MPLS Technology Using GNS3

Aditya Chavan[1] Arihant Pandey[2] Prof. Amit Kukreja[3]
[1,2,3]K J Somaiya Institute of Engineering and Information Technology, Sion, India

Abstract— MPLS is in discussion since last decade. It has been introduced to improve the performance and speed of the backbone network. There has been demand for transition from conventional network to the MPLS network in the service provider's network. A comparative study and performance behaviour of the service provider's network. A comparative study and performance behaviour of the service provider's network with MPLS network under different traffic conditions with various services is being proposed. There has been significant improvement in the demand for the bandwidth requirement in the near future. This requires the access network and the backbone network to be significantly improved with respect to various services. One of the contenders for the above problem is MPLS protocol. A network with MPLS protocols will take care of all the future demands for large bandwidth access for the subscribers. This work proposes analysis of network performance parameter such as Latency, Throughput, Packet loss, Jitter with traditional routing and MPLS.

Key words: MPLS, LDP, GNS3, Service Provider Network, Traffic Engineering, VPN

I. Introduction

Multiprotocol Label Switching (MPLS) is a network architecture that uses labels attached to packets to forward them through the network. This chapter explains why MPLS became so popular in such a short time. This chapter starts with a definition of MPLS. It also provides a short overview of pre-MPLS network solutions. The benefits of MPLS are listed, and the end of the chapter explains briefly the history of MPLS. The MPLS labels are advertised between routers so that they can build a label-to-label mapping. These labels are capsulated to the IP packets, to forward the traffic by looking at the label and not the destination IP address. The packets are forwarded by label switching instead of by IP switching. The label switching technique is not new. Frame Relay and ATM use it to move frames or cells throughout a network. The similar feature of ATM and Frame Relay is the value of the labels in the header is changed at each hop. This is not the same while forwarding IP packets in the traditional routing method. When a router forwards an IP packet, it does not change a value that pertains to the destination of the packet; that is, it does not change the destination IP address of the packet. The fact that the MPLS labels are used to forward the packets and no longer the destination IP address have led to the popularity of MPLS.

II. Literature review

In this chapter different author papers are discussed with their different approaches in MPLS topic. Some author perform simulation with different testing environment these methods are helpful for understanding concept. Chuck Semeria in "MPLS enhancing routing in the new public network" explained about Multilayer switching describes the integration of Layer 2 switching and Layer 3 routing. Today, some ISP networks are built using an overlay model in which a logical IP routed topology runs over and is independent of an underlying Layer 2 switched topology (ATM or Frame Relay). Layer 2 switches provide high-speed connectivity, while the IP routers at the edge interconnected by a mesh of Layer 2 virtual circuits provide the intelligence to forward IP datagrams. The emergence of the multilayer switching solutions and MPLS is part of the evolution of the Internet to decrease complexity by combining Layer 2 switching and Layer 3 routing into a fully integrated solution. Wojtek, Bernard, Stephane, Morgane & Hisao in "Survivable MPLS over optical transport network: cost & resource usage analysis" investigated about different options for the survivability implementation in MPLS. We conduct two ways to the deployment: single layer and multilayer and present various methods for spare capacity allocation (SCA) to reroute disrupted traffic. The comparative analysis shows the influence of the offered traffic granularity and the physical network structure on the survivability cost: for high bandwidth LSPs, close to the optical channel capacity, the multilayer survivability outperforms the single layer one, whereas for low bandwidth LSPs the single layer survivability is more cost-efficient. On the other hand, sparse networks of low connectivity parameter use more wavelengths for optical path routing and increase the configuration cost as compared with dense networks. We demonstrate that by mapping efficiently the spare capacity of the MPLS layer onto the resources of the optical layer one can achieve up to 37% in the optical layer cost. These results are based on a cost model with different cost variations, and were obtained for networks targeted to a nationwide coverage.

III. IP Parameters

Once we create an internetwork by connecting service provider WANs and LANs to a router, we'll need to configure logical network addresses, like IP addresses, to all hosts on that internetwork for them to communicate successfully throughout it. Routing is irrelevant if our network has no routers because their job is to route traffic to all the networks in service provider internetwork, but this is rarely the case! So here's an important list of the minimum factors a router must know to be able to affectively route packets:

- Destination address.
- Neighbours routers from which it can learn about remote networks.
- Possible routes to all remote networks.
- The best route to each remote network.
- How to maintain and verify routing information.

IV. Open shortest path first

Open Shortest Path First is an open standard routing protocol that's been implemented by a wide variety of network vendors, and it's that open standard characteristic that's the key to OSPF's flexibility and popularity. Most people opt for OSPF, which works by using the Dijkstra algorithm to initially construct a shortest path tree and follows that by populating the routing table with the resulting best paths. OSPF has quick convergence therefore it's a favourite. Another two great advantages OSPF offers are that it supports multiple, equal-cost routes to the same destination, and it also supports both IP and IPv6 routed protocols. Here's a list that summarizes some of OSPF's best features:

- Allows for the creation of areas and autonomous systems.
- Minimizes routing update traffic.
- Is highly flexible, versatile, and scalable.
- Supports VLSM/CIDR.
- Offers an unlimited hop count.
- Is open standard and supports multi-vendor deployment.

V. MPLS ARCHITECTURE

MPLS stands for Multiprotocol Label Switching. The multiprotocol aspect of MPLS was fulfilled after the initial implementation of MPLS. Although at first only IPv4 was being label switched, later on more protocols followed. Label switching indicates that the packets switched are no longer IPv4 packets, IPv6 packets, or even Layer 2 frames when switched, but they are labelled. The most important item to MPLS is the label. This chapter explains what the label is used for, how. The most important item to MPLS is the label.

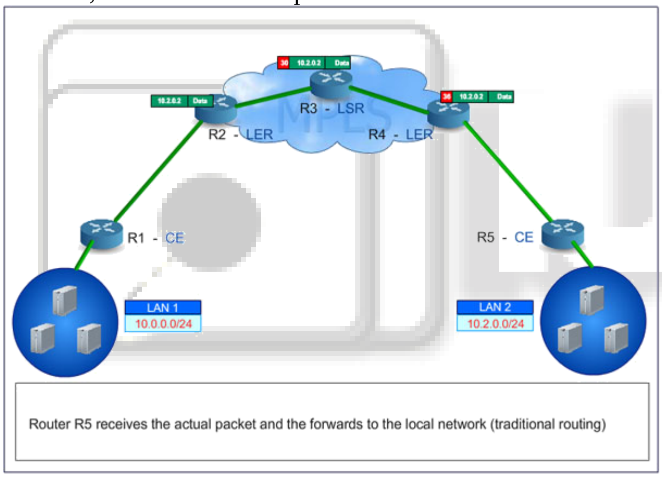

Fig. 1:

A. MPLS and OSI Reference Model

The bottom layer is Layer 1, or the physical layer, and the top layer is Layer 7, or the application layer. Whereas the physical layer concerns the cabling, mechanical, and electrical characteristics, Layer 2, the data link layer, is concerned with the formatting of the frames. Examples of the data link layer are Ethernet, PPP, HDLC, and Frame Relay. The significance of the data link layer is only on one link between two machines, but not beyond. This means that the data link layer header is always replaced by the machine at the other end of the link. Layer 3, the network layer, is concerned with the formatting of packets end to end. It has significance beyond the data link. The most well-known example of a protocol operating at Layer 3 is IP. Where does MPLS fit in? MPLS is not a Layer 2 protocol because the Layer 2 encapsulation is still present with labelled packets. MPLS also is not really a Layer 3 protocol because the Layer 3 protocol is still present, too. Therefore, MPLS does not fit in the OSI layering too well. Perhaps the easiest thing to do is to view MPLS as the 2.5 layer and be done with it.

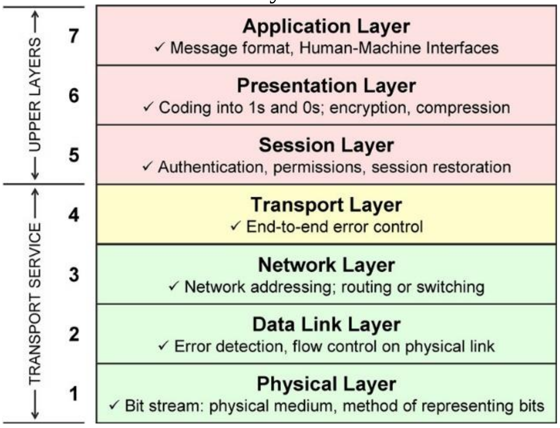

Fig. 2:

B. Label Switch Router

A label switch router (LSR) is a router that supports MPLS. It is capable of understanding MPLS labels and of receiving and transmitting a labelled packet on a data link. Three kinds of LSRs exist in an MPLS network:

- Ingress LSRs—Ingress LSRs receive a packet that is not labelled yet, insert a label (stack) in front of the packet.
- Egress LSRs—Egress LSRs receive labelled packets, remove the label(s), and send them on a data link. Ingress and egress LSRs are edge LSRs.
- Intermediate LSRs—Intermediate LSRs receive an incoming labelled packet, perform an operation on it, switch the packet, and send the packet on the correct data link.

An LSR can do the three operations: pop, push, or swap. It must be able to pop one or more labels (remove one or more labels from the top of the label stack) before switching the packet out. An LSR must also be able to push one or more labels onto the received packet. If the received packet is already labelled, the LSR pushes one or more labels onto the label stack and switches out the packet. If the packet is not labelled yet, the LSR creates a label stack and pushes it onto the packet. An LSR must also be able to swap a label. This simply means that when a labelled packet is received, the top label of the label stack is swapped with a new label and the packet is switched on the outgoing data link. An LSR that pushes labels onto a packet that was not labelled yet is called an imposing LSR because it is the first LSR to impose labels onto the packet. One that is doing imposition is ingress LSR. An LSR that removes all labels from the labelled packet before switching out the packet is a disposing LSR. One that does disposition is an egress LSR. In the case of MPLS VPN, the ingress and egress LSRs are referred to as provider edge (PE) routers. Intermediate LSRs are referred to as provider (P) routers. The terms PE and P routers have become so popular that they are also used when the MPLS network does not run MPLS
VPN.

C. Label Switch Path

A label switched path (LSP) is a sequence of LSRs that switch a labelled packet through an MPLS network or part of an MPLS network. Basically, the LSP is the path through the

MPLS network or a part of it that packets take. The first LSR of an LSP is the ingress LSR for that LSP, whereas the last LSR of the LSP is the egress LSR. All the LSRs in between the ingress and egress LSRs are the intermediate LSRs. In Figure 4.5, the arrow at the top indicates the direction, because an LSP is unidirectional. The flow of labelled packets in the other direction right to left between the same edges LSRs would be another LSP A label switched path (LSP) is a sequence of LSRs that switch a labelled packet through an MPLS network or part of an MPLS network. Basically, the LSP is the path through the MPLS network or a part of it that packets take. The first LSR of an LSP is the ingress LSR for that LSP, whereas the last LSR of the LSP is the egress LSR. All the LSRs in between the ingress and egress LSRs are the intermediate LSRs. In Figure4.-5, the arrow at the top indicates the direction, because an LSP is unidirectional. The flow of labelled packets in the other direction right to left between the same edge LSRs would be another LSP.

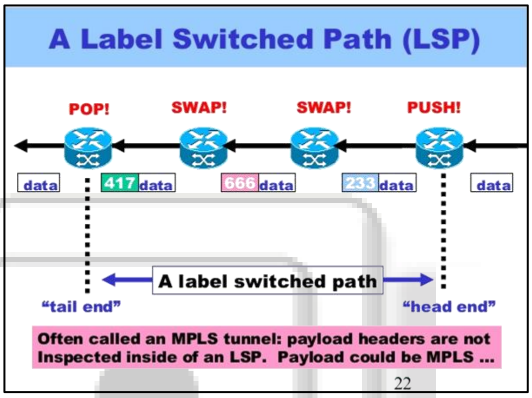

Fig. 3:

VI. IMPLEMENTATION

The experiment is carried out in GNS3 Software where five Cisco 3725 Series MPLS enable routers are used for testing and troubleshooting purpose. Two windows based PCs are used in this Experiment, one for traffic generation and other for traffic capture.

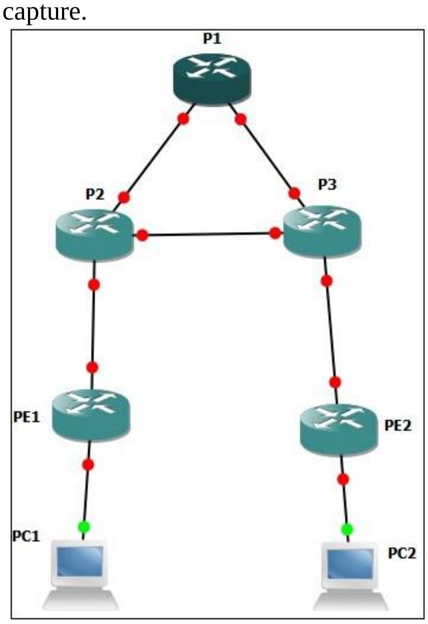

Fig. 4:

VII. RESULT

A. Latency in Network

This Latency is based on TCP connection of network it is round trip time for each packet. Network Latency is measured in terms of milliseconds.

1) Average Latency in IP and MPLS

Graphical representation of latency is obtain by using capture file during test. By applying appropriate filters in Wireshark we can obtain different graphical and statistical

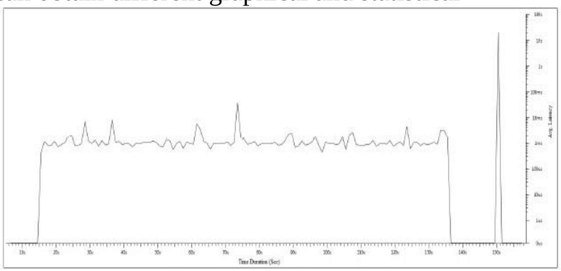

Fig. 5: Average Latency in OSPF

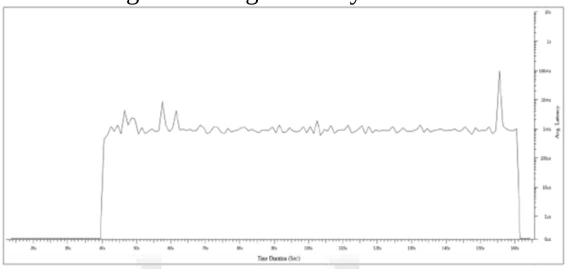

Fig. 6: Average Latency in MPLS

B. Packet Loss

Packet loss is cased due to congestion in the network, connectivity issue, delay in network etc. Wireshark Capture file at PC1 gives details about packet loss.

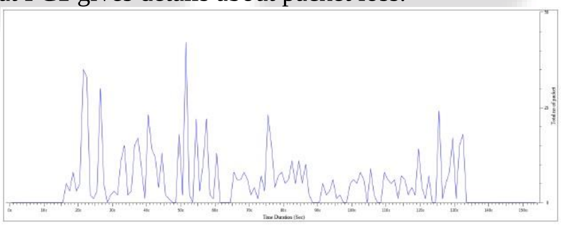

Fig. 7: Packet Loss in OSPF

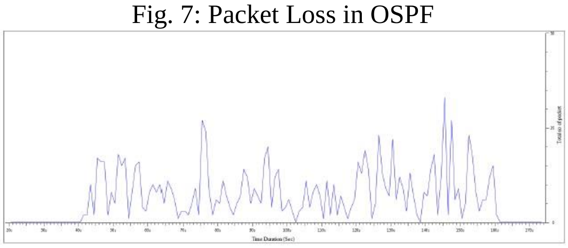

Fig. 8: Packet Loss in MPLS

VIII. CONCLUSION

In this work, experimentation is carried out in Lab environment with the MPLS network under various traffic conditions. The traffic condition is similar to the present traffic conditions of the service providers. The enhanced condition of the traffic is generated considering the future demand in the growth of the traffic. This is achieved by limiting the link bandwidth and traffic was generated by various tools to check Performance parameter. This traffic causes congestion in the network and behaviour of MPLS protocol is observed. Latency is improved MPLS enabled network than traditional IP network. There is significant visible difference in throughput of MPLS network which can generate high revenue for Service provider. As throughput was increased packet loss also increased in MPLS. This indicate performance is not as good as traditional IP but this can be improved with TCP packet loss avoidance mechanism. Average one way jitter in VoIP call is less than 30ms and we observed MPLS has edge in jitter value which is less than IP (OSPF), only one VoIP call is made between 3CX phone system clients, when traffic is more congested and severe then we may get different values of jitter but both mean jitter values are accepted for making VoIP call successful. MPLS definitely has edge in Service provider network where internet traffic is increasing day by day / The effect of various performance parameters of and MPLS network under different conditions will helpful in finally deploying and designing the MPLS network for a service providers (Such as MTNL).

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