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Review on QoS Improvement with MPLS Mechanism in NGN

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Abstract: This review paper mentions that the appearance of new uses underlines the need for a greater quality of service (QoS) not only for conveying accurately or increasing certain traffic, but also conveying it as soon as possible, which implies a network management even more complex. These lead to development of technology known as Multi-Protocol Label Switching (MPLS). Due to the MPLS technology mechanisms traffic engineering, QoS and security become possible for IP network to be efficient. Various methods of engineering of traffic for IP networks have been specified for several years (such as DiffServ (Differentiated Services), IntServ/RSVP (Integrated Services / Resource Reservation Protocol) to get end-to-end quality of service but MPLS is found simple, scalable and better among them. This allows the traffic in network to manage in a more effective way and avoid the cases of congestion. In this review paper principle operation of MPLS is discussed. We strongly focus on the importance of the MPLS used for the transport of the IP datagram and the traffic as well as underlined the advantages of MPLS utility in the IMS platforms to provide guarantees of QoS from beginning to end. At the end of this review paper simulation results from an MPLS network is mentioned.

Keywords: Next Generation Network (NGN), Multi-Protocol Label Switching (MPLS), Quality of Service (QoS), Label Switch Router (LSR), Label Edge Router (LER).

I. INTRODUCTION

NGN in [1] is a packet-based network able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. NGN provides revolution in the mobile networks, the capacity to ensure the seamless mobility with end-to-end QoS present a vital criterion of the success in the NGN.

There are various factors such as low throughput and high latency, jitter and delay, which degrade the service level by affecting the QoS, so, here we discuss the needs to ensure the continuity of end-to-end QoS in such an environment. Development of MPLS technology makes it possible to design the multiservice network that able to meet the different requirements from various flows which they transport. The IETF thus defined new MPLS protocol with two main aims:

1. To allow a fast routing of IP packages by replacing the function of routing by a switching function much faster due to the substitution of the traditional tables of routing by much smaller matrices of commutation.
2. To facilitate engineering network by providing to the operators the control of the routing of the data which was very complex for the traditional protocols of routing like OSPF.

MPLS technology is key with the evolutionary virtual private networks (VPNs) and quality of service (QoS), allowing the effective use of existing networks to meet the future growth and the fast correction of fault of the failure of node. MPLS was conceived to provide a seamless service of transport of data for the customers by using a switching technique of label. MPLS can be used to practically transport any type of traffic (data, voice, video…etc).

This paper is composed of 6 sections they are organized as follow. Section 2 presents related work of QoS and MPLS. Section 3 presents Basic concept of MPLS, objective of MPLS, comparison between MPLS and ATM and operation of MPLS. Section 4 describes Traffic engineering with MPLS. Section 5 presents result of simulation. Finally conclusion and future scope presented in Section 6.

II. LITERATURE REVIEW

Quality of Service (QoS) is an important issue as more number of multimedia services and more interconnections are increasing day by day. Hence various mechanisms have been developed to improve and maintain QoS in every network generation since from first generation to the NGN. Josheff David C. And Paul Sanmartin M. [2] presented a model of QoS for NGN and verified its performance by conducting the experiments on a NGN Pilot on simulation tool OPNET modulator. They also discussed the policies such as Access control, the protocol controls and the algorithms of signaling and routing. To improve QoS though several works have been done such as RSVP, DiffServ but due to their issues like complexity and scalability these mechanisms have not been deployed yet. Jayoung Park and Shin Gak Kang in [3] proposed a simple and reasonable mechanism to provide end to end QoS that is resource reservation mechanism in this sender first reserves the path then sends the data. The result show the core router is always ensured data to correspond to resource reserved for. Also here QoS guarantee mechanism structure was proposed. Elloumi, T. Desprats, M. Sibilla in [4] proposed solution to ensure the seamless mobility with the end to end QoS by converging the QoS plan that is data plan, control plan and administration plan. Secondly they proposed to enrich Home Subscriber Server with more decision-making information to ensure the dynamic adaptations and make the IMS/NGN session more effective.

For Third Generation network Dongjie Huang and James J. Shi in [5] have proposed a mechanism to maximize system throughput while maintaining quality of service for users of wireless data applications. The mechanism used token bank leaky bucket (TBLB) for QoS provisioning followed by carrier-to-interference based radio resource management for optimum system performance. The results show that the proposed mechanism obtained the better performance in throughput an achieved the desired balance between QoS and system performance. For Forth Generation mobile network Yile Guo and Hemant Chaskar in [6] have proposed the QoS framework with low complexity and better efficiency for air interfaces in future wireless networks will need to support diverse IP multimedia applications. In this article they presented a class-based QoS framework and proposed a class-based bandwidth scheduling algorithm as a means of implementing this QoS framework over CDMA air interfaces. Divya and Sanjay Singh [7] have proposed Differentiated QoS methods allow the differentiation of users based on their priority levels and channel conditions so that the network can allocate the bandwidth for a particular request based on the QoS requirements. In this they have proposed two RRM algorithms which are modification to the existing scheduling algorithms. One is Prioritized C/I scheduling, which takes the priorities into consideration, and this algorithm serves the user with highest priority. Other algorithm is Modified Inverse C/I scheduling, which takes channel conditions into consideration and serves the users in degraded conditions, thereby improving QoS.

The greater QoS is not only needed convey or increase certain traffic but also to convey it as soon as possible and for that proper management of resources is to be done. Since last several years various methods of engineering of traffic for IP network have been specified. A. saika and R. E. Kouch in [8] proposed the mechanism that is Multi Protocol Label switching (MPLS) with its supporting platform IP Multimedia Subsystem (IMS) to provide guarantee of QoS from beginning to end. Multiprotocol label switching (MPLS) networks require dynamic flow admission control to guarantee end-to-end quality of service (QoS) for each Internet protocol (IP) traffic flow. In this paper Desire Oulai in [9] proposed to tackle the joint routing and admission control Problem for the IP traffic flows in MPLS networks without rerouting already admitted flows. They proposed two mathematical programming models for this problem. The first model includes end-to-end delay constraints and the second one, end-to-end packet loss constraints. The objective function of both models is to minimize the end-to-end delay for the new flow. Results showed that the mean end-to-end delay has been significantly reduced.

MPLS is a widely used protocol to forward packet by matching link-specific labels in the packet header. It is implemented by full IP routers but James Kempf and Scott Whyte in [10] described an extension of the Open Flow forwarding elements control interface and model to include MPLS without the need for IP routing to provide greater QoS. Where open Flow is an interface for controlling a routing or switching box by inserting floe specification into the box’s flow table. So, various researches have been done with MPLS technology to improve the performance of the network and study says, now-a-days MPLS technology is growing in popularity.

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Vol. 3, Issue 2, February 2014

III. MPLS

MPLS is a high-performance mechanism that directs data from one network node to the next based on short path labels rather than long network addresses, avoiding complex lookups in a routing table. The labels identify virtual links (paths) between distant nodes rather than endpoints. It uses the packet switching technique. MPLS can encapsulate packets of various network protocols. MPLS supports a range of access technologies, including ATM, Frame Relay, and DSL. MPLS technologies can overcome disadvantages of ATM. Many network engineers agree that ATM should be replaced with a protocol that requires less overhead, while providing connection-oriented services for variable-length frames. Therefore the advantages of MPLS primarily revolve around the ability to support multiple service models and perform traffic management.

The primary benefit is to eliminate dependence on a particular OSI model data link layer technology, such as Asynchronous Transfer Mode (ATM), Frame Relay, Synchronous Optical Networking (SONET) or Ethernet, and eliminate the need for multiple layer-2 networks to satisfy different types of traffic. MPLS is a scalable, protocol-independent transport. In an MPLS network, to every data packet labels are assigned and based on the content present in it every node takes the decision of packet forwarding. This allows one to create end-to-end circuits across any type of transport medium, using any protocol. MPLS networks allow the supply of advanced services such as virtual private networks (VPN) or voice (Voice over MPLS) offering a safety and an increased reliability, extremely fast switching times, ways (LSP) by class of service, the engineering of the traffic, a better control of quality of service. One more functionality it allows a better use of the resources from beginning to end in order to ensure the quality of service required by the applications in the data processing networks and telecommunications.

The MPLS label is shown in figure below:

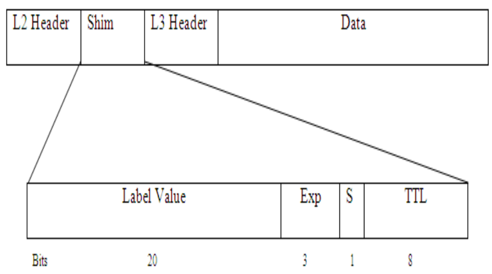

Fig. 1 MPLS label

This is called a label stack. Each label stack entry contains four fields:

- A 20-bit label value.
- Experimental field (3 bits) can be used for Classes of Service.
- A 1-bit bottom of stack flag. If this is set, it signifies that the current label is the last in the stack.
- TTL(8 bits)- time to leave.

The characteristics of MPLS are:

- Multiprotocol (multiprotocol): it is able to support the various protocols of lower level.
- Label switching (commutation of labels): it is based on a label or identifying for the commutation of the packages. This label is allotted to the packages by the equipment EP (Provider Edge) at the time of their entry in infrastructure MPLS [11].

A. Objective of MPLS

MPLS is a technical network in the course of standardization with the IETF whose main role is to combine the concepts of IP routing of level 3, and the mechanisms of the commutation of level 2 as shown in following figure implemented

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Vol. 3, Issue 2, February 2014

in ATM or Frame Relay, to improve the performance ratio/price of the equipment of routing, to improve the effectiveness of the routing (in particular for the wide-area networks) and to enrich the Services by routing.

MPLS operates at a layer that is generally considered to lie between traditional definitions of layer 2 (data link layer) and layer 3 (network layer), and thus is often referred to as a "layer 2.5" protocol. It was designed to provide a unified data-carrying service for both circuit-based clients and packet switching clients which provide a datagram service model. One of the initial objectives of MPLS was to increase the speed of treatment of IP packages to be conveyed in the network compared to the time wasted by the determination of the shortest way in the table of routing which is growing. Due to this following functionalities are possible:

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- The engineering of traffic and Quality of service.
- The creation of virtual private network (VPN).
- The integration of IP on ATM.

B. Comparison Between MPLS and ATM

MPLS and ATM both provide a connection-oriented service for transporting data across computer networks. In both technologies, connections are established between endpoints and it is maintained at each node in the path, and encapsulation techniques are used to carry data across the connection. The most significant difference is in the transport and encapsulation methods. MPLS is able to work with variable length packets while ATM transports fixed-length (53 byte) cells. Packets must be segmented, transported and re-assembled over an ATM network using an adaptation layer, which adds significant complexity and overhead to the data stream. MPLS, on the other hand, simply adds a label to the head of each packet and routs it on the network.

Differences exist, as well, in the nature of the connections. An MPLS connection is unidirectional allowing data to flow in only one direction between two endpoints. ATM point-to-point connections (virtual circuits), on the other hand it is bidirectional, allowing data to flow in both directions over the same path. The biggest advantage that MPLS has over ATM is that it was designed to be complementary to IP. Modern routers are able to support both MPLS and IP natively across a common interface allowing network operators great flexibility in network design and operation. ATM's incompatibilities with IP require complex adaptation, making it comparatively less suitable for today's predominantly IP networks.

C. *Operation of the MPLS*

The operation of the MPLS on the level of the transport layer of the IMS described detail in [12], MPLS forwards the data based on label content without considering the packet contents. The path establishes in between EP (Provider Edge) either in a manual way (action of an administrator in the plan of administration) or automatic (via a protocol of indication like LDP - Label Protocol Distribution - in the plan of control).The router of entry performs encapsulation of the traffic received on his interfaces. He assigns a label to the received package and sends it towards one of its outgoing interfaces. To create the label, the router uses the FEC (Forwarding Equivalence Class), which are tables of correspondences whose keys are an element of the package (addresses MAC, addresses IP, Class of Service, port TCP/UDP, etc). When the packages enter to a MPLS-BASED network, labeling Routers of Edge (LER) gives them a label (the identifier).These labels contain the information such as the destination, the bandwidth, the delay and of another metric also the field of IP heading (the source). The package reaches then switches of transit (P-router).Those have a table of commutation comprising four entries:

- Two keys: interface of entry of the package, label (Label) MPLS in entry
- Two values: label MPLS of exit (or withdrawal of the label), interface of exit of the package on the level of architecture.

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(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 2, February 2014

Label lookup and label switching in MPLS were faster than a routing table because they could take place directly within the switched fabric and not the CPU. The entry and exit points of an MPLS network are called label edge routers (LER), which, respectively, push MPLS label onto an incoming packet and pop it off the outgoing packet. Routers that perform routing based only on the label are called label switch routers (LSR). In some applications, the packet presented to the LER already may have a label, so that the new LER pushes a second label onto the packet. Labels are distributed between LERs and LSRs using the "Label Distribution Protocol" (LDP). Label Switch Routers in an MPLS network regularly exchange label and reach ability information with each other using standardized procedures in order to build a complete picture of the network they can then use to forward packets. Label Switch Paths (LSPs) are established by the network operator for a variety of purposes, such as to create network-based IP virtual private networks or to route traffic along specified paths through the network.

D. MPLS Packet Forwarding

An example of the MPLS Network and packet forwarding are shown in the following figures:

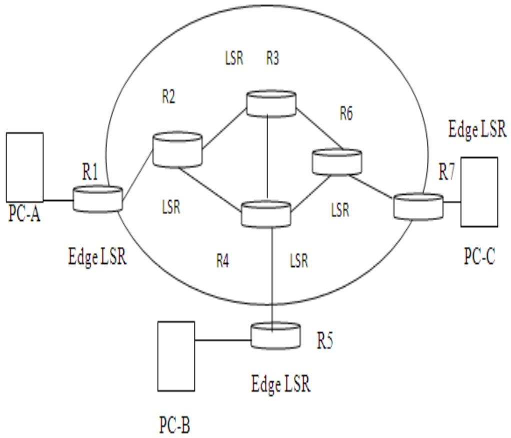

Fig. 2 MPLS Network

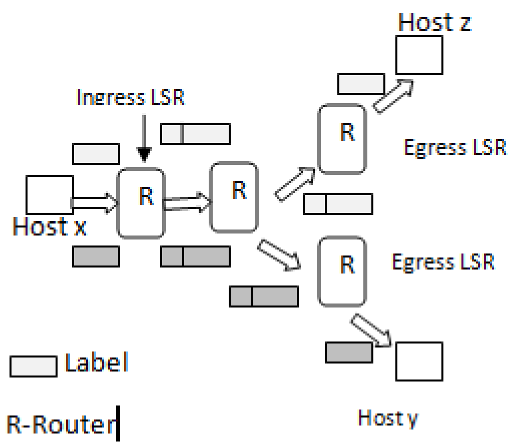

Fig. 3 MPLS Packet Forwarding

- In this network, R1, R2, R3, R4, R5, R6 and R7 are LSRs (Label Switch Router), among them R1, R5 and R7 these are edge LSRs. The LSR present at entry side is called ingress and at exit side is called as egress node.

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Vol. 3, Issue 2, February 2014

When host A in network is sending packets to network C, R1 is the ingress LSR, and R7 egress LSR. However, if host C in network is sending packets to network A, R1 becomes the egress LSR, and R7 ingress LSR.

- The ingress LSR will encapsulate the packet with the label, LSRs in the core network will swap the label, and the egress LSR will de-capsulate the packet.
- When a host in network A sends an IP packet to a host in network C, it sends an un-labeled packet (i.e. frame without the label). The ingress LSR, R1, after examining the destination IP address and other information in the packet header, pushes a label into the packet and forwards the labeled packet to the output port. Router R2, an LSR, receives the labeled packet.
- It examines the label and performs a table loop-up at the forwarding table to find the new label and the output port. R2 then swaps the old label with the new label and routed the new labeled packet to the output port.
- Other LSRs will perform the same tasks. The labeled packet will reach the egress LSR, R7. It then examines the label and performs a table loop-up at the forwarding table to find that the packet is to be sent to network C. It then removes the label and sends an unlabelled packet to network C.
- In this way packet transfer from one network to another takes place. The forwarding of the packet is done based on the contents of the labels, which allows "protocol-independent packet forwarding" that does not need to look at a protocol-dependent routing table and avoids the expensive IP longest prefix match at each hop. Hence MPLS is connection-oriented and it routes the IP packets based on a variable length short label.

IV. TRAFFIC ENGINEERING

MPLS is today mostly used for traffic engineering, as in [13] to control traffic flows through a network to optimize resource utilization and network performance. Basically it is used to overcome 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 hence causes drop of packets. MPLS can be used as a traffic engineering tool to direct traffic in a network in a more efficient way than traditional one. Traffic engineering (TE) is a form of congestion avoidance mechanism, to avoid congestion from occurring along the best path (shortest path) which carries all traffic. TE is a process used to measure, analyze network behavior and be applied to traffic pattern to achieve end-to-end packet transfer without drop. Traffic engineering with MPLS integrates label swapping framework with network layer routing.

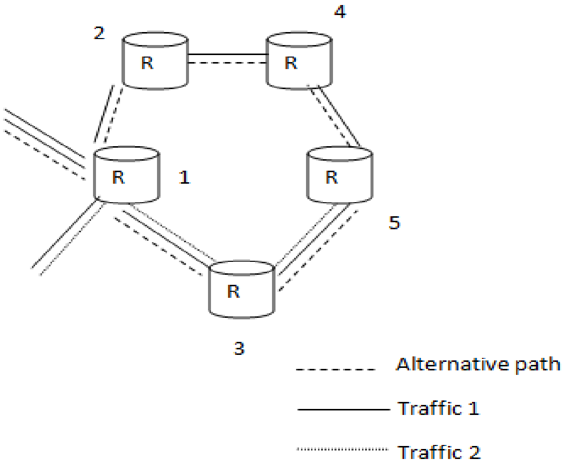

Fig. 4 Traffic Engineering

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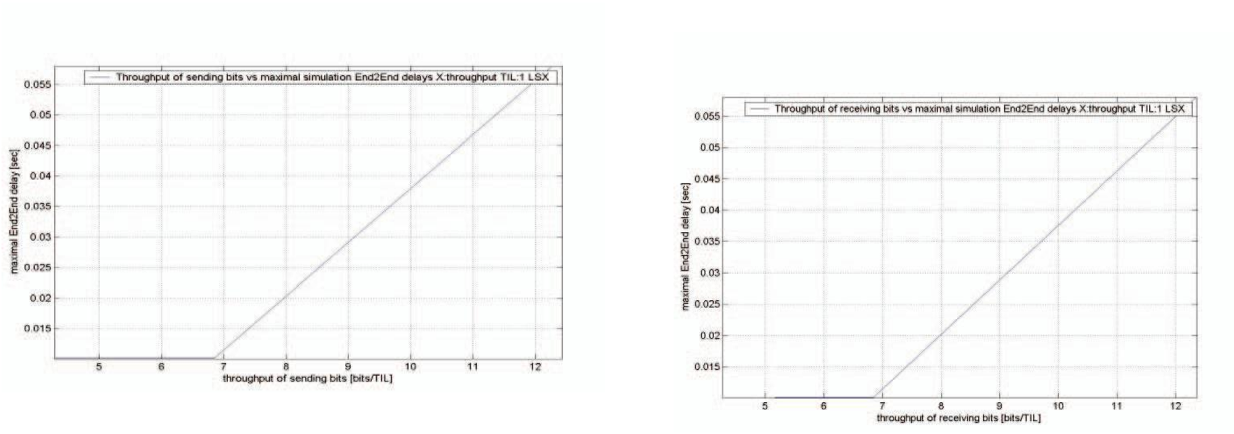
Vol. 3, Issue 2, February 2014

MPLS TE, attempts to take the best of connection oriented traffic approach and merge it with IP routing. The main difference between MPLS and IP is, IP routing is destination based and each node along the path independently follows the least cost principle to get traffic around network as quickly as possible where as MPLS network, head end has the capability to decide a path through the network for a particular FEC. Due to MPLS it easy to establish shortest as well as efficient path between any type of network using different protocol so called it as protocol independent.

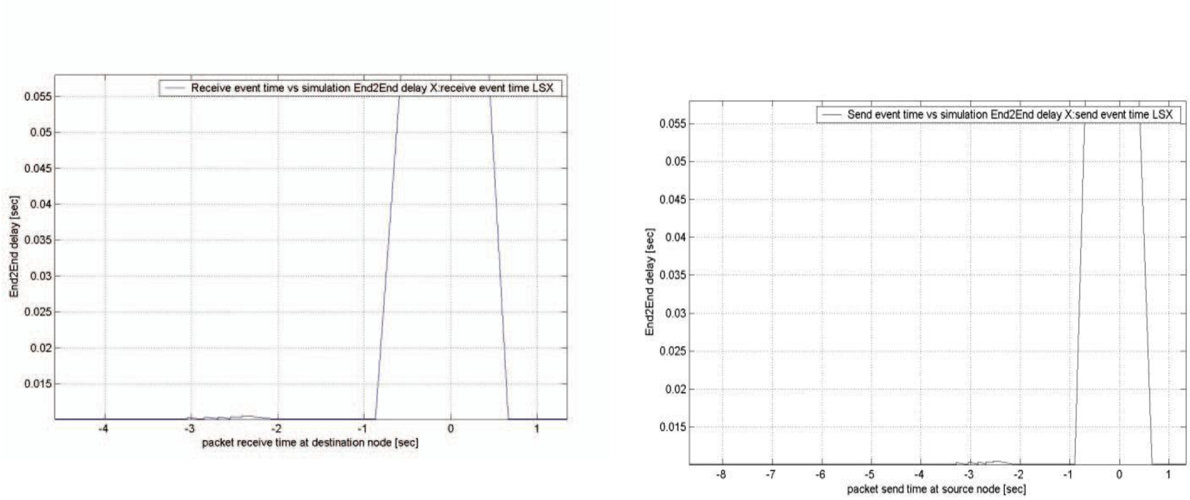
V. STUDY OF RESULT OF SIMULATION

The researcher had selected the topology of MPLS node in which they are placed close to each other hence forming MPLS field. This MPLS network is used for simulation on NS2. The simulation results obtain in this tool was in textual file and from that data two dimensional graphs are drawn that are given below:



(a) (b)

Fig. 5 (a) Maximum time from beginning to end increases according to flow in MPLS, (b) Maximum time from beginning to end increases according to flow in MPLS [8].



(a) (b)

Fig. 6 (a) Time from beginning to end according to time of simulation, (b) Time from beginning to end according to time of simulation [8]

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Vol. 3, Issue 2, February 2014

Figure 5. (a) and (b) show the graph of throughput of sending and receiving bits respectively verses end-to-end delay in sec, also the maximum time from beginning to end increases according to flow for protocol routing where as figure 6. (a) and (b) show the graph of packet receive time at destination node and packet send time at source node (sec) respectively verses end-to-end delay in sec also the maximum time from beginning to end increases according to simulation time for Protocol MPLS.

From result it is cleared that when the time increases, there is a very important increase on the level of the packages on the time interval [- 1, 1], and we can observe that the curve obtained increases gradually with time. Thus it is noted that the more time increases, the more time starts to increase very quickly.

VI. CONCLUSION AND FUTURE SCOPE

Due to increase demand of new and broaden network the term QoS plays an important role for providing better consumer satisfaction. So to provide good services Grade of service have to maintain and prioritizing of packet also very essential factor. Hence there should be some techniques to be followed in improving the service quality so, MPLS is one of the simple, scalable, flexible and dynamic way to provide greater Qos to the user in degraded condition hence improving the overall QoS. Fast failure node recovery and Traffic Engineering these main properties of MPLS are help to improve Network performance and end-to-end QoS.

MPLS is currently replacing some of the technologies (like ATM, SONET, and Frame Relay etc.) in the marketplace. It is highly possible that MPLS will completely replace these technologies in the future.

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