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Comparative analysis of IP, ATM and MPLS with their QoS

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Abstract*—An ancient philosopher said" Humans are social animals." Peoples exchanges ideas and information about themselves and other and bout current and past events. People were curious to know what happen and this curiosity combined with inventiveness led them to build networks to facilitated information exchange. For this, networks plays vital role for enhancements of technology. Internet has raising popularity. For its network reliability, efficiency & QoS is required. This kind of real time traffic (i.e. voice and video) required extra care because of delay sensitive, QoS, limited bandwidth. For this we have three technologies IP, ATM and MPLS. IP is highly used in network core and also it support real time traffic. But IP offers random delay in transmission. All telecommunication operators which provides voice services as significant part their business. They choose ATM has backbone technology. ATM integrate voice and data to guaranty of good QoS & support for further development such video conferencing or ISDN but ATM is not best way to carry IP traffic for transmission of voice, because we cannot replace IP based network. Because of this IP over ATM increases overhead problem to traffic. ATM have not another way to carry IP traffic Solution to all this is MPLS, MPLS is label based technology. MPLS support characteristics of IP & ATM. It based on label switched path (LSP) in network means packet carry label in network . MPLS make super highway for all types of transmission. It supports all types of services.

***Index Terms*— Communication protocol, IP, ATM & MPLS.**

I. INTRODUCTION

In environment of World Wide Web (WWW), internet has expontial growth in real time application such as voice over IP (VoIP), video conferencing, video on demand and telemedicine. It is an indication of evolution of network protocol. We need an intelligent backbone support protocol which fulfills requirement of low end – end delay and guarantees to QoS. There are number of challenges for network in that 1st to enhance network to that extend to accommodate and increasable demand of band width , another one is to manage installed capacity effectively and efficiently to enhanced end user service quality. And last important challenge is survivability i.e. fast recovery and restoration.

Currently we 3 main technology IP, ATM and MPLS. IP (internet protocol) is oldest and widely used in WAN and equally important in private, intranet to link up computers. IP is networking topology protocol i.e. designed to work above wide variety of lower layer, which turned as data link layer. IP provides best efforts delivery, dynamic path establishment etc. But it shows poor performance at time congestion. On the other hand, ATM (Asynchronous transfer mode) is networking standards that was developed with many goals, one of which integration of voice and data networks. ATM with connection oriented and supports QoS. ATM is integration of difference prioritized traffic in real time because of guaranteed delivery, but we cannot replace already installed network infrastructure i.e. IP network & ATM is not good choice for IP traffic means carry IP over ATM infrastructure raise some problem in real time traffic. New technology i.e. MPLS (Multi protocol label switching) give solution to this.

MPLS is hybrid technology which is sandwich between IP and ATM layer. The remaining paper organized as follow,

Section two presents IP network, their routing flow and QoS.

Section three presents ATM network, their routing flow and QoS.

Section four presents MPLS network, their routing flow and QoS.

Section five presents comparative study.

Section six concluding remark.

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II. IP (INTERNET PROTOCOL)

IP is 1st defined and used protocol. De-facto the only protocol for global internet working. IP transport information in the form of packet which have variable length. IP has connectionless approach. Internet consists of many computer networks connected with router. Router forwards packet from incoming link to outgoing link.

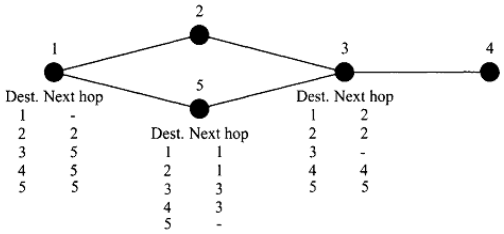

Fig.1 Routing in IP network.

Here we describe classical routing mechanism use in IP network. In IP environment each router maintained routing table like lookup table. Routing table consists of one or more entries for each destination router in network. These entries show that next node adjacent this router to which packet need to forwarded. Forwarding process is carried out as follows, Router looks at header in packet arriving on incoming link. Header contain information of router for that packet. Router then check out its routing table and identify next adjacent node for that packet and forward packet on link leading to that node. Fig.1 shows consider packet from node 1 having its destination node 4. Node 1 looks at its table and forward this packet to node 5 . Node 5 forward packet to node 3 which in turn forward packet to node 4 i.e. destination.

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Maintaining these routing table is the central task of network at every router. In network various problems like link or node in a network may fail or reappear. The router detect these changes automatically and update routing table using distributed routing protocol (DRP). Each router has capability of determine whether its link to its neighbor are up or down. Whenever router detect changes in status of link, it generate link status packet and use flooding technique. In this flooding technique router send flood packet across network, each router forward these packet except the link it come from. On receiving flood packet, each router update it routing table based on new information. IP use shortest path algorithm for example, flood packet may take different path through new and undergo different delay. One interesting example flood packet as consider what happen when link goes down and come back up. First link state packet (packet Y). Says link is down and successive packet (packet X) indicated link is up. Node receiving packet Y after packet X will think that link is down even after it has come out. To avoid this link state packet have sequence number. If router receive link state packet whose sequence number is lower than previous link state packet, it simply discard packet. The problem with IP network is chance of packet loss, point to point connectivity, operates on first come first serve which increase delay and also sequencing and neither possible to share available bandwidth on particular link.

A. QoS (Quality of Services)

In IP each router compute shortest path from itself to other router and store identity of next router. IP experiences random delay and some packet loss because of sequence number may dropped if there congestion in network means there is great deal to improve QoS. Within IP, Diff-serv (Differentiated services) mechanism has been proposed. In Diff-serv packet are grouped into different classes, with class type indicated in IP header. Class type specifies how packets are treated in within each router. Packet marked as Expedited Forwarding(EF) are handled in separate queue and routed as quickly as possible and another one is Assured Forwarding (AF) , it has two attributes ; xy. Attribute x typically indicated queue to which packet is held in router prior to switching. Attribute y indicate drop preference for packet. Suppose packet with y=2, have higher likehood of being dropped than y=1. In Diff-serv tackle QoS issue but does not provide end to end method to guarantees QoS in IP. So we adopted next technology ATM.

III. ATM (ASYNCHRONOUS TRANSFER MODE)

ATM is standardized technology that offer various services like low bandwidth-high bandwidth, synchronous-asynchronous, real time-non real time, slotted-packetized, switched-nonswitched.ATM use variety of transmission media like wire, wireless or fiber.ATM is connection oriented data transfer protocol. In this information is collected over several octets (8 bit), some overhead information is attached to it & then it is send. This completes structure is called packets. In ATM packets has fixed size of 53 octets , known as cell. In that five octets for overhead field & remaining 48 octet for information.

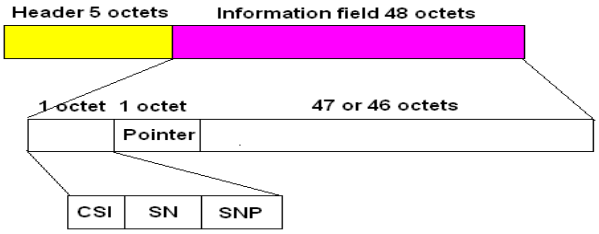

Fig 2: ATM cell information

In ATM usable data only 48 octet so efficiency is

$E_{cell}=48/53=0.90566$ (1)

But from Fig2, Actually we use 47 or 46 octets means information field does not contain 48 octets One or two octets used for administration & cell sequences & also first octets contain 3 fields in that,

1. First bit known as conversion sub layer indicator (CSI) used to indicate whether pointer used or not.
2. Next three bits are sequence number (SN) from 000 to 111 used to detect lost cell.
3. Next four bits used for sequence number protection (SNP), it perform error detection on CSI & SN subfield.

Means in ATM actually we use 46 octets if we consider above two octets so efficiency is

Ecell=46/53=0.8679 (2)

From equation 2 we say that if we use two octets extra ATM efficiency decreases by 3 %. In ATM application like VoIP used 100 bytes but file transfer application use maximum 1500 bytes. Using average value of 500 bytes for MTU (maximum transfer unit) efficiency decreases to 80 %. ATM is connection oriented because of this every packet rotated in each node which will increases propagation time. The round trip time between two adjacent nodes is below 9.99ms & round trip time between non adjacent nodes is multiple of 9.99ms. ATM uses fixed size cell for transmission but ATM is capable for voice, video & variable size IP packets, In this case it is necessary to map user data in ATM. This work is accomplished by ATM adaptation layer (AAL) .Main function of AAL is segmentation & reassembly (SAR) , & AAL segment user data at source into ATM cell & reassemble ATM cell into user data at destination. This make ATM complex.

A. QoS (Quality of Service)

ATM is capable of give guarantees to QoS for connection. ATM is able to provide QoS with combination of traffic shaping & admission control. Traffic shaping (TS) gives end point connection to achieve desired QoS & ATM monitors traffic parameters for QoS. Admission control (AC), it is based on knowledge of traffic characteristics. ATM use varies services to give QoS such as CBR- constant bit rate, UBR – unspecified bit rate. Another aspects of guarantee QoS with combination of TS & AC is ATM use queuing policy. ATM use queuing technique to ensure QoS for each service class & also it use mathematical technique to determine AC policy to meet QoS.

IV. MULTIPROTOCOL LABEL SWITCHING (MPLS)

MPLS is Internet Engineering Task Force (IETF), MPLS is advanced technology that supports IP services.

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MPLS is capable of allowing multiple locations to communicate with each other & share bandwidth. MPLS gives varies types of services like voice , data & video over single network .MPLS arranged between layer 2 & 3 as shown below,

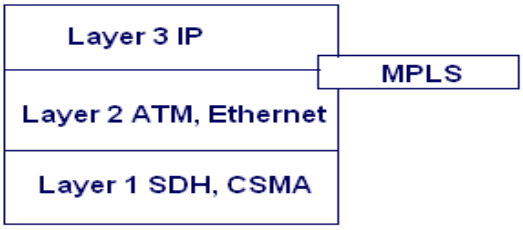


Fig. 3: MPLS arrangement

MPLS is based on label switching. In this label can enter into MPLS network & exist from MPLS network, this entry & exit point called Label edge router(LER).MPLS perform simply push pop operation means push on MPLS label on incoming packets & pop it off from outgoing packets for this push pop operation MPLS implements Label Switched Router (LSR) . Labels are distributed between LERs & LSRs using label distribution protocol (LDP).Label switch path (LSP) are established by network. Now each packets carries label which associated with LSP. Each LSR maintain label forwarding table, when LSE receives packets simply it extracts label use it to index into forwarding table & replace by new label & forward packet in next LSP.

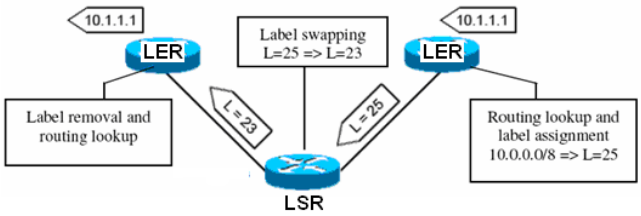
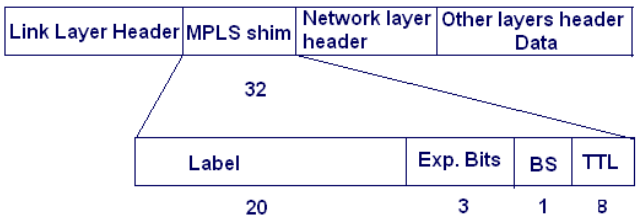


Fig. 4. Label forwarding and swapping

LSR does forwarding process & replace label by new label with in fraction of second means MPLS offer less forwarding time & less propagation delay.

A. *MPLS Header & Efficiency*



Exp. Bits: Experimental Bits, often used for class of services
BS: Bottom of Stack bit, is set if no label follows
TTL: Time To Leave, used in the same way like in IP

Fig. 5. MPLS Header format

Field	Description
20 bit label	The actual label.
3bit experimental field	Used to define a class of services(QoS)(IP precedence)
Bottom of stack bit	MPLS allows multiple labels to be inserted; this bit determine if this label is the last label in the packet. If this bit is set (1), it indicates that this is the last label.
8 bit time to live (TTL) fields	A timer fields that has the same purpose as the TTL field in the IP header which is to track the lifetime of the datagram.

Table. 1 Description of MPLS Header

MPLS uses a default MTU of 1500 bytes. If you are using an MPLS implementation that uses just one label, increase it to 1504bytes. MPLS VPNs and MPLS traffic engineering use two labels, 8 bytes, so you must increase the MTU size to 1508 bytes if you are using either of these, 4 + 8 bytes. Increase the MTU to 1512 bytes when using MPLS VPNs. MPLS use 32 bit header so efficiency is more.

B. *MPLS QoS*

MPLS reserved BW along the link at the time of LSP setup so give guarantee to QoS. Packets belonging to particular LSP can be re routed to another LSP when there is chance for network failure. In MPLS environment packet cannot loss because MPLS provide diverse path. If an LSP fail we can reroute packet from that LSP to another LSP means MPLS give fast distortion service. It is sign of high quality of service. Finally MPLS can use multiple virtual private networks (VPN) & each VPN is carried over separate set of LSPs to provide QOs & security. IN MPLS to signaling protocol is used to setup LSP across network to provide 100 % QoS that is first resource reservation protocol (RSVP), second label distribution protocol with constrained routing (CR-LDP).

Refer the table no. 1

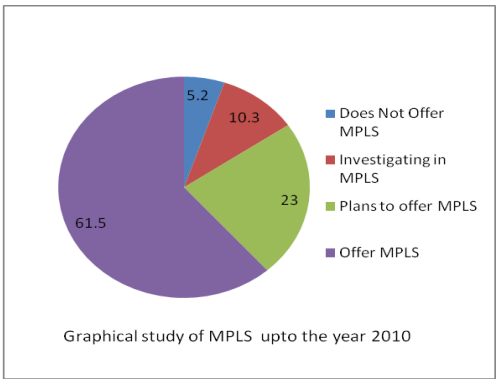


Fig.6 Garphical representation of MPLS.

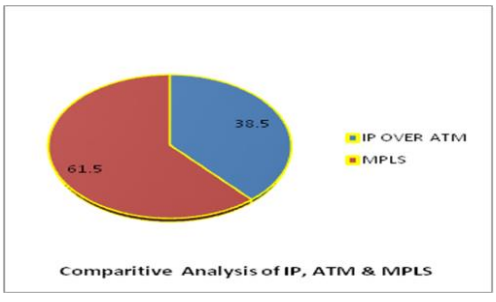


Fig. 7 Comparative Analysis of IP, ATM & MPLS.

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V. CONCLUSION

Today IP have its own identity because of it is widely used everything ranging from desktop computers to core.So it is hard to displace. As a result , ATM standards have interface with IP as its immediately lower layer. ATM protocol as much better developed & standardied because of its fixed size allows high speed switches & its connection oriented nature give good QoS. Next MPLS is better various application in traffic energy, transport layer in UMTS access network. If we use IP , ATM , MPLS indually there will be problem. MPLS & ATM are lower layer of IP. IP over ATM gives problem with QoS. MPLS over ATM methods give gurantes QoS & many MPLS router use ATM switches internally to perform high speed. In future IP over MPLS gives sophicated bandwidth provisionaly capability & dynamic wavelength routing based on generalized MPLS (GMLS). Though induvidual protocol cannot give good performance but combination gives better future growth. So, in future MPLS , IP & ATM have equal valued protocol.

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Sr No.	Parameter	IP	ATM	MPLS
1	Communication Type	Connectionless	Connection-oriented	Connection-oriented
2	Packet flow direction	Bi directional	Bi directional	Uni directional
3	Number of byte transfer	100 to 1500 bytes	Fixed 53 bytes	Variable packet length
4	Switching method	Packet switching	Circuit switching	Both
5	Restoration Facility	Less	More	Highest
6	Efficiency	Less	Higher than IP	Highest
7	Propagation Delay	More	More	Less
8	Survivability	Less	Less	More
9	Delay offer	Makes delay	Lower than IP	Lowest
10	Complexity	Less	More	Less
11	QoS	Less	Less than IP	Highest
12	Compatibility with future technology	Compatible with MPLS but not with ATM	Compatible with MPLS but not with IP	Compatible with IP & ATM, Compatible with future technology.

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