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Multi Protocol Label Switching with Quality of Service in High Speed Computer Network

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***Abstract* — This research paper represents the Multi-Protocol Label Switching (MPLS) contributing high scalability in computer network. In this research paper, we first briefly analyze MPLS and then have a discussion about the working methodology of an MPLS system. We also thrash out how to provide Quality of Service (QoS) in a network with MPLS. Putting these simultaneously and then demonstrate the Traffic Engineering in MPLS.**

***Index Terms*— MPLS, ATM, LDP, LSR, TCA, PHB, QoS, TE.**

I. INTRODUCTION

Multi Protocol Label Switching is a method that directs data from one system node to the next based on short path labels rather than long network addresses in high-performance telecommunications association [1]. It offers high scalability, end-to-end IP services having simple configuration and management for customers and service providers. It forwards packets in any system protocol, which are the building blocks of data transmitted over the Internet. Each packet has a header. In a non-ATM background, the header contains a 20-bit label, a 3-bit Class of Service and 1-bit label stack. In an ATM background, the header contains only a VCI / VPI that stand for Virtual Channel Identifier/Virtual Packet Identifier encoded label. These labels reduce the time of a router to search for the address to next node to forward packet.

Table 1: Layers of OSI Model

Application Layer (7)
Presentation Layer (6)
Session Layer (5)
Transport Layer (4)
Network Layer (3)
Data Link Layer (2)
Physical Layer (1)

In this table, MPLS operates in Layer 2 & 3 MPLS operates between layer 2 and 3 of OSI that stand for Open Systems Interconnection) model. MPLS is known as "multi-protocol" because it works with Internet Protocol (IP), Asynchronous Transport Mode (ATM) and Frame Relay network protocols [2]. MPLS supports a range of access technologies including ATM, Frame Relay, PPP (Point to Point Protocol), Packet over SONET, LAN technologies like that example such as Ethernet, Token Ring and DSL that stand for Digital Subscriber Line.

II. WORKING METHODOLOGY OF MPLS

MPLS works by prefixing packets with an MPLS header having one or more label known as label stack. With the contribution of MPLS-capable routers or switches in central gateway protocols such as Open Shortest Path First (OSPF) or Intermediate System to Intermediate System (IS-IS), the network automatically builds routing tables. Label Distribution Protocol (LDP) uses this table to establish label values between neighboring devices. The entry and exit part of MPLS network is known as Label Edge Routers (LERs). Through LERs a packet enters Label Switching Router (LSR) for processing to determine the service it requires such as Quality of Service (QoS) and

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bandwidth management [3]. LSR then selects and apply a label to the packet header based on routing and strategy requirement and forward the packet. LSR reads the label on each packet and swaps it with a new one from the table and forward it. In a push operation, a new label is pushed on the top of existing label and this process is called encapsulating the packet. In a pop operation, the label is removed from the packet and this process is known as decapsulation. LSR reads the packet header and send it to its final target.

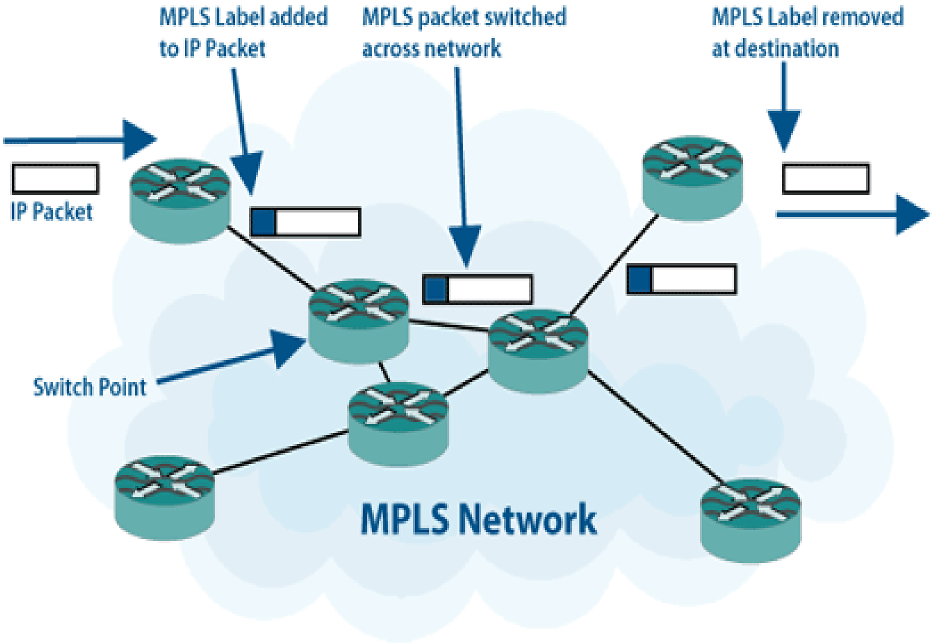

Fig 1: Working Methodology of MPLS

The ability of MPLS to allocate a label is most considerable in business IP services. Set of labels is used to discriminate between routing information and application type. The label is compared with the pre computed switching table to apply the accurate IP Services to the packet. This attribute is crucial to implement advanced IP Services such as Quality of Services (QoS), Virtual Private Networks (VPNs) and traffic engineering.

III. QUALITY OF SERVICE OF MPLS

QoS stand for Quality of Service is defined as the set of techniques to control bandwidth, delay, and jitter and packet loss in a network. QoS also provides techniques to supervise network traffic. It refers to a number of related features of telephony and computer networks that permits the transportation of traffic with the necessities. QoS manage when and how data is dropped when obstruction occurs through network administrators [4]. At LER that stand for Label Edge Routers and Internet Protocol (IP) precedence is copied as Class of Service (CoS) and can be mapped to set the value of suitable MPLS CoS value in MPLS Label. Thus IP QoS is based on the IP precedence field in the IP header [5]. MPLS QoS is based on the CoS bits in MPLS Label. This is the only dissimilarity between the IP QoS and MPLS QoS. Therefore MPLS CoS enables continuous IP QoS across the network. One can decode the customer's commercial requirements into technical provision which are used to map detailed configurations providing reliability, supportability and assured level of services using service design viewpoint. The fundamental components of Service Design Viewpoint (SDV) are Traffic Conditioning Agreements (TCA), service metaphors and business agreements. There are service classes also which support SDV. Traffic receives different levels of presentation under different classes. The most important task of SDV is to allocate responsibility for mapping traffic as following:

- Traffic Conditioning Agreements (TCA): TCA defines the mechanism used to recognize the service (accounting, advertising and disposal).
- Service Metaphors: It includes service name, business function, application type, application requirements etc.
- Per Hop Behavior (PHB): Defines a combination of forwarding, categorization and drop behaviors at each hop. It is applicable for transmitting packets of one particular service type.

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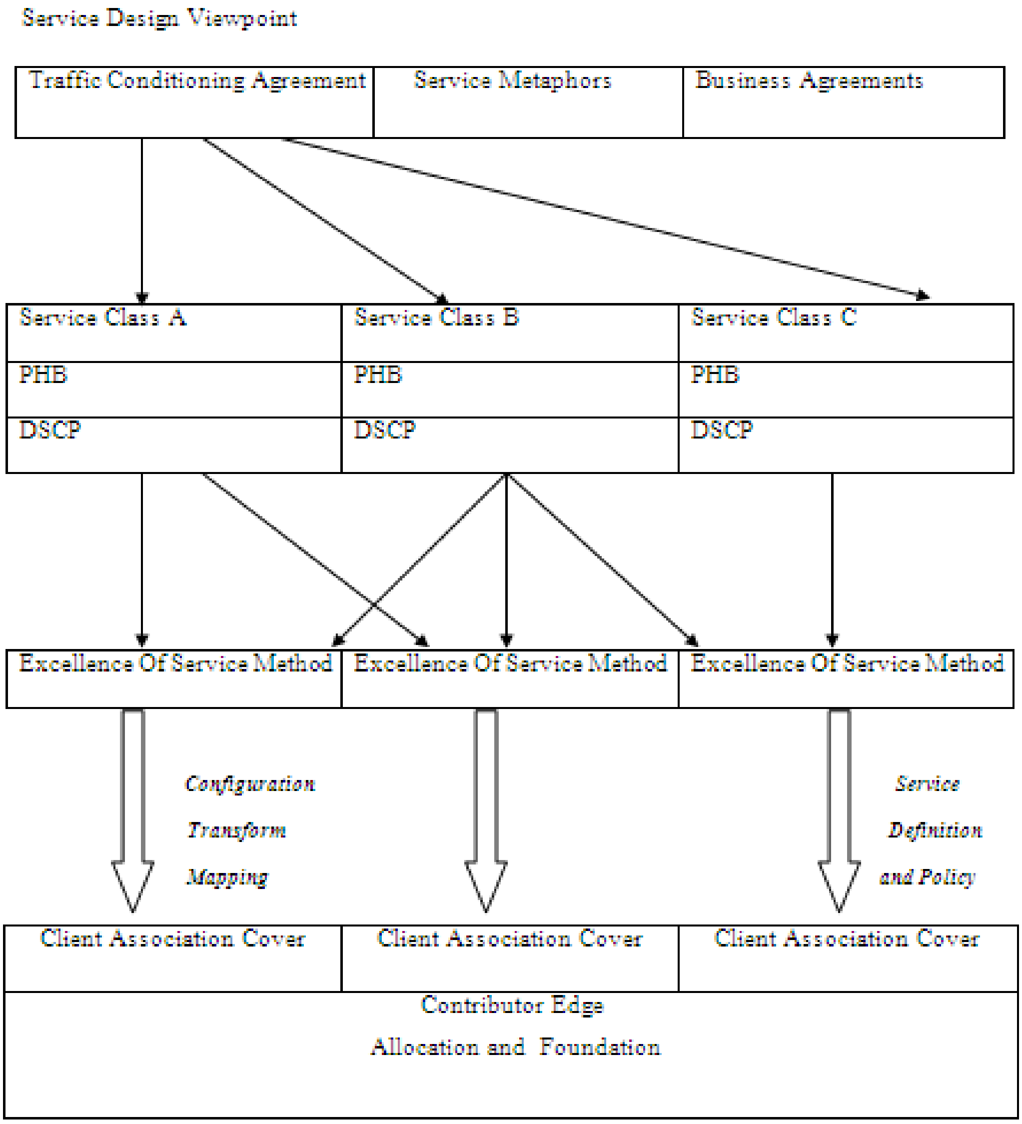

Fig 2: Service design viewpoint in Quality of Service of MPLS

We can use service prevailing conditions, in which rules are written to categorize customer's traffic, to interpret business necessities into service legal agreements as following table:

Table 2: Service Prevailing Conditions

Service Metaphors	Traffic Conditioning Agreement (TDA)	Per Hop Behaviour (PHB)	Operations support and supervision
• Delay tolerant applications such as Internet/Intranet browsing, file transfer	• Finest attempt release • Unmanaged presentation • Regular accessibility	• Default PHB	• Regular

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• Operation significant data • E business	• Low loss rate • Prohibited latency • Prohibited Jitter • High accessibility	• Secured forwarding PHB	• Regular • Optional improvements
• Real-time applications • Video streaming • Video conferencing	• Very low loss rate • Very low jitter • Very low latency • Highest accessibility	• Advanced forwarding PHB	• Regular • Optional improvements

To provide differential services to different service classes queuing technologies such as Class-Based Weighted Fair Queuing (CBWFQ), Low Latency Queuing (LLQ), Modified Deficit Round Robin (MDRR) and Weighted Random Early Detection (WRED) are used. PHB provide the forwarding instruction sent to generate a packet management for internal scheduling and buffering of collective class based flows that is used on a hop by hop basis. MPLS enabled CoS provides all the benefits with very less complexity. There are two ways to specify service class in MPLS flow:

A.IP Precedence: It permits 8 service classes. The IP Precedence bit is copied to CoS field in MPLS header. This method is used in routed cores.

B.Set of Labels: It is used to find out which traffic requires priority queuing. This method is used in IP+ATM networks in addition to routers networks.

I. TRAFFIC ENGINEERING IN MPLS

Traffic Engineering (TE) refers to the process of controlling traffic across a network with the purpose of balancing the load on various links, routers and switches, to make the use of available bandwidth easy and increase the cost efficiency. In MPLS traffic engineering is performed by IP or ATM depending on the protocol. A Label Switched Path (LSP) is established for transporting traffic which is different from standard destination based routing path [6]. IP networks have numerous pathways for traffic to arrive at its destination. TE with IP is implemented mostly when there are multiple paths between two end points. Based on Open Shortest Path First (OSPF), some paths are congested while others are underused. MPLS specify a route, Voice-Over IP (VoIP), which takes less congested routes and maintain high linkage consumption by avoiding packet loss.

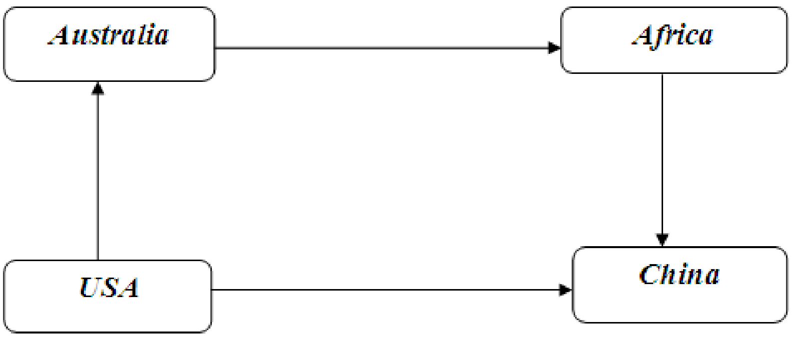

Fig3: Traffic Engineering In MPLS

In above figure there are two paths from USA to China. Each path has equal bandwidth. Most IGPs select US-China because it has direct link. This makes the direct link very congested but on other side USA-Australia-Africa-China will be underused. Using MPLS TE, a TE channel can be established between USA and China. This channel links to China directly reducing congestion. In this case, TE shows optimal utilization of available network resources.The advantage of implementing MPLS TE is that it combines the IP CoS with the capabilities of ATM's TE. The advantage also includes the minimization of network congestion, identification of

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customer traffic and flexibility. It is flexible when overflowing packets are transferred to their links. TE is essential for Internet Service Provider (ISP). TE enables ISP to offer best services in terms of throughput and delay to router networks.

V. CONCLUSION

The objective of this paper is to provide Multi Protocol Label Switching which is a method that directs data from one system node to the next based on short path labels rather than long network addresses in high-performance telecommunications association with high scalability to deliver IP services. In MPLS traffic engineering is performed by IP or ATM depending on the protocol.

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