SJIF IMPACT FACTOR: 4.110 CRDEEPJournals
International Journal of Basic and Applied Sciences Shah & Bhaskar Vol. 3 No.4 ISSN: 2277-1921
International Journal of Basic and Applied Sciences Vol. 3. No. 4 2014. Pp. 163-169

Full Length Research Paper

Improving Quality of Service in Multimedia Applications by using Multi-Protocol Label switching Network

Syed Mehar Ali Shah[1] and Bhaskar Reddy Muvva Vijay[2*]
[1-]HOS & Lecturer, Department of IT, Shinas College of Technology, Al-Aqar, Shinas, Oman.
[2-]Lecturer, Department of IT, Shinas College of Technology, Al-Aqar, Shinas, Oman.

*Corresponding author: Bhaskar Reddy Muvva Vijay

Abstract
In the 21st century real time applications demand for higher bandwidth and QoS guarantees and to be able to keep the businesses running, researcher are struggling to figure the solution to categorize and implement the routing protocols that separate the class of services at the core network. By using Traditional IP network switching mechanisms we are unable to provide higher bandwidth and QoS. MPLS is one solution; it not only takes different paths to avoid congestion, but uses label switched technology to efficiently deliver the packets through MPLS network. This paper provides broader information about IP and MPLS technologies and problems in IP networks are illustrated and also we focus on design and implementation of MPLS networks architecture. Finally, we compare IP network over MPLS network by using NS2 and results are discussed.

Keywords: IP network, MPLS network, QoS.

Introduction

The traditional IP network routers forward the packets by one of the three different switching mechanisms. They are Process switching, fast switching and Cisco forward expressing (CFE). (Reagan (2002) & Alvarez(2006).

Process Switching

The original switching mechanism available on Cisco routers was process switching is shown in Figure-1. With process switching, when a packet comes in, the scheduler calls a process that examines the routing table, determines which interface the packet should be switched to and then switches the packet. The problem is, this happens for the every packet seen on every interface. This is why; process switching is very slow because it must find a destination in the routing table. Process switching must also construct a new Layer 2 frame header for every packet. As a result, process switching is no longer widely used in modern networks.

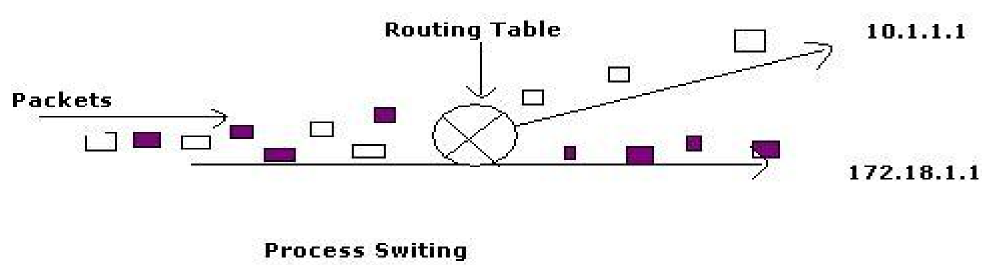


Figure-1. Process Switching

Fast Switching

Cisco IOS platforms have the capability to overcome the slow performance of process switching. The platforms support several switching mechanisms that use a cache to store the most recently used destinations. A cache uses a faster searching mechanism than process switching does while storing the entire Layer 2 frame header to improve the encapsulation performance. With the first packet, the router adds an entry to the fast-switching cache, sometimes called the route cache. The cache has the destination IP address, the next-hop information, and the data link header information (MAC) that needs to be added to the packet before forwarding. Future packets to the same destination address match the cache entry, so it takes the router less time to process and forward the packet. But fast switching has a few drawbacks. The first packet must be process switched. The cache entries are timed out relatively quickly, because otherwise the cache could get overly large as it has an entry per each destination address, not per destination subnet/prefix. Also, load balancing can only occur per destination with fast switching not per packet basis.

Cisco Express Forwarding (CEF)

The most recent and preferred Cisco IOS platform switching mechanism is CEF, which incorporates the best of the previous switching mechanisms. One of the benefits of CEF is that this mechanism supports per-packet load balancing, which was previously supported only by process switching. CEF also supports per-source or per-destination load balancing, fast destination lookup, and many other features that are not supported by other switching mechanisms.CEF uses a Forwarding Information Base (FIB) to make IP destination prefix-based switching decisions. The FIB is conceptually similar to a routing table or information base. It maintains a mirror image of the forwarding information contained in the IP routing table. When routing or topology changes occur in the network, the IP routing table is updated, and those changes are reflected in the FIB. The FIB maintains next-hop address information based on the information in the IP routing table.Because there is a one-to-one correlation between FIB entries and routing table entries, the FIB contains all known routes and eliminates the need for route cache maintenance that is associated with switching paths such as fast switching. But drawback with CEF Switching is all about the ingress interface and has nothing to do with the egress interface because FIB is created before a packet is forwarded. To solve all these switching problems, In this paper we focus on new switching mechanism called Multi-Protocol Label switching (MPLS).

What is MPLS?

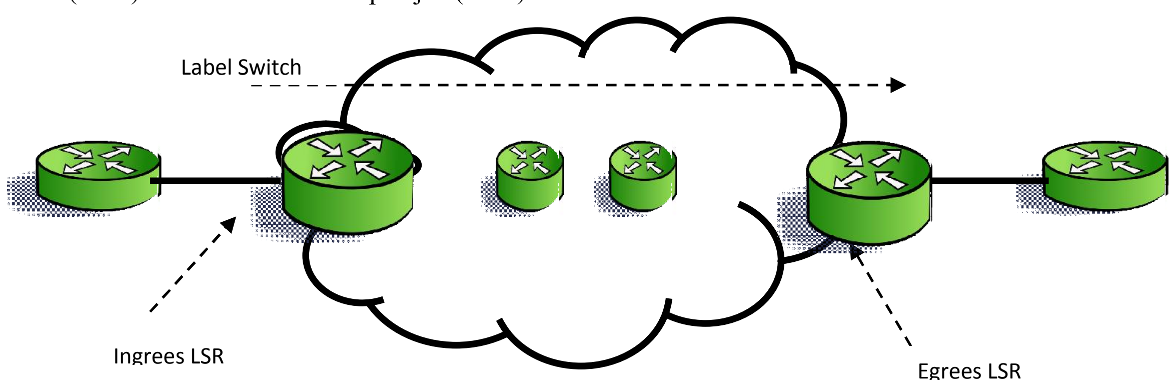
MPLS is a new technology for design and implementation of reliable, secure, efficient and standard QoS services and application classes. MPLS is evolved through ATM and frame relay VAN networks; MPLS uses labels to advertise between different routers by means of label mapping through label switching mechanism. Previously frame relay uses frames while ATM uses cells to map labels, to label switching techniques, frames cannot be of fix length while the cells consists of fix length with 5 bytes of header and 48 bytes of payload. ATM and frame relay are identical in a way when label traversing each hop in the network causes the label to change the header value. This differentiate from the traditional IP network when IP packets are forwarded through router it does not change the value at the header of the IP packet i.e. destination IP address. MPLS also adds the label at the ingress Label Edge Router (LER) of the MPLS network, changes the label value at each LER within MPLS network until it reaches the egress LER, where completely removes the MPLS label and the data packet is forwarded towards destination IP address.

Study Design

The present paper focuses on, the first task is how to design MPLS architecture and what are the different components, mechanisms involved in that. Secondly, the operation of MPLS and Finally we are going to compare MPLS network over IP networkin Multimedia Applications for this we usethe simulator NS2.

MPLS Architecture

MPLS architecture consists of MPLS routers connected through mesh topology. MPLS infrastructure network consists of following routers (Minoli (2002) and Guichard and Pepelnjak (2000).



a. Ingress/Egress label Switch Router (LSR)

LSRs deployed at perimeter of MPLS network which provides an interface to inside MPLS domain and to outside the IP network. The role of ingress/egress LSR is to insert and remove labels when deployed as an ingress and egress. An ingress LER inserts label on the data packet called as imposing LSR and forward it towards egress LSR after passing through number of hops where egress LSR removes the label called as disposing LSR and forward it towards data link. These two routers are also known as Provider Edge Routers.

B. Intermediate Label Switching Router

LSR are devices present in MPLS domain to perform swapping, push and pop operations of incoming and outgoing packets towards ingress/egress LSRs. They receive an incoming label packets swap, push and pop labels perform packet switching and forward it towards correct data link. The packet forwarding mechanism based on information present at each label.

c. Label Switching Path (LSP)

It's a sequence LSR path from ingress LSR followed by number of selectable intermediate paths towards egress LSR. The Figure-2depict unidirectional LSP from ingress LSR followed by three intermediate LSR towards egress LSR. If the packet has already been labeled by ingress LSR then this case is called as nested LSP.

What is MPLS Label?

An MPLS label consists of 32 bits depicted in Figure-3.a.

\

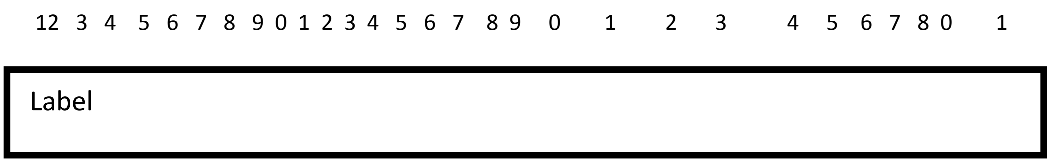


Figure-3.a. Label

The first label value consists of 120 bits followed by 3 experimental (exp) bits to control quality of services (QoS). Bottom of stack (BoS) identifies the number in the stack label, if it's 0 which mean bottom label stack otherwise if it's 1 stack contain number of labels above the packets so the stack can have one or more labels. First label in the stack is called top label while the last label is term as bottom label which is shown in Figure-3.b.

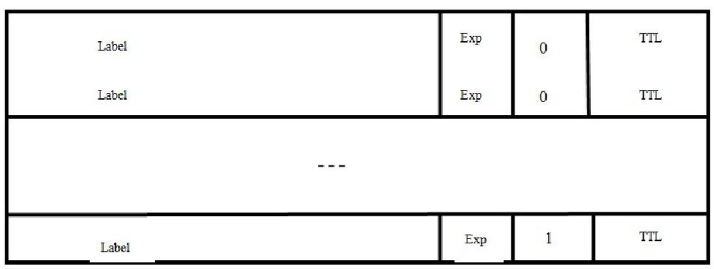


Figure-3.b. Label

Time to Live (TTL) consists of 8 bits with the same functionality present in IP header. It avoids routing loops by decreasing TTL value after traversing each successful hop. If TTL value in label becomes 0, packet is discarded.

A. Forward Equivalency Class (FEC)

This term is used in MPLS to allow same group of packets to follow along same path and should be treated identically during packets forwarding. All the packets which belong to same class have same level however in some cases they have different labels if EXP have different value that will consider different forwarding mechanism due to different FEC. Ingress LSR decides packet forwarding based on FEC because it classify labels in the initial stage. Layer 3 packets following towards destination IP address contain prefix, it might be certain group of multicast packets or packets based on precedence or forwarding treatment, and also layer 3 IP address maintaining same BGP prefix and same next BGP hop are some examples of Forwarding equivalency class.

B. LSR Operational Modes

There are three different modes of LSR during label distribution mechanism to other LSR.

- **Label Distribution Mode**
  Its consists of downstream on demand label distribution mode in which every LSR make request to the coming hop in a downstream LSR through LSP for binding FEC. Single FEC binding is received by LSR through down streaming LSR is upcoming hop describe in IP table. The other distribution mode is downstream label distribution mode binds FEC distribution to nearby LSR, where every LSR received binding information through neighboring LSR. Downstream on demand label distribution mode offer single binding while unsolicited downstream gives multiple FEC bindings.

- **Label Retention Mode**
  Liberal and conservative label retention modes are present. In case of liberal label retention Label Information Base (LIB) maintains remote binding information through down streaming or through upcoming hop. The label binding is utilized in Label forwarding information base (LFIB) but no other labels are kept which are not used for forwarding packets. The cause for storing remote binding in LFIB is subject to topological change and implementation of dynamic routing due to downlink of router. Conservative label retention mode configure on an LSR does not contain all remote bindings except an associated upcoming hop in its LIB. However LLR will help in rapid routing topological change while CLR utilizes memory efficiently.
- **LSP Control Mode**
  In LSP control mode independent and ordered FEC bindings are performed. FEC local binding is established independently by the LSR without involving other LSR and creating a specific FEC local binding according to FEC classes. Ordered LSP binds FEC unless recognition is obtained through egress LSR or label binding from an upcoming hop.

How MPLS works?

In MPLS network label packet forwarding has different phenomena then traditional IP packet forwarding. In this paper we describe packet forwarding mechanism in a step by step procedure.

STEP-1:

Three main operations are performed in labels i.e. Push, Pop and Swap. Figure-4 illustrates an example of push pop and swap. LSR determines according to the LFIP information when label packet is received at LSR either top label should be swap, pop and push. In label swap operation label 20 is replaced by label 35 when it pass through LSR. During Pop operation stack label 12 is removed from the stack after passing through LSR. While in push operation label 9 is inserted on the top of stack.

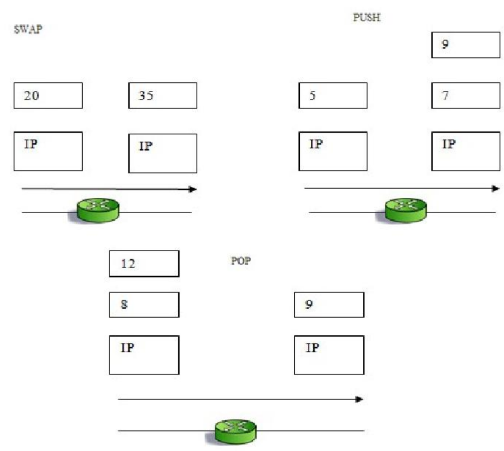


Figure-4. Operation of MPLS

STEP-2:

IP lookup is performed when IP packet is received at router while label lookup is performing at the router through LFIB with particular Cisco Express Forwarding (CEF) class. So router identifies an IP over label packet through protocol information at layer 2 header. If CEF or LFIB forward the packet so it can be unlabeled or labeled depending upon CEF-IP lookup or LFIB-label lookup. Both cases are shown in Figure-5.In first caseCEF performs IP lookup for an incoming IP packet at LSR that leads to two possible outcomes i.e. IP-IP packet or IP-label packet respectively. In second case a label packet is received by the router so LFB performs label lookup and forward the packet either label-IP or label-label respectively.

STEP-3:

Load balancing for desired label packets is performed by Cisco IOS, these packets may have same or different outgoing labels. Same label exist if the link is between the link and routers belonging to label platform space but they are different in case multiple upcoming LSR are present since upcoming LSR independently provide labels. However IP over MPLS network offer packet labeling procedure for MPLS domain and whenever packet leaves MPLS network it becomes unlabelled.

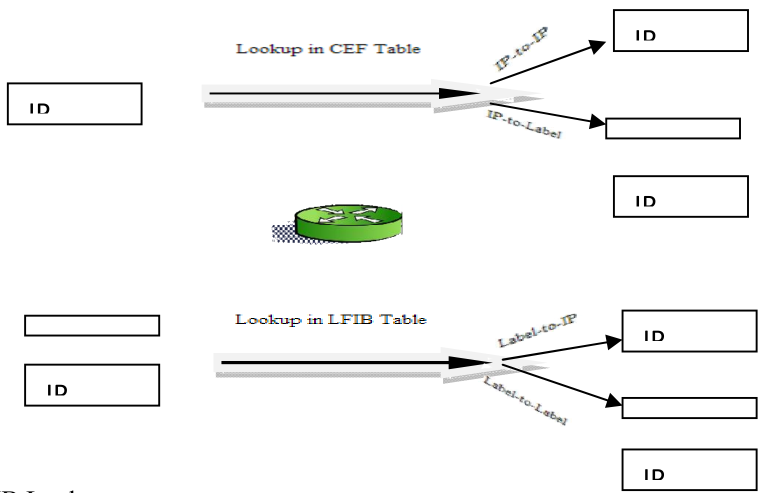


Figure-5. CEF Lookup and LFIB Lookup

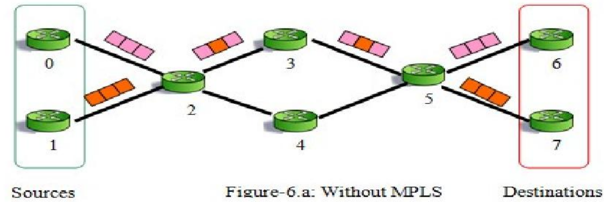
STEP-4:
There are 0 to 15 labels reserved which LSR doesn't use in normal cases to forward packet where label 0 stands for explicit null label and label three for implicit null label. Implicit null label is assigned by egress LSR if label is not assigned for FEC to accomplish pop label operation. Alert label is defined by label 1 while OAM alert label is used through label 14 that provides network management operation and maintenance.

STEP-5:
Beside reserved labels, unreserved label are used to forward normal packets and it consists of 20 bits, with the range of 16-10000 labels. They are significantly enough for normal labeling packet but if IGP prefixes are to be labeled we can change the range to make them sufficient.

STEP-6:
Time to live (TTL) changes its values based on the label operation i.e. swap, pop and push at each arriving LSR. In order to perform swap label operation incoming packet label TTL become equal to current label – 1, for push label operation the incoming packet label TTL becomes also label – 1 and copied at swap label. In case of pop operation the incoming packet label TTL copies label – 1 to expose label. When LSR receives the packet with TTL equal to 1, it automatically drop that packet and generate ICMP message for time expiry.

Implementation of Multimedia services in MPLS network over IP network
In the present paper, we examine the MPLS network over the IP network for Multimedia application traffic. To analyze the traffic we use simulation tool NS2 with identical network topology is shown in Figure-6a, 6b.We configured IP network (without MPLS) with duplex communication, drop tail queuing and first come first serve parameters are deployed on the nodes with real time and best effort traffic. Best effort utilises background traffic while to obtain QoS real time parameters are configured. TCP, UDP and CBR Protocols are used with variable packet sizes to transmit data across network.

MPLS implements similar topology but offers labels instead of shortest path links through CR-LDP to offer explicit route in real time traffic. Network performance for multimedia applications is observed through packet loss and packet received by TCP and UDP Protocols. An increase in number of TCP and UDP packets are obtained from MPLS TE simulation, throughput and network utilization has also increased as compare to non TE IP network.



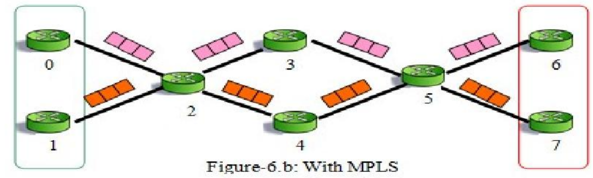


Figure-6.a, 6.b. Representation of IP network over MPLS network

From the above Figure, we depicted the symmetric network topology for simulation without and with MPLS network implementations. On the left side of the figure, router 0 and router 1 are source router while router 6 and router 7 are destination routers.In Figure-6a, data flows between the networks through router 2-3-5 and reaches the destinations while router 4 is left under utilized due to traditional IP network protocols implementations. In Figure-6b, data flows from source to destination throughutilizing all the resourcing and thus router 4 serves for the data transmission between route 1 and router 7.

Results and Discussions

Simulations are performed in NS2 and results are displayed to measure and compare the performance of both networks. G.711 codec is used with CBR, UDP protocol for VOIP services with 226 media streaming are obtained. Voice packet size depends on the layer2 header, plus IP, UDP, RTP header and voice payload. UDP packet size consists of UDP header, RTP header and voice payload while drop tail queue mechanism is considered.

Table-1. Throughput Comparison of IP network and MPLS network.

Transmission Type	Traditional in bits	MPLS in bits
CBR PKT send	4567280	**5389310**
CBR PKT received	**3876930**	**5105790**

In Figure-7, we see that the bytes receive at sources in 4.5 sec are less than in Figure-8. which means implementing MPLS TE concepts will improve the performance of the network and resources as well as QoS but having high throughput of data stream. Also the number of nodes has strong effect on the throughput since with 6 nodes, more data is transmitted in IP networks whereas small difference is seen in the graphs Figure-8 when the number of nodes are increased.

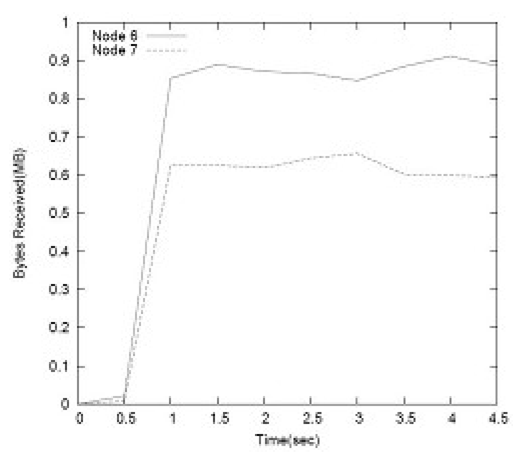


Figure-7. IP network Throughput

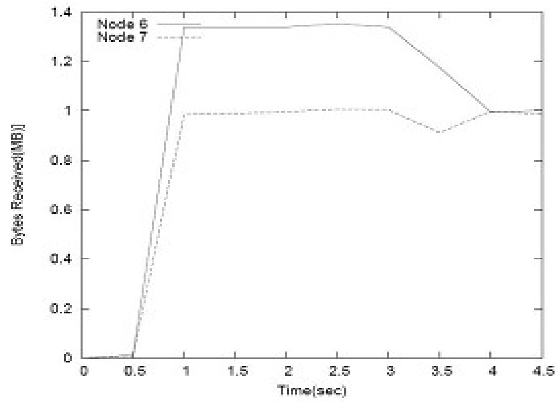


Figure-8. MPLS network Throughput

If the relationship in the difference at network throughputs is high, so in reality every real time multimedia application is challenging the network resources to cater enough data bits that can sustain the QoS guarantee otherwise it will high influence single application, user, and network or as a whole on transmission, congestion, application, in terms of delay, jitter, load, packet loss, etc.

Conclusions

This paper aim was to conduct theoretical study of an IP and MPLS network technologies and observe the problem associated within IP networks. We have tried to demonstrate the need for new technology emergence and its implementation over IP network to increase throughput i.e. transmission rate, decrease delay and jitter for better QoS delivery. IP technology is however not capable handling high data rate stream of voice and video data as compared to simple datagram. To overcome the problems associated in IP network, MPLS networks are introduced because they use label switching technology at the IP core routers to make routing mechanism efficient, configure data packet with small labels at the start and the end of the MPLS domain and to deliver QoS guarantee transmission almost any voice and video application. MPLS uses forwarded equivalency class parameters differentiate incoming traffic classes and label then according to diffident priority based on MPLS traffic engineering implementation. MPLS also offers various routing protocols to define routs at each MPLS domain and outside MPLS domain and performs connectivity operation through BGP and EGP.

Future Work

During the last few years MPLS is the most prominent and most of the service providers going to replace their frame relay and ATM services with the MPLS technology. There are also so many implementation of the MPLS technology especially Cisco which will provide us the features of QOS and enhanced out network. MPLS technology now lies at the backbone of the network, now days a lot new research is going on the QOS, VPN, and voice collaboration with the MPLS features in order to use its features. MPLS service works with the CoS (Class of Service) and is useful for the VOIP applications such as the video conferencing, ERP, CRM etc. It is also true that MPLS Technology is the future of the communication for businesses. There are also some future aspects with respect to the MPLS on which service provider's poses serious attention like new sensors in the MPLS traffic, raising cost and complexities and multiple management touch points.

References:

J. Guichard and I. Pepelnjak," MPLS and VPN Architecture",October 2000.
J. Reagan, "CCIP: MPLS Study Guide", 2002.
Minoli ,"Voice Over MPLS:Planing and Desiging Networks",2002
S. Alvarez, "QoS for IP/MPLS network", June 2006