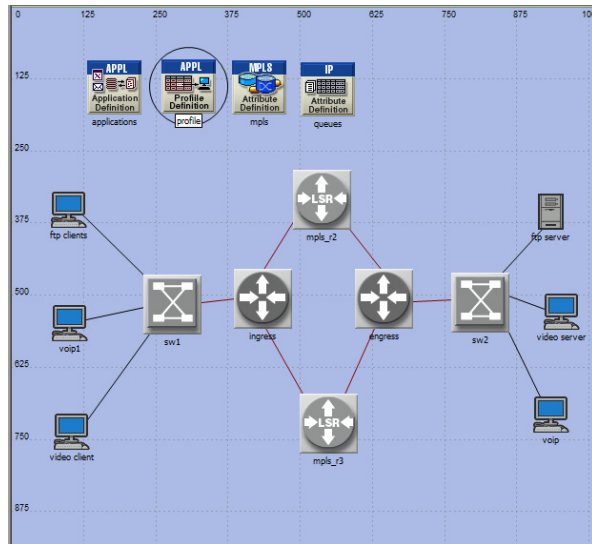


Fig 6.MPLS Simulation method with TE

Composition of Network topology	Use
2 LSRs	Works as switching routers.
2 LERs (Ingress_R1 and Egress_R4)	Works as edge routers
Two switches (SW1 and SW2)	Connected to routers
2 VoIP stations	For Transmission of packets.

DS3 links are used to connect all the routers and 100 Mbps links are used for connecting workstations to the two switches.

VII. ANALYSIS AND RESULTS

The performance metrics obtained for MPLS and conventional IP networks. From the graphs it is observed that there is an increase in the performance when the VoIP traffic is transmitted using MPLS technology. For each scenario the duration of the simulation is 420 seconds. The VoIP traffic starts at the 100th second and ends at the 420th second of the simulation time. In both scenarios VoIP calls are added at fixed time intervals i.e., for every two seconds starting from 100th second till 420th second.

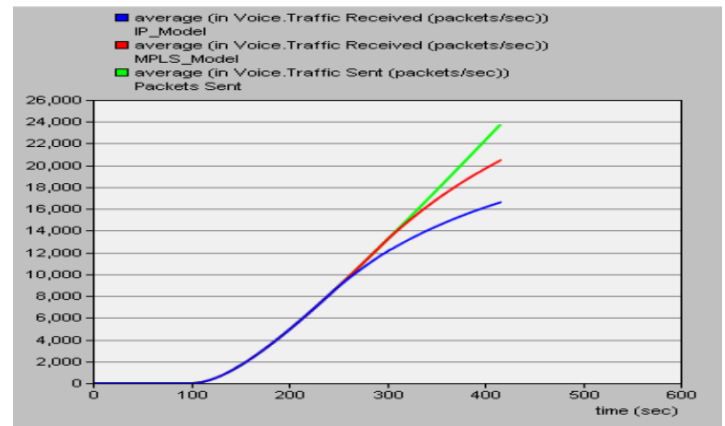


Fig 7. Voice packet send and received

It gives the average number of packets send and received in both MPLS and conventional IP networks. By the end of simulation it is observed that MPLS model gives more throughput than the IP model.

It can be judged that voice packets start to drop from 240 second in the IP network whereas in MPLS voice packets are started to drop from 300 second.

VIII. CONCLUSION

The research has shown the effective implementation of resources in MPLS network. The simulation results shows that the performance of traffic engineering parameters like packet delay. In MPLS network is very stable and much better as compared to traditional IP network. The network resources are optimized with the help of Traffic engineering.

In this research, performance metric of MPLS-TE and IP model networks are compared. Parameters that are compared includes throughput (packet send and receive), end to end delay, FTP response time. It is clearly observed that MPLS-TE performed better than IP network model. In the case of heavy load i.e. high traffic the performance of MPLS-TE are again better.

REFERENCES

- [1] Configuring Applications and Profiles. OPNET Documentation.
- [2] V.P. Kumar, T.V. Lakshmana, D. Stiliadis, "Beyond Best Effort: Router Architectures for the Differentiated Services of Tomorrow's Internet," IEEE Communications Magazine, May 1998.
- [3] Eric C. Rosen, Arun Viswanathan, Ross Callon, "Multiprotocol Label Switching Architecture," Internet Draft, April 1999.



- [4] Bilel Jamoussi, "Constraint-Based LSP Setup using LDP," Internet Draft, Oct. 1999.
- [5] http://www.cisco.com/en/US/docs/ios/12_0s/feature/guide/TE_1208S.html.
- [6] Cisco systems, "Implementing Cisco MPLS, Version 2.1.
- [7] E. Rosen, A. Viswanathan, R. Callon. January, "Multiprotocol Label Switching Architecture", Network Working Group RFC 3031, 2001.
- [8] E. Rosen, A. Viswanathan, R. Callon. "Multiprotocol Label Switching Architecture", IETF RFC 3031, 2001.
- [9] http://www.cisco.com/c/en/us/products/collateral/ios-nx-os-software/multiprotocol-label-switching-traffic-engineering/whitepaper_c11-551235.html
- [10] Research paper on using Multiprotocol Label Switching (MPLS) to improve IP Network Traffic Engineering by Frank Gonzales, Chia-Hwa Chang.
- [11] Traffic Engineering with MPLS written by Eric Osborne & Ajay Simha.