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A Detail Review on Multiprotocol Label Switching (MPLS)

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Abstract— Multiprotocol level switching is rapidly emerging technology which plays a main role in new generation network by improvising QoS scalability speed and other features like traffic engineering. MPLS provide a framework that efficient for routing, switching and forwarding. MPLS allow for creating end-to-end circuits by using any transport protocol. The main goal of MPLS is to eliminate the dependency of OSI model data link layered technology i.e. frame relay, Ethernet, asynchronous transfer mode. This paper provides a detail overview on MPLS with its terminologies, functioning and the services that it offers

Keywords— MPLS, VPN, LSR, LDP, LER, LSP, FEC.

I. INTRODUCTION

IP based networks typically provide minimum QOS features available in circuit switch network such as ATM and frame relay. MPLS brings the mundanely of a connection oriented protocol to the connectionless IP protocols [2]. MPLS is an Internet Engineering Task Force (IETF) specified framework that offers efficient routing, switching and traffic forwarding. It is a technology for delivering IP based services. It provides the ability to offer highly advance IP services and highly scalability features with easy configuration and management for both customers and service providers. In a conventional IP networks each router performs an IP lookup determines the next hop based on its routing tables and forewords the packet to the nearby neighbors due to this creating lot of load at each router interface [3]. On the other hand MPLS makes packet forwarding decision that based on timestamp of label. MPLS works in OSI,DLL and network layer so due to this reason it is also known as layer 2.5 networking protocol. MPLS is an innovative technique that using label based forwarding paradigm [4].

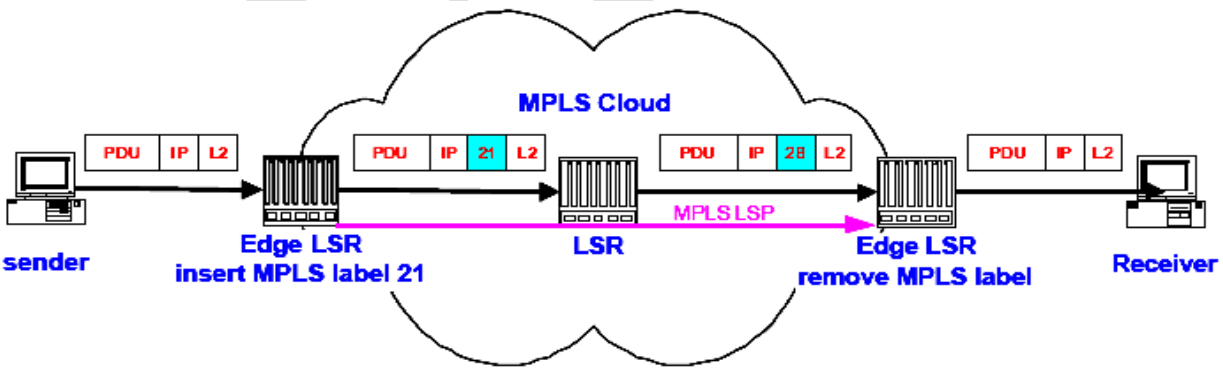

Figure 1: MPLS Infrastructure

II. MPLS

MPLS is standardized by the Internet Engineering Task Force (IETF) is a packet switching technology that support QOS on internet and transmits traffic efficiently. MPLS improves the routing performance in the network layer [3].

MPLS is used by internet service provider networks and provide QOS and guaranteed efficient bandwidth to internet protocol. MPLS supports layer 2 protocols such as Ethernet, ATM and frame relay. Because of different type of network structure, MPLS is able to constitute end-to-end IP connections with multiple QOS characteristics associated with multiple transport media; its aim is to give router a big power communication. So it especially basses on label instead in between layer 2(data link layer) and the layer 3 (network layer) in OSI mode that's why it is called layer 2.5 protocol [5].

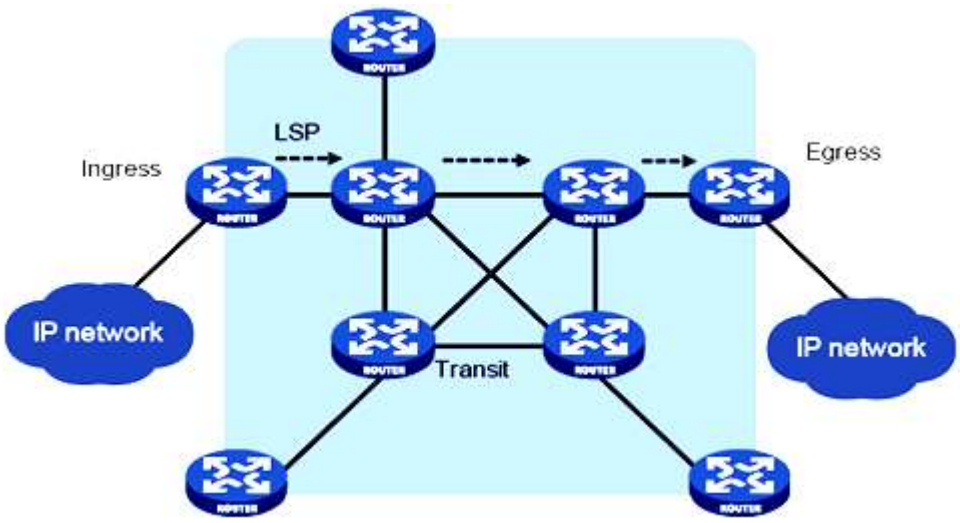

Figure: 2 MPLS Network

In MPLS network, arriving packets are allotted a "label" by a "LER (label edge router)" according to their forwarding equivalence class (FEC) [5]. Packets are forwarded along a "label switch path (LSP)" where each "LSR (label switch router) Makes forwarding decision based entering on the contents of the label, eliminating the need of the IP address so that intermediate router does not have to execute a time consuming routing lookup [6]. For each hop, the LSR acquires the existing label and put on a new label for the next hop. The forwarding of packet is also decided by next hop by reading the label on the packet these established paths, label switch paths can ensure a certain label of performance or to create IP tunnels for network based virtual private networks [7].

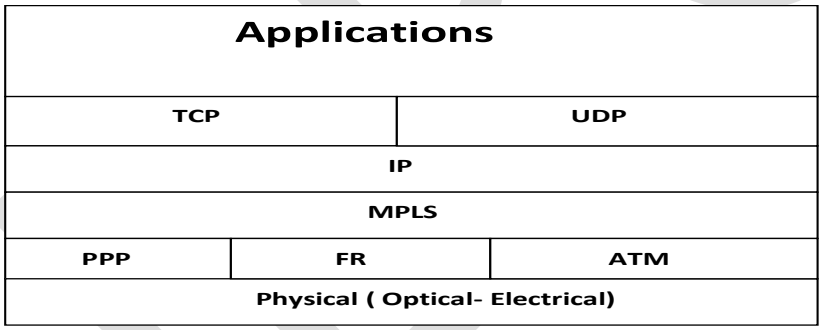

Figure: 3 OSI Reference Model for MPLS

2.1 MPLS Shim Header

Data packets when reaches the LER, "Shim Header" is placed in between Data link Layer of OSI model. This MPLS Shim Header is structured in four parts has total length of 32 bits, for label 20 bits, for experiment 3bits, for bottom of stack 1 bit and for time to live (TTL) 8 bits [6]. MPLS Shim Header comprises of an identifier called "label". It acts as identifier of forwarding equivalence class (FEC); and also for determining the label switched path (LSP). Followed by label is experimental field (exp) that is reserve for the experimental use or often used for QOS purpose [8]. Stack field is used to indicate that the label is in the lower level of the stack. The value of the label is set to one else is set to ZERO if the label is at the last entry of the stack [8].

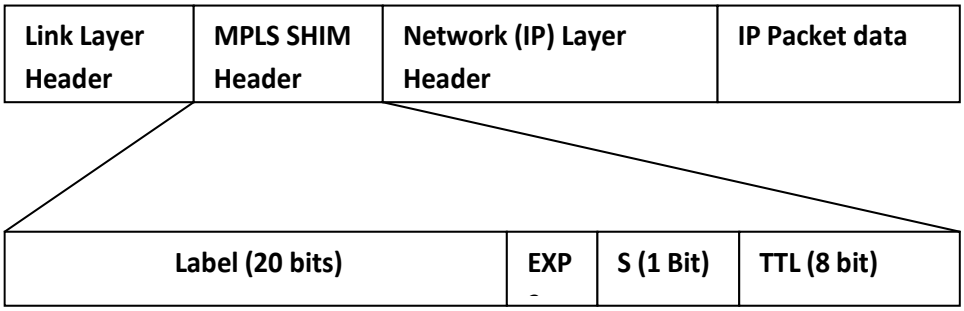

Figure: 4 MPLS shim header

The last one is the (TTL) value. The value of TTL decreases by 1 at every hop when it goes through the LSRs. when TTL value reaches to 0 the packet is dropped. Level and SHIM HEADER plays a very important role among all the fields of MPLS [8].

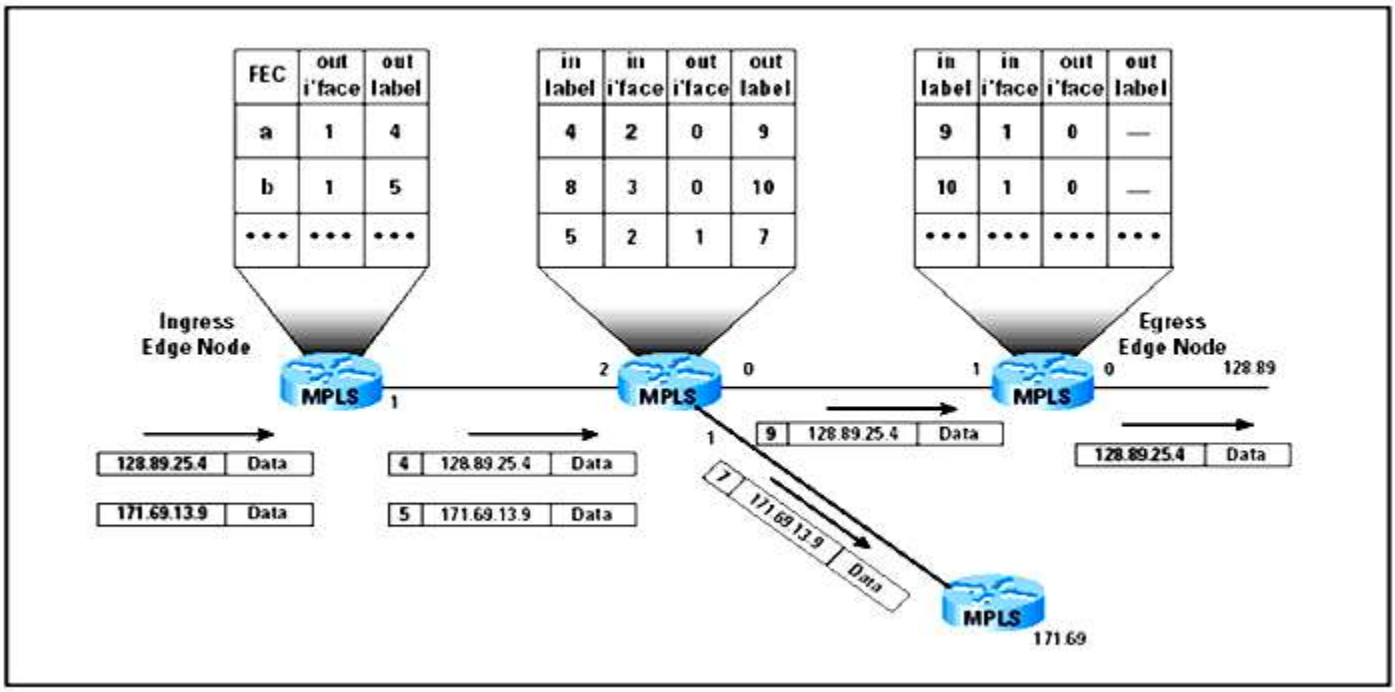

Figure 5 : MPLS Packet Forwarding.

III. MPLS Elements

Label: It identify the path that is followed in the MPLS network which allows the routers to enhance the routing speed [9].

Label switch routing (LSR): A router which is plays in the MPLS domain and send the packets based on label switching is called LSR and usually provider cloud is located by this type; whenever LSR receive a packet it check only lookup table and then determines next hop value [9]. After that before sending the packet to the next hop it removes label from the header and then attaches new label [9].

Label edge router (LER): it handles L3 lookups that is responsible for removing or adding the labels from packets when they leave or enter the MPLS domain [10]. Whenever a packet is leaving an entering in MPLS domain it has to pass across LER router, whenever packet enter into MPLS domain via LER which is called “ingress router” or whenever a packet levels the MPLS domain via LER which is called “egress router” [10].

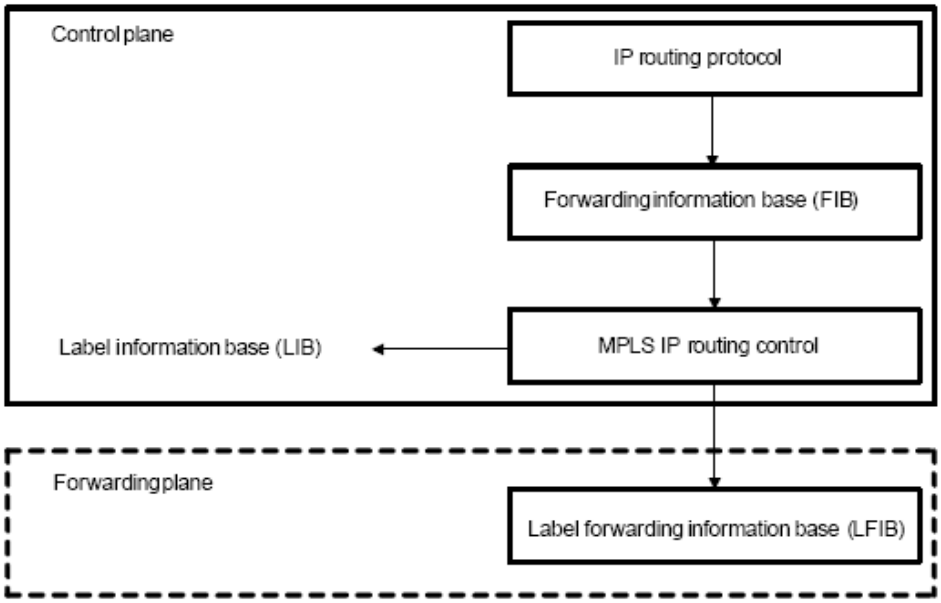

Figure: 6 Structure of an LSR

Label distribution protocol (LDP): LDP protocol where the information of label mapping is exchange between LSRs. It is responsible for maintaining a establishing Labels between routers and switches [10].

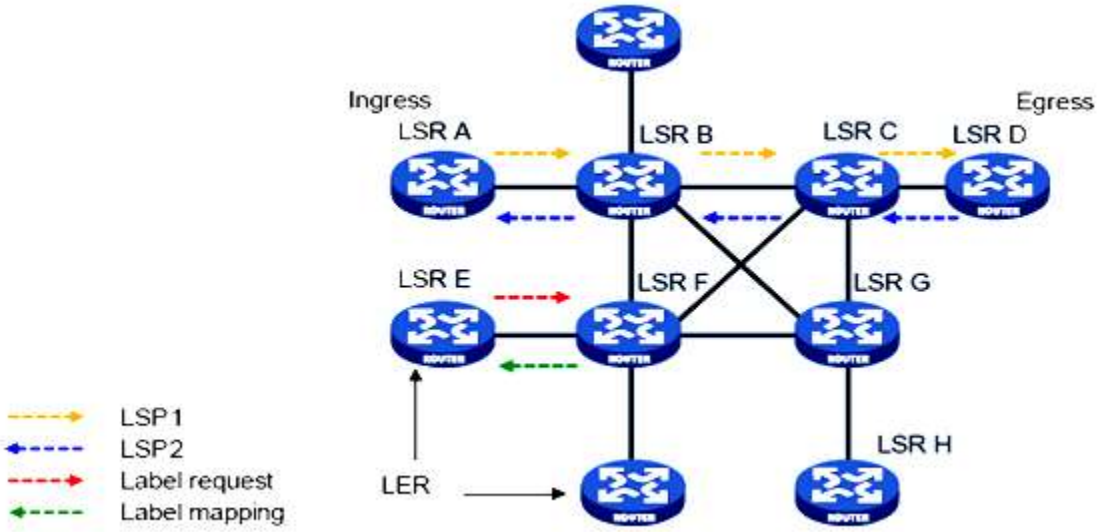

Figure: 7 Label distribution

Forward equivalence class (FEC): In FEC , set of packets that having same behavior and priority are forwarded to the same path this set of packet has same MPLS label [10]. IN MPLS network is packet is assigned with FES only once at the ingress router [9].

Label switched path(LSP): In MPLS domain the path is set by signaling protocols. In MPLS domain there are lots of LSPs that are coordinated at ingress router and traverses one or more core LSRs and stop egress router.there are two nodes to create LSPs in MPLS network, one is control driven LSP and another one is explicitly routed LSP [9]. Control driven are also known as hop-by –hop LSP that are set by using LDP protocol [10].

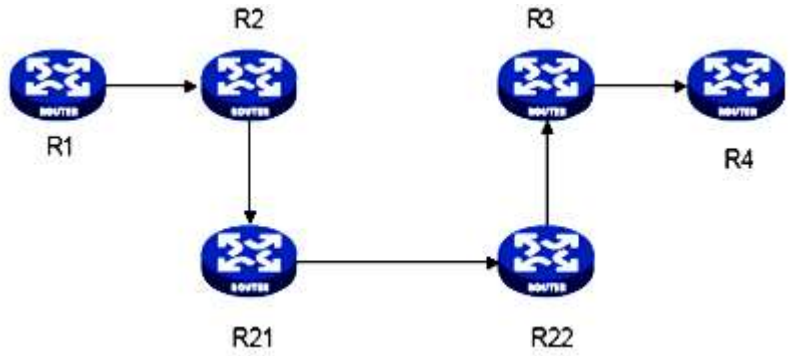

Figure: 8 Diagram for an LSP

IV. Traffic Engineering

It is the process of ensuring traffic across the network with the purpose of balancing load on various switches, links and routers to increase the cost efficiency and make the use of available bandwidth easy [11]. In MPLS the traffic engineering is performed by ATM or IP dependency upon the protocol. The goal of traffic engineering is to promote the reliable and efficient IP network operation. While simultaneously optimizing network performance and resource utilization [12].

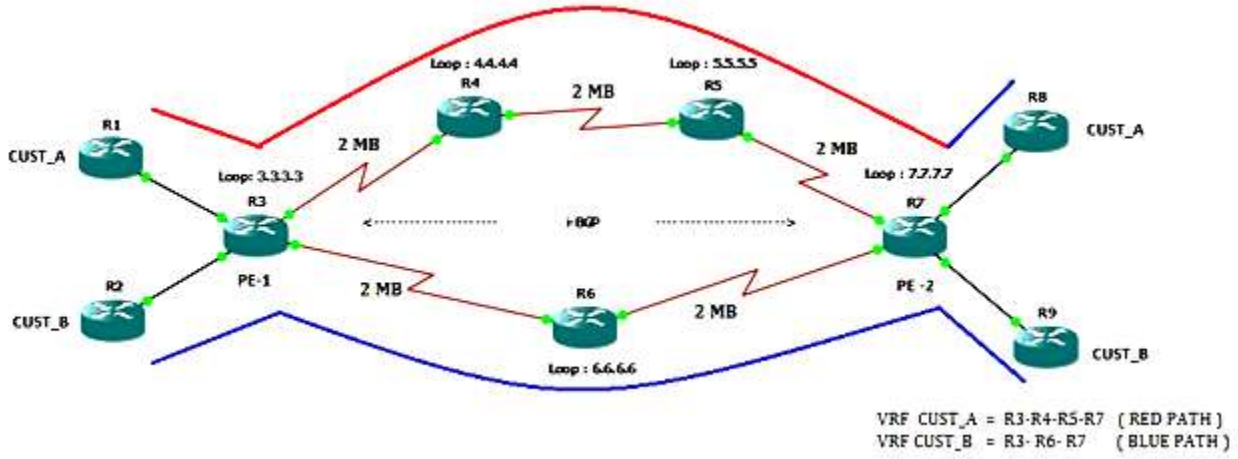

Figure: 9 Traffic Engineering

The LSPs are produced independently, specifying various paths that are based on user defined policies. On other hand it may require extended operator intervention. CR-LDR and RSVP are the two possible approaches to supply QOS and dynamic traffic engineering in MPLS [12]. Voice over IP (VOIP) route specify by MPLS, VOIP maintain high linkage consumption and takes less congested area by avoiding packet loss [13]. To provide efficient mapping of network of network resource to traffic stream traffic engineering modifies the routing patterns. This mapping can lessen the occurrence of congestion and can play an necessary role in implementing network services with quality of service (QOS) guarantees. These MPLS traffic engineering efficiency bring bandwidth reservation, constraint-based routing and explicit routing to MPLS network [12].

V. MPLS OPERATION

Step1:- The network automatically forms routing tables as MPLS enabled router participate in interior gateway protocols over the network [14]. Label to destination network mappings are establish by label destination protocol (LDP). To establish label values between the adjacent devices label distribution protocol uses the routing topologies in the table [14].

Step 2:- When a packet enter the ingress edge label switching router then firstly it is processed to find out which layer 3 services it requires ,such as bandwidth management and (QOS) and also edge LSR selects and applies a label to the packet header and applies a label to the packet header and forwards it [14].

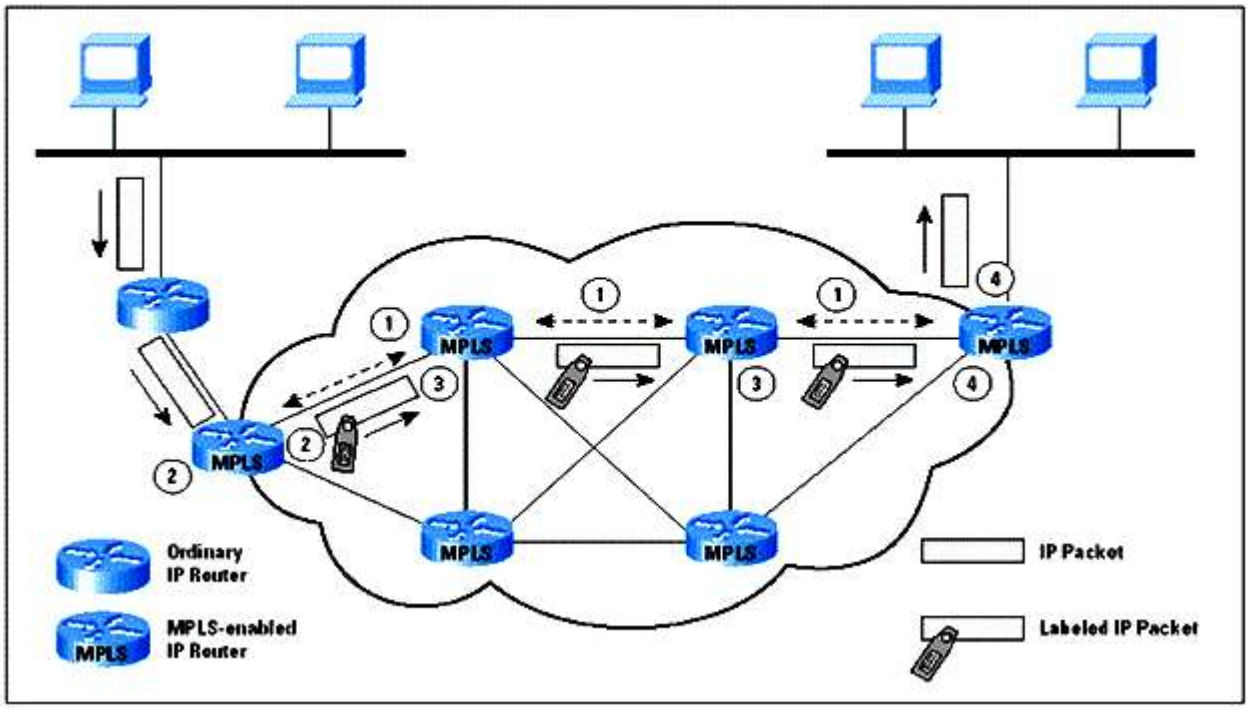

Figure: 10 MPLS OPERATIONS

Step3:- The LSR reads the label values first on each packet then replace with new one as listed in the table and then forward the packet [14].

Step4:- Egress edge routers strip the label value first then read the packet head and then forward it to the final destination [14].

VI. MPLS Services

MPLS VPN: - virtual private networks (VPNs) are a technique of interconnecting multiple sites belonging to the different client employing a service provider network in place of dedicated charted lines [15].

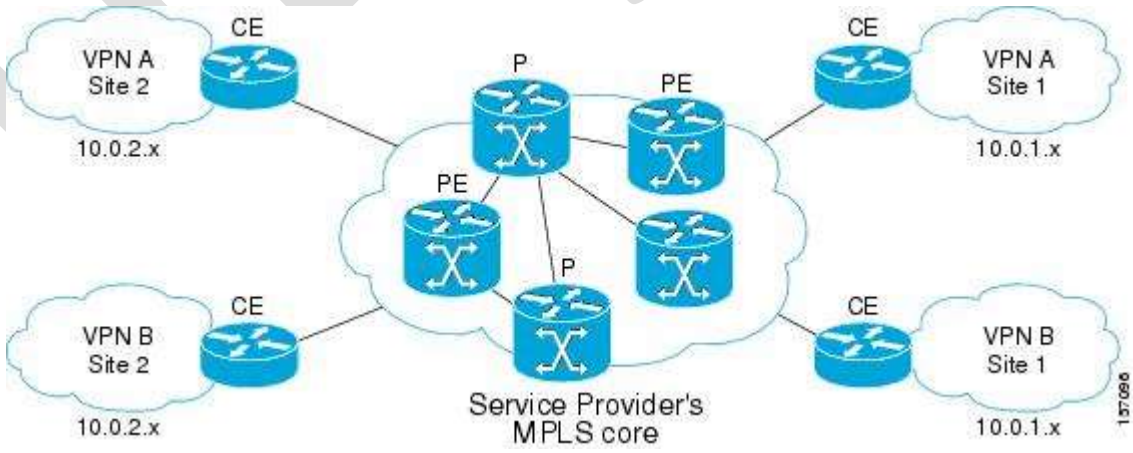

Figure: 11 MPLS VPN

Every client employing a service provider network in place of dedicated charted lines. Every client site is directly connected to the SP backbone. The SP offers a VPN services more economically then dedicated non-public VPNs are engineered by every individual client as a result of SP will share a similar backbone network resource between many shoppers [16]. The client conjointly gains by

outsourcing the complicated task of planning, provisioning and managing a geographical distributed network to SP.MPLS enabled informatics VPN are connectionless IP networks with similar privacy as frame relay and multiple IP services categories to enforce business based policies. MPLS based VPN builds operations router more economical [16].

The classical overlay VPN solution need tunneling or encryption deployed over a frame relay ATM or IP network. This mesh answer is made point-to-point requiring spate configuration of every tunnel or virtual circuit [17]. Moreover fails the traffic tunnel or overplayed the circuit doesn't grasped which sort of traffic it carries. By contrast if the client traffic are often classified by application client like voice, email or mission critical application, the network will simply assign traffic to the acceptable VPN while not configuring point-to point meshes [18]. Compare to the VPN overlay answer associate degree MPLS enabled VPN network will separate traffic and supply privacy while not tunneling or encryption. Using labels MPLS enabled network give privacy on a network-by-network basses very much like frame relay provides it a connection- by-connection basses. The frames relay VPN offers transport whereas MPLS enabled network supports services MPLS is that technology which offers switches and routed networks. It allows fast and cost efficient preparation of VPN of all sizes all over a similar infrastructure [18].

MPLS & QOS: Some form of traffic like video, place specific demand on network for flourishing transmission. QOS outlined as those mechanism that provide network manager the power to rectangle the combination of information measure delay jitter and packet class within the network at the ingress to the MPLS network internet protocol precedence information may be traced as class of service (COS) bits or may mapped to line the suitable MPLS (COS) worth with in the MPLS label [19]. This can be the excellence between IP QOS that supported IP precedence field within the IP header and MPLS QOS that's that supported the COS bits within the MPLS label. MPLS COS information is employed to produce differentiated services. Thus MPLS COS allows end-to-end IP QOS across the network [19].

MPLS Tunneling: In the MPLS network when a packet enters firstly a label is inserted within the front of the packet header therefore the packet is encapsulated inside the MPLS network. MPLS creates a label switch path through the network for tagged packets. Then the packet change follows this label switch path rather than routing the packet supported the destination address within the IP header. Therefore PMLS effectively creates tunnel through the network [20].

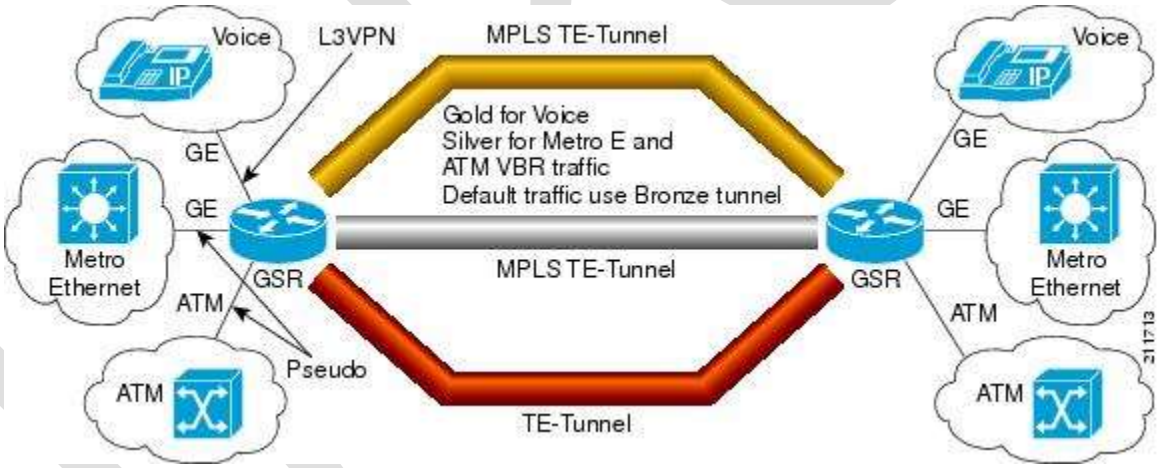

Figure: 12 MPLS Tunneling

This tunnel encompasses well defined entrance. A well defined exit and a gate to manage what's allowed into tunnel. Packets getting into the tunnel should pass the getting criteria once within the tunnel there are no branch exist since the packet isn't routed at intermediate mode. Since only the network operator will produce label switched methods, malicious users cannot produce further tunnel entrance or dispute the network The overhead caused by the MPLS tunneling depend upon the depth of the label stack [20]. Flow Merging:-MPLS permits the mapping from IP packets to forwarding equivalence class should be performed only one time at the ingress to the MPLS domain a forwarding equivalence category could be a set of packet which will be handled equivalently for the aim of forwarding and therefore it is appropriate for binding to a single label form a forwarding point of view packet inside constant subset are treated by the label switching router within the same approach even through the packet dissent from one another with relevance the knowledge within the IP header [20]. The mapping between information carried within the IP header of the packet and also the forwarding equivalence class is many to one. That is packet with completely different content of their IP header may will be mapped into constant forwarding equivalence category. For instance a collection of packet whose IP destination address matches a specific IP address prefix are often mapped into a specific forwarding equivalence category so the packet area unit tagged with constant label value and follow constant label switched path within the MPLS domain [19].

CONCLUSION

Multiprotocol Label Switching (MPLS) combines the intelligence of routing with the performance of switching and provides considerable benefits to networks with a pure IP architecture as well as those with IP and ATM or a mix of other Layer 2 technologies. This paper highlights the need for implementing MPLS technology to overcome some of the limitations involved in pure IP based forwarding. The innovative label based system simplifies IP based traffic routing from source to destination without affecting and manipulating the IP packets, thus highlighting the security aspect of MPLS networks. The paper also explains in-depth the technological standards involved and the use of these standards. The paper provides a detailed insight over the improved packet forwarding performance in MPLS based networks. MPLS operation and the signalling protocol called LDP which is most widely used in service provider networks are discussed at length.

REFERENCES:

[1] Yan Chen, Toni Farley and Nong Ye, "QoS Requirements of Network Applications on the Internet", International Journal of Information Knowledge Systems Management, 2004, IOS Press (55-76).
[2] Er. Sourabh Jain. July, "Performance Analysis of Voice over Multiprotocol Label Switching Communication Networks with Traffic Engineering", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 7, 2012
[3] Junaid Ahmed Zubairi., "Voice Transport Techniques over MPLS", International Symposium of High Capacity Optical Networks and Enabling Technologies, 2008.
[4] Aruna Kapoor, Sunila Godara, Sanjeev Khambra, Amandeep, "Comparative Analysis of Signaling Protocols in Mpls Traffic Engineering", National Workshop-Cum- Conference on Recent Trends in Mathematics and Computing (RTMC), 2011.
[5] Dr. Reyadh Shaker Naoum and Mohanand Maswady, "Performance Evaluation for VOIP over IP and MPLS" , World of Computer Science and Information Technology Journal (WCSIT), Vol. 2, No. 3, 2012, 110-114.
[6] Jasmina Barakovic Himzo Bajric, and Amir Husic., "Multimedia Traffic Analysis of MPLS and non-MPLS Network", International Symposium ELMAR-2006, Zadar, Croatia, June 2006.
[7] Mahesh Kr. Porwal, Anjulata Yadav, S. V. Charhate. July, "Traffic Analysis of MPLS and Non MPLS Network including MPLS Signaling Protocols and Traffic distribution in OSPF and MPLS", International Conference on Emerging Trends in Engineering and Technology, ICETET, June 2008.
[8] Md. Arifur Rahman, Ahmedul Haque Kabir, K. A. M. Lutfullah, "Performance Analysis and the Study of the behavior of MPLS Protocols",\ International Conference on Computer and Communication Engineering, Kuala Lumpur, Malaysia, May 2008.
[9] Abdellah Jamali, Najib Naja and Driss El Ouadghiri, "An Enhanced MPLS-TE for Transferring Multimedia packets", International Journal of Advanced Computer Science and Applications, (IJACSA), Vol. 3, No.8, 2012.
[10] Keerthi P. Jannu. June, "OPNET simulation of voice over MPLS with Considering Traffic Engineering", M.Sc. Thesis, School of Computing, Blekinge Institute of Technology, Sweden, 2010.
[11] Faiz Ahmed and Dr. Irfan Zafar, "Analysis of traffic engineering parameters while using multi-protocol label switching (MPLS) and traditional IP networks", Asian Transactions on Engineering (ATE ISSN: 2221-4267) Volume 01 Issue 03, 2011.
[12] Anupkumar M Bongale and Nithin N., "Analysis of Link Utilization in MPLS Enabled Network using OPNET IT Guru", International Journal of Computer Applications (0975 – 8887), Volume 41– No.14, March 2012.
[13] E. Rosen, A. Viswanathan, R. Callon. January, "Multiprotocol Label Switching Architecture", Network Working Group RFC 3031, 2001
[14] Wei Sun Praveen Bhaniramka, Raj Jain, "Quality of Service using Traffic Engineering over MPLS: An Analysis", 25th Annual IEEE Conference, Local Computer Networks, LCN Proceeding, 2000.
[15] Abdellah Jamali, Najib Naja, Driss EI Ouadghiri and Redouane Benaini, "Improving Quality of Service (QoS) in Multi-Protocol Label Switching Module", IEEE Mediterranean Microwave Symposium, Nov 2009.
[16] Hang Man and Yang Li, "Multi-Stream Video Transport Over MPLS Networks", IEEE Workshop of Multimedia Signal Processing, Dec 2002.
[17] Jeevan Kharel, "Performance Evaluation of Voice Traffic over MPLS Network with TE nd QoS Implementation", M.Sc. thesis, School of Computing Blekinge Institute of Technology, Sweden, Nov 2011.
[18] Muhammad R. A. Rahimi, Habibah Hashim, Ruhani Ab Rahman, "Implementation of Quality of Service (QoS) in Multi-Protocol Label Switching (MPLS) Networks", International Colloquium on Signal Processing & Its Applications (CSPA), 2009
[19] Jawad Oubaha, Adel Echchaachoui, Ali Ouacha, and Mohammed Elkoutbi, "New Method: Mapping of 802.11e into MPLS Domains, Conception and Experimentation",
Springer-Verlag Berlin Heidelberg CCIS 189, 2011, pp. 470–483.
[20] Mohsin Khan, "MPLS Traffic Engineering in ISP Network", International Journal of Computer Applications (0975 – 8887), Volume 59– No.4, Dec 2012.
[21] Tatiana Onali, "Quality of Service Technologies for Multimedia Applications in Next Generation Networks", Ph.D. thesis, University of Cagliari, Italy, 2009.