International Journal Of Computer Science And Applications Vol. 1, No. 2, August 2008
ISSN 0974-1003

Multimedia Traffic Analysis of MPLS and Non MPLS Network

Mahesh Kr. Porwal
M.E. (E & Tc) Final Yr SGSITS, 23 Park Road Indore (M.P) – 458003
Mobile: 09826435234
porwal5@yahoo.com

Anjulata Yadav
Astt. Prof. Dept. of E &Tc SGSITS, 23 Park Road Indore (M.P) – 458003
Mobile: 09425437959
yadawanjulata@rediffmail.com

S. V. Charhate
Prof. and Head, Dept. Of E & Tc SGSITS, 23 Park Road Indore (M.P) – 458003 +919425081593
scharhate@sgsits.ac.in

ABSTRACT

Multi-Protocol Label Switching (MPLS) is rapidly emerging technology, which plays a key role in next generation networks by delivering Quality of Services and traffic engineering features. MPLS is helpful in managing multimedia traffic when some links or paths are under and/or over utilized. In MPLS a look – up in switching table is certainly less complex and time consuming than a corresponding routing table look – up in an IP router.

This paper presents a comparative analysis of MPLS and non-MPLS network and shows that MPLS provides improved network performance for multimedia type applications in heavy traffic environments.

CATEGORIES AND SUBJECT DESCRIPTORS

I.6.6 [Simulation Output Analysis], B.8.2 [Performance Analysis]

GENERAL TERMS

Performance, Measurement and Verification.

KEYWORDS

MPLS, LSP, Performance, Routing Protocol, Traffic Engineering.

1 INTRODUCTION

IP networks are often layered over ATM networks, which is very costly in terms of overhead (adding 25 percent or more of overhead to every IP packet)[6], but had one great advantage: IP packets could be forced onto particular ATM circuits, overriding IP routing, which alleviated the congestion known as traffic engineering. What service providers wanted was a ways to do traffic engineering without using ATM. Traditional IP networks have no means of tagging, cataloging, or monitoring the packets that cross them. MPLS technology works to solve those shortcomings of IP, placing labels on IP packets and providing the labeling function. MPLS is not designed to replace IP, it is deigned to add a set of rules to IP so that traffic can be classified, marked, and policed.

Two major candidates that are in competition to become the dominant future network protocol and network architecture are Multiprotocol label switching (MPLS) and differential services (DiffServ).

MPLS (Multiprotocol label switching) as a traffic-engineering tool has emerged as an elegant solution to meet the bandwidth management and service requirements for next generation Internet Protocol (IP) based backbone networks [10]. Traditional IP networks offer little predictability of service, which is unacceptable for application such as telephony, as well as for emerging and future real time applications. One of the primary goals of traffic engineering is to enable networks to offer predictable performance.

An MPLS[2] network can offer the quality of service guarantees that data transport service like frame relay (FR) or ATM give, without requiring the use of any dedicated lines. MPLS was devised to convert the Internet and IP backbones from best effort data networks to business-class transport mediums capable of handling traditional real time services. The initial trust was to deliver much needed traffic engineering capabilities and QoS enhancements to the generic IP cloud. The availability of traffic engineering has helped MPLS reach critical mass in term of service provider mind share and resulting MPLS deployments.

Most carriers run MPLS underneath a wide range of services, including FR, wide-area Ethernet, native IP, and ATM. Advantages accrue primarily to the carriers. User benefits include lower cost in most cases, greater control over networks, and more detailed Quality of Services.

Banking is one industry that has been actively involved in evaluating MPLS, followed by manufacturing. Greenfield operations the likes of ITeS and BPO-which generally deploy next-generation computing infrastructure such as Web services, peer-to-peer or grid computing, and often requires QoS capability-are also driving MPLS.

As the tariffs are expected to drop further MPLS-if viable for an organization-would be a cost-efficient alternative. MPLS improves IP scalability and quality of service by creating virtual label-switched paths (LSP) across a network of label switching routers (LSR). GMPLS' primary enhancement to MPLS is its capability to establish connections at layer 1.

This paper present a comparative analysis of MPLS and non-MPLS network and shows that MPLS improved network performance for multimedia type application in heavy traffic environment.

2 COMPARATIVE ANALYSIS OF MPLS AND NON-MPLS NETWORK

2.1 Traditional IP Routing

In conventional IP routing, each router in the network has to make independent routing decisions for each incoming packet. When a packet arrives at a router, the router has to consult its routing table to find the next hop for that packet based on the packets destination address in the packets IP header (longest match prefix lookup). To build routing tables each router runs IP routing protocols like Border Gateway Protocol (BGP), Open Shortest Path First (OSPF) or Intermediate System-to-Intermediate System (IS-IS). When a packet traverses through the network, each router performs the same steps of finding the next hop for the packet[1].

The main issue with conventional routing protocols is that they do not take capacity constraints and traffic characteristics into account when routing decisions are made. The outcome is that some segments of a network can become congested while other segments along alternative routes become under utilized. Even in the face of congested links, traditional routing protocol will continue to forward traffic across these paths until packets are dropped.

Conventional IP packet forwarding has several limitations. It has limited capability to deal with addressing information beyond just the destination IP address carried on the packet. Because all traffic to the same IP destination – prefix is usually treated similarly, various difficulties arise. For example, it becomes difficult to perform traffic engineering on IP networks. Also, IP packet forwarding does not easily take into account extra addressing-related information such as Virtual Private Network (VPN) membership [8].

To accommodate highly interactive application flows with low delay and packet loss threshold, there is a clear need to more efficiently utilize the available network resources. The process whereby this is accomplished is known as traffic engineering and MPLS provides these capabilities.

2.2 MPLS Technology

A common technique used among large ISPs is to use a layer 2 network (ATM or FR) to manage a network. In this approach often called the overlay solution, a complete mesh of virtual circuits connects the IP backbone. This serves to prevent the aggregation that occurs by hop-by-hop routing in an IP backbone with destination based routing. In this approach the flows can be individually routed through the layer 2 topology and traffic engineering can be achieved. But the drawback to this approach is the issue of scalability and that a single link failure can result in dozens of Virtual Circuits going down, forcing the IP routing protocols to reconvert. A solution for this problem can be coordination between the layer 2 networks and the layer 3 IP network. This solution is MPLS, a set of procedures for combining the performance, QoS and traffic management of the Layer 2 label-swapping paradigm with the scalability and flexibility of Layer 3 routing functionality.

Multiprotocol label switching (MPLS) is an extension to the existing Internet Protocol (IP) architecture. By adding new capabilities to the IP architecture, MPLS enables support of new features and applications. In MPLS short fixed-length labels are assigned to packets at the edge of the MPLS domain and these pre assigned labels are used rather then the original packet headers to forward packets on pre-routed paths through the MPLS network [10]. In MPLS, the route the packet is forwarded through the MPLS domain is assigned only once i.e., when the packet enters the domain. Before a router forwards a packet it changes the label in the packet to a label that is used for forwarding by the next router in the path.

2.3 MPLS Domain

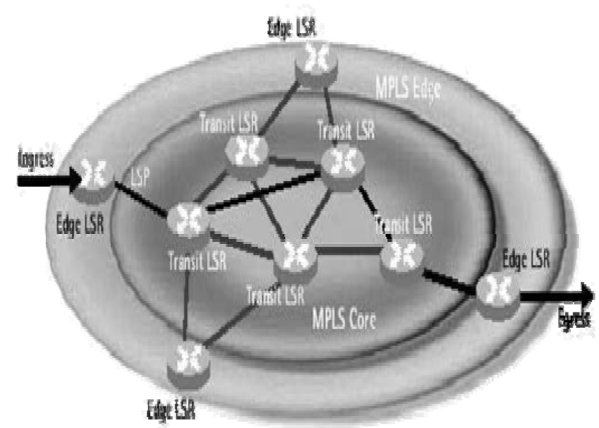
In [10] the MPLS domain is described as "a contiguous set of nodes which operate MPLS routing and forwarding". This domain is typically managed and controlled by one administration. The MPLS domain can be divided into MPLS core and MPLS edge. The core consists of nodes neighboring only to MPLS capable nodes, while the edge consists of nodes neighboring both MPLS capable and incapable nodes. The nodes in the MPLS domain are often called LSRs (Label Switch Routers). The nodes in the core are called transit LSRs and the nodes in the MPLS edge are called LERs (Label Edge Routers). If a LER is the first node in the path for a packet traveling through the MPLS domain this node is called the ingress LER, if it is the last node in a path it's called the egress LER. A schematic view of the MPLS domain is illustrated below.

Figure 1. A schematic view of the MPLS domain.

3 LABEL SWITCHING BENEFITS

MPLS offers many advantages over IP routing [10].

3.1 Speed and delay



Traditional IP – based forwarding is too slow to handle the large traffic loads in the Internet. Label switching is much faster because the label value that is placed in an incoming packet header is used to access the forwarding table at the router; that is, the label is used to index into table. This look up requires only one access to the table but in traditional routing table access might require several thousand lookups. Hence in MPLS packet is sent through the network much more quickly than with the traditional IP forwarding operation.

3.2 More scalability

Scalability refers to the ability or inability of a system, in the case of Internet to accommodate a large and growing number of Internet users. Label Switching offers solutions to this rapid growth and large networks by allowing a large number of IP address to be associated with one or a few labels. This approach reduces the size of address (actually label) table and enables a router to support more users.

3.3 Simplicity

MPLS is basically a forwarding protocol (or set of protocols). It is elegantly simple: forward a packet based on its label. How that label is ascertained is quite another matter.

3.4 Resource consumption

Label switching networks do not need a lot of network's resources to execute the control mechanism to establish label switching paths for users' traffic.

3.5 Standards based

MPLS is an Internet Engineering Task Force (IETF) standard available to all industry vendors to ensure interoperability in multi vendor networks [11].

4 TRAFFIC ENGINEERING

Traffic engineering is the process of controlling how traffic flows through a network to optimize resource utilization and network performance [5]. Traffic engineering enables the network to quickly and automatically reroute traffic when failure congestion conditions are detected.

Traffic engineering is basically concerned with two problems that occur from routing protocols that only use the shortest path as constraint when they construct a routing table. The shortest paths from different sources overlap at some links, causing congestion on those links. The traffic from a source to a destination exceeds the capacity of the shortest path, while a longer path between these two routers is under-utilized.

MPLS can be used as a traffic engineering[3] tool to direct traffic in a network in a more efficient way then original IP shortest path routing. MPLS can be used to control which paths traffic travels through the network and therefore a more efficient use of the network resources can be achieved. Paths in the network can be reserved for traffic that is sensitive, and links and router that is more secure and not known to fail can be used for this kind of traffic. MPLS include traffic-engineering (TE) capabilities needed for the efficient use of network resources. Traffic engineering enables you to shift the traffic load from over utilized portions to underutilized portions of the network, according to traffic destination, traffic type, traffic load, time of day, and so on.5. PROPOSED METHODOLOGY

The simulation environment employed in this paper is based on QualNet 4.0 simulator. The simulations were setup using a normal IP network without Traffic engineering and a MPLS network with Traffic Engineering implemented. The results from these simulations are used for comparison between the two networks. Both simulations are based on the common topology as shown in figure 2.

The network consists of 11 nodes. All links were setup as duplex with 10 ms delay and using DropTail Queuing, which serve packets on a First Come First Serve (FCFS) basis. The Traffic connection was set up between node 0 and node 10 using UDP with CBR of 1000 byte packets and 3 ms inter-arrival time.

The MPLS Traffic Engineering simulation topology is similar to the IP topology with only difference being that nodes 2 through 8 are MPLS capable, which allow non-shortest path links to be used.

The output trace file from the simulation is used to measure the performances of the network such as: Throughput at the destination node, link utilization and total number of packets received.

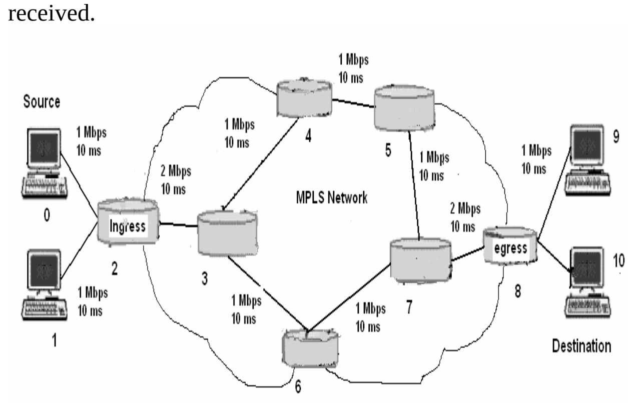


Figure 2. Simulation Topology

5 SIMULATION RESULTS

5.1 IP Network without Traffic Engineering:

In the IP network traffic uses the shortest path (2_3_6_7_8) to forward traffic, which causes this path to overlap at the link from node 3 – 6 thus causing congestion on this link. The traffic from (2_3_6_7_8) exceeds the capacity of the shortest path, while a longer path between (2_3_4_5_7_8) is under-utilized. When the path (2_3_6_7_8) of the network is busy, congestion is occurring within the network. Packet from link (3 – 6) get dropped and delayed as buffer overflow because the resources in the network cannot meet all traffic demands.

5.2 MPLS Network with Traffic Engineering:

In MPLS an LSP is set up when a 'label request message' propagates from the ingress (node2) to the egress LSR (node8). When the requested path satisfies the constraints and labels are allocated, then a "label-mapping message" propagates back from the engress LSR (node 8) to the ingress LSR (node 2) carrying details of the final traffic parameter reserved for the

LSP. When LSP is setup, MPLS traffic engineering is applied to switch the traffic flow through an explicit rout (2_3_4_5_7_8), hence under-utilized path is also used for forwarding the traffic. Throughput at destination Node is shown in figure3 and figure4.

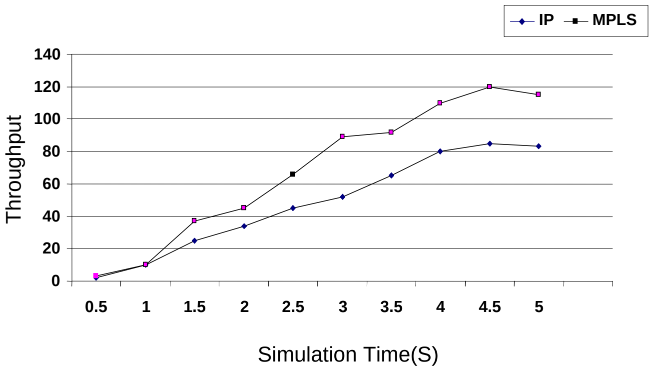


Figure 3. Throughput V/s Simulation Time

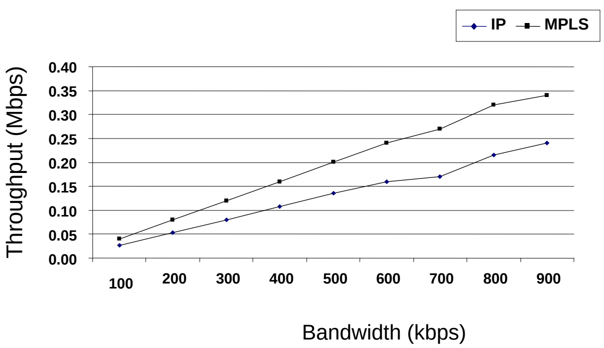


Figure 4. Throughput V/s Bandwidth

6 CONCLUSION

An IP-based network is connectionless, MPLS based network defines definite paths for network traffic based on some Quality of Service level. Multi-Protocol Label Switching is helpful in managing multimedia traffic when some links or paths are under and/or over utilized. Traffic engineering is the main strength of MPLS. The simulation study is an effort to quantitatively illustrate the benefit of using MPLS in implementing multimedia applications.

Through simulation results and analysis, it is clear that with proper MPLS Traffic Engineering applied to the network, the performance of the network is significantly improved.

Table 1. Comparison between conventional routing (IP) and MPLS routing.

	IP	**MPLS**
No. of Packets received	712	867
Throughput (Mbps)	0.5832	0.7102
BW Utilization (%)	58.32	71.02
End to End Delay (s)	0.042	0.038
Average Jitter (s)	0.35*10-3	0.21*10-4

7 REFERENCES

[1] A. Ghanwani. "Traffic Engineering Standards in IP Networks Using MPLS" IEEE Coniniunications Magazinc, vol. 37, no. 12, pp. 49- 53. December – 1999.

[2] A. Viswanathan, R. Callon, “Multiprotocol Label switching Architecture” RFC 3031.

[3] D.O. Awduche,”MPLS and Traffic Engineering in IP networks”, IEEE Communication Magazine, pp.42-47, December – 1999.

[4] D. Awduche, “Requirements for Traffic Engineering Over MPLS”, RFC 2702, September – 1999.

[5] D. Awduche, J. Agogbua, M. O'Dell, “Requirements for Traffic Engineering over MPLS (RFC 2702)” http://rfc-2702.rfc-list.net/rfc-2702.htm September - 1999.

[6] IEEE Communication magazine, September – 2006.

[7] IEEE Communication magazine, October – 2004.

[8] Muzammil Ahmad Khan. “Quantitative Analysis of MPLS in VPN's”, Sir Syed University of Engineering and Technology, from www.ieeexplorer.org.

[9] R. Callon at al, ”A Framework for MPLS”, Internet Draft, September – 1999.

[10] UYLESS BLACK – MPLS and Label Switching Network.