PERFORMANCE EVALUATION OF TRAFFIC ENGINEERING BASED IP AND MPLS ROUTING

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Abstract

Routers in the core network are forced for interconnection of more and more networks due to the growth and popularity of the internet. Requirement for high speed connection and increase in traffic volumes are in demand due to continues increase in number of users. An efficient routing scheme based on assignments of labels to routed packets is forced as there is a need for convergence of voice and data on a single network infrastructure. Delivery of IP services is enhanced through the technology called Multi Protocol Label Switching (MPLS). Benefits of internetworking and routing in Network Layer and Data Link Layer are achieved through the Multi- Protocol Label switching [10]. This paper analyses the traffic flow over conventional and MPLS network with application of traffic engineering.

Keywords—*MPLS, CR-LDP, RSVP-TE, QoS, Network Simulator (NS2).*

I. Introduction

Entities such as data, voice, video, multimedia and so on are integrated in the internet gradually. Network should guarantee quality of service in multimedia applications. Quality of Service (QoS) is achieved through the MPLS network by routing with some specific constraints. MPLS do not replace IP routing, but its functionality can be overlayed on the top of existing and future routing technologies. Data forwarding across a variety of physical layers can be made efficient by reserving bandwidth for traffic flow with QoS metrics like bandwidth, delay, jitter, packet loss and reliability.

Encapsulation mechanism is made efficient in MPLS by adding labels to packets[1]. Router supporting MPLS are called Label Switched Router (LSR).Edge node in MPLS network are connected to a non- LSR. Routers in the MPLS network through which packet enter are called ingress LSR and routers through which packet leaves are called egress LSR. Labels are locally significant identifier placed in the packet by the ingress LSR and removed by the egress LSR. Labels are applicable for a single link, between adjacent LSRs. The path through which packet traverse between adjacent LSR is called Label Switched Path (LSP). When the packets are labeled, traffic transits through multiple LSR's[12]. LSP is unidirectional. Another LSP is formed when the packets flow from right to left. In Figure 1, the LSP is shown with arrow at the top. The labels are distributed by label distribution protocols such as LDP (Label Distribution Protocol), RSVP-TE (Reservation Protocol)[7] and CR-LDP (Constraint Based Routing - Label Distribution Protocol).

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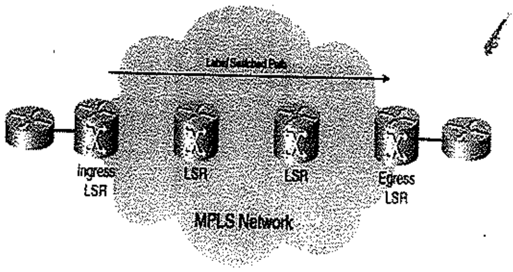

Figure 1: MPLS NETWORK

II. Tradiotional IP Routing

Routing decisions are made independently when the packet arrives in IP routing [11]. Next hop for the packet is found by the router by consulting its routing table based on the destination address of the packet which is in the packets IP header. Each router executes a network layer routing algorithm to find the hop. IP routing protocols like Border Gateway Protocol (BGP), Open Shortest Path First (OSPF) or Intermediate System-to-Intermediate System (IS-IS) are used to construct routing tables. Router executes the same procedure when the packet moves through the network [2].

The main problem in the IP routing protocols is that they do not take the constraints like capacity and traffic metrics into account when routing decisions are made. The result is that some path of the network becomes congested while other paths remain underutilized. Routing protocol continue to transmit the packet in the congested paths till the packets are dropped [13][14].

Traditional IP packet forwarding has few drawbacks. It has less capability to deal with the addressing information in spite of the destination IP address carried on the packet. Problem arises as all the packets to same destination prefix are treated in the same way. Traffic engineering becomes problem in traditional networks. Efficient utilization of available network resources is needed for interactive application to have less delay and packet loss [9]. This process is termed as traffic engineering and these capabilities are provided by MPLS [3].

III. Traffic Engineering With MPLS

Traffic Engineering is the means by which available bandwidth between a pair of routers are utilized efficiently. Prior to MPLS TE, traffic engineering was performed either by IP or by ATM, depending on the protocol in use between two edge routers in a network [15]. Multi Protocol Label Switching technology allows traffic engineering and enhances the performance of the existing protocols over the traditional IPv4 network [8]. Three signaling protocols are used in MPLS networks: Label Distribution Protocol (LDP) [4], Constraint based Routing LDP (CR-LDP) [5] and Resource Reservation Protocol – Traffic Engineering (RSVP-TE) [6].

IV. Performance Analyses of MPLS Over IP Network

Network Simulator is used to perform simulation of the work. The results are examined for both IP and MPLS network with traffic engineering applied. IP network is composed of OSPF protocol and MPLS includes protocol CR-LDP and RSVP-TE. Results from two networks are used for comparison. For simulation common topology is used as shown in Figure 2. The network comprise of 11 nodes and nodes 1 and 2 act as source node and nodes 10 and 11 are used as the destination. Delay is set as 10 ms and all links are duplex. Packets of 500 byte and 3ms inter-arrival time are set up between node 1 and node 11. When traffic engineering is applied through the nodes 3 to 9 which are made MPLS capable, the long path are also utilized. The metrics like throughput, bandwidth, Packet delivery ratio and delay are measured.

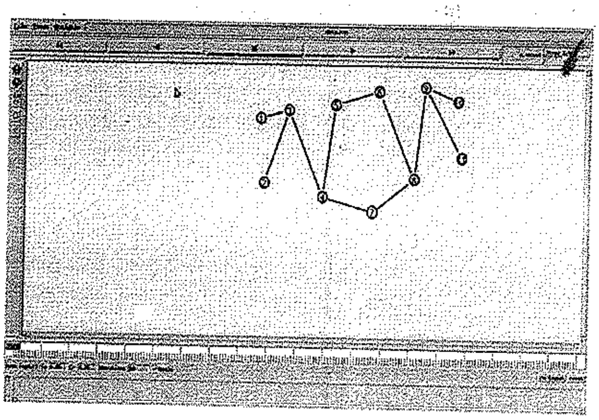

Figure 2 : NETWORK TOPOLGY

V. Simulation Results

A. IP Network Without Traffic Engineering

Figure 3 below shows the network without MPLS. Traffic is directed in the shortest path (3_4_7_8_9) in the IP network, which makes congestion in the link from node 4 – 7. The capacity of the shortest path is exceeded in the nodes (3_4_7_8_9) while the longer path between (3_4_5_6_8_9) is not utilized. Congestion occurs in the network when the path (3_4_7_8_9) is busy. Since the network could not meet all traffic demands the packets in the link (4 – 7) get dropped and delayed. In node 2 the packets are lost and same scenario occurs when no traffic engineering is applied for MPLS network.

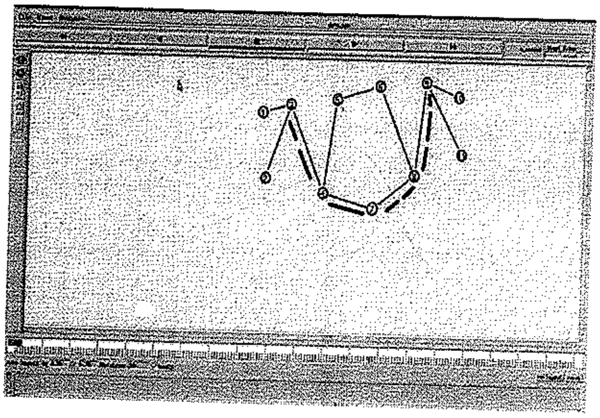

Figure 3 : SYMMETRIC NETWORK WITHOUT MPLS

B. MPLS Network With Traffic Engineering

Figure 4 below shows the symmetric network with MPLS. In MPLS network, nodes from 3 to 9 are made as LSR. Label request message are sent from node 3 to node 9, and LSP is formed. Label-mapping message is sent from node 9 to the node 3 when the path meets the demand and labels are allocated. This message includes the traffic parameter reserved for the LSP. After LSP is established, MPLS traffic engineering is applied and traffic is made to follow the explicit path (3_4_5_6_8_9). Hence traffic is forwarded in the under-utilized path.

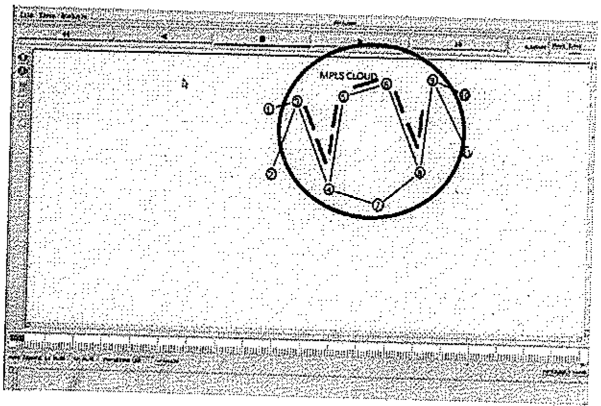

Figure 4 : SYMMETRIC NETWORK WITH MPLS

C. Results and Analysis

The parameters like Packet Delivery Ratio, Throughput, Delay and Bandwidth Utilization were taken for comparison in IP and MPLS networks. The following section shows the performance of the above said parameters.

PACKET DELIVERY RATIO

Packet delivery ratio is the ratio of the number of delivered data packet to the destination. Figure 5 below shows the number of packets received at destination node before and after traffic engineering is applied. After applying Traffic Engineering in MPLS, network congestion as well as packet received level is improved. For 500 byte packet transmitted from source, number of packets received is 312 for IP network and 397 for MPLS approximately. The greater value of packet delivery ratio means the better performance of the protocol.

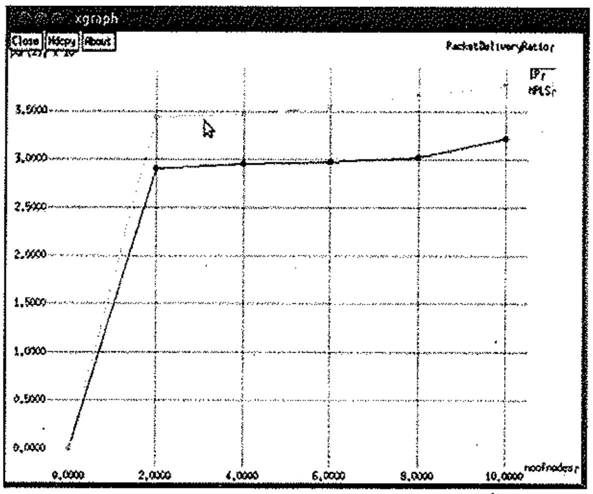

Figure 5 : PACKET DELIVERY RATIO OF IP NETWORK WITH MPLS

Throughput

It is defined as the total number of packets delivered over the total simulation time. Figure 6 below shows throughput before and after traffic engineering is applied. The figure below shows the throughput of received packets (MB) for each flow of traffic from source nodes before applying traffic engineering where received level is approximately 0.6 MB for IP network and 1.1 MB for MPLS network. In MPLS network, packets received level improved about 40% compare to the traditional network.

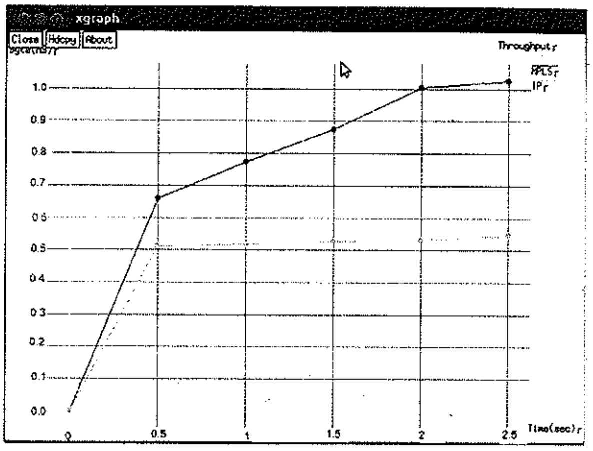

Figure 6 : THROUGHPUT OF IP NETWORK WITH MPLS

Delay

End-to-end Delay is defined as the average time taken by a packet to arrive in the destination node. Delay caused in discovery of route and the queue in data packet transmission is also included. Packets that successfully arrive in the destinations are counted. Figure 7 below shows the delay before and after traffic engineering is applied. The delay in the case when traffic engineering is applied is lower than when it is not applied.

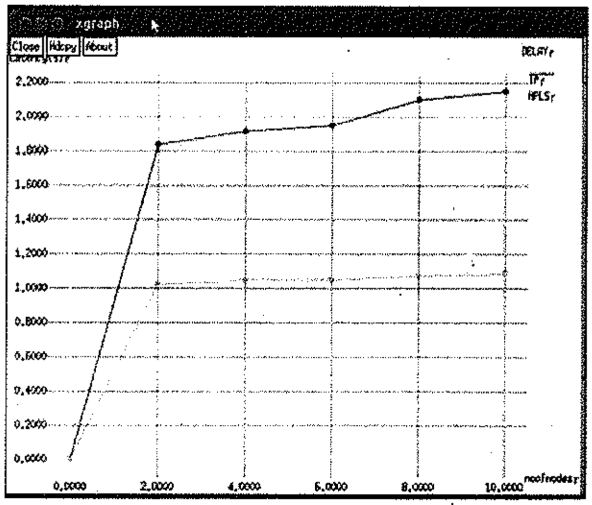

Figure 7 : DELAY OF IP NETWORK WITH MPLS

Bandwidth Utilization

Figure 8 below shows the bandwidth utilization before and after traffic engineering is applied. After applying Traffic Engineering in MPLS, bandwidth utilization is improved. Bandwidth

utilization is 0.34% for IP network and

0.42% for MPLS approximately.

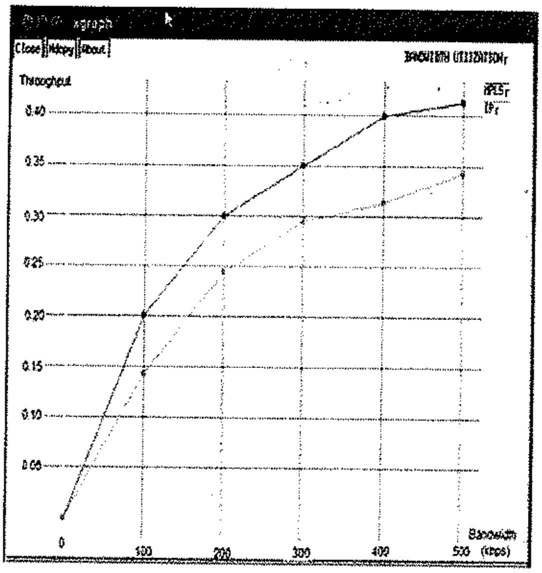

Figure 8 : BANDWIDTH UTILIZATION OF IP NETWORK WITH MPLS

Performance Evaluation of Traditional (IP) and MPLS Network

Table 1 : Comparisons between IP and MPLS Networks

	IP	MPLS
NO.OF PACKETS RECEIVED	312	397
THROUGHPUT	0.68	1.12
BANDWIDTH UTILIZATION	34.32	42.02
DELAY	0.021	0.012

The following Table 1.1 represents a comparative analysis of IP network over MPLS network. Here, parameters such as No. of Packets Received, Throughput, Bandwidth Utilization and delay are considered. In comparison, MPLS shows the better performance than IP network.

VI. Conclusion

This paper is prepared based on the traffic flow over both conventional and MPLS network, where network topology and other simulation parameters are chosen as common to establish the better performance of MPLS network over traditional network. In the simulation, when MPLS signaling protocols were implemented in MPLS network of TE, the traffic is moderately distributed into several LSPs, which is not able to achieve in the conventional routing protocol. The results obtained after simulation shows that packet transmissions (in terms of both delay and loss) are improved in MPLS network. Traffic Engineering made packet transmission better in MPLS. MPLS traffic engineering optimizes network resources and maximizes network bandwidth utilization.

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Author's Biography

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Dr. G.M. Kadhar Nawaz He has presented and published papers in various national and international Conferences and journals. He has also organized national conferences. He has completed Ph.D in Computer Science from Periyar University and his area of research includes network security and network communications. Currently he is working as Director in the Department of Computer Applications, Sona College of Technology, Salem.