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A Novel Study on Improved Re-Route Model to Reduce Traffic in MPLS Network

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Abstract: In this work, it presents a review on Rerouting model in MPLS Network for reducing traffic. It is based on fault tolerant model concept in MPLS network. This describes the process of routing scheme and link resource distribution. QoS is the mechanism of the network to provide different service level to a different traffic type as business need.The main objective of this work is to improve QoS in network by reducing delay. It provides a distribution of traffic between source and destination so that delays between the paths are minimum between each other. It works on reliability by limited usage of bandwidth. The projected mechanism will be implemented with MATLAB.

Keywords: MPLS Network, Congestion Management, Re-Route Model, Quality of Service etc.

I. INTRODUCTION

Customer traffic often suffers from congestion due to the bottlenecks in the network which leads to degradation of service's quality. Traffic engineering (TE) is a way of efficient resource optimization is being deployed to address this problem. By balancing the traffic load distribution in the network and minimizing bandwidth consumption, traffic engineering provides the maximization of network's utilization [1].

Multi-Protocol Label Switching (MPLS) is rapidly emerging as an Internet Engineering Task Force (IETF) standard intended to enhance the speed, scalability and service provisioning capabilities in the Internet. Over the last few years, the internet has evolved into a ubiquitous network and inspired the development of a variety of new application in business and consumer market. These new applications have driven the demand for increased and guaranteed bandwidth requirement in the backbone of the network. In additional to the traditional data service currently provided over the network new voice and multimedia services are being developed and deployed. The internet has emerged as the network of choice for providing these converged services. However, the demands placed on the network by these new applications and services, in terms of speed and bandwidth have strained the resources of the existing internet infrastructure [2].

In addition to the issue of resource constraints, another challenge relates to the transport of bits and bytes over the backbone to provide differentiated class of services to users. Class of Service (CoS) and Quality of Service (QoS) issues must be addressed in order to supports diverse requirement of wide range of network users. Despite some initial challenges MPLS plays an important role in the routing, switching and forwarding the packets through the network in order to meet the service demands of network users. MPLS VPNs (Virtual private network) are new alternatives to private WANs (Wide area networks). They are gaining popularity in industries day by day. Enterprise customers are moving to service providers that offer MPLS VPNs. The main reason for this shifting is the capability of MPLS VPN to provide built in security features and any-to-any connectivity. QoS (Quality of service) is the most important element for network service providers [3].

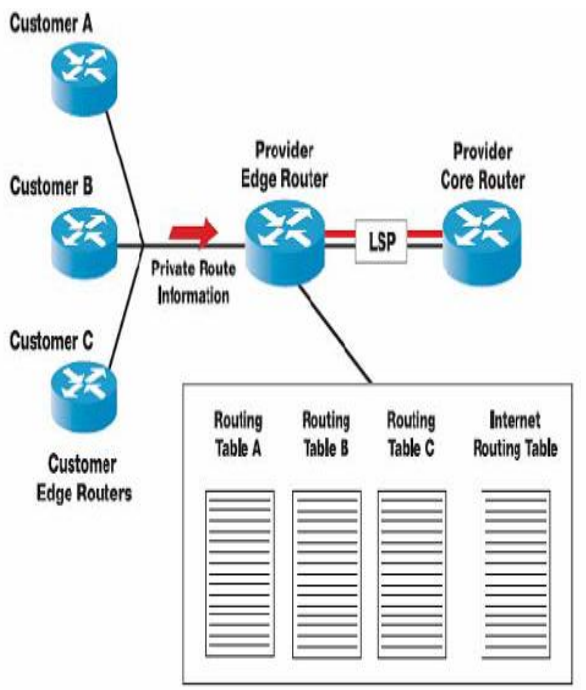

Figure 1.1: Provider Edge/Customer Edge Router Relationship in a MPLS VPN [4]

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The efficient QoS model provides better control and administration of network traffic. It limits the different applications to use the network resources as per business needs. The outcomes of this thesis will help network engineers to make their traffic management decisions. It will provide better understanding as to how improved QoS model and VPNs work together and how it is useful for enterprise network that run video, audio and data traffic over the same network infrastructure. Fault tolerance is also an important QoS factor that needs to be considered to maintain network survivability. The network users require QoS, not only guaranteed bandwidth and delay but also with high availability. MPLS VPN networks exhibits fast restoration which is one of the key factor using these network service providers.

The rest of paper is ordered as follows. In section II, we discuss correlated work with MPLS networks. In Section III, It defines basic MPLS network scheme. In Section IV, it describes proposed work of system. Finally, conclusion is explained in Section V.

II. LITERATURE REVIEW

Authors [1] proposed an online Traffic engineering (TE) server to optimize the data flow in the network and maximize the utilization of the network resources. The proposed server was implemented and experimentally tested in laboratory environment. To provide QoS traffic engineering methods were used. In this paper we focus on traffic engineering in MPLS networks and the question of quality of service, since it was the main reason of deploying TE.

Some [2] proposed a fault-tolerant routing model for unicast flows in MPLS-network. The flow-oriented model was represented by algebraic equations and inequalities characterizing the state of MPLS-network, i.e. load of its communication links. The proposed model included the possibility to implement three basic backup schemes in accordance with the concept of Fast ReRoute: link, node and path protection. The model described also three different types of condition of the links overload prevention for different variants of channel resource use.

Some authors [3] described modelling and simulation tools that are used to evaluate MPLS-based networks. The first tool was GNS3 that could be used in designing and modelling computer networks; while Wireshark can enhance the protocols investigation process. The second tool was OpenSim MPLS tool which enable the designers to make the modelling and simulation process as an interactive study. The third tool was the well-known OPNET tool. However, using OPNET the VOIP application was examined on MPLS network and then compared with conventional IP/TCP network.

Some [4] proposed the mathematical model of multipath routing with load balancing in the MPLS network. This model described the processes of routing and distribution links resource. This model takes into account the characters of links (duplex, half-duplex or simplex links) and prevented the effect of packets looping. And criterion of load balancing in proposed model was quality service parameters. Authors [5] presented a routing scheme for MPLS networks with probabilistic failures. Our routing scheme simultaneously maximized the expected satisfied demand and minimized the maximum link utilization of the network. Our approach was novel in that it was the first to jointly address the traffic engineering and the routing through reliable paths problems. In addition to the optimal routing algorithm, they presented a lower complexity heuristic algorithm based on Linear Programming and Yen's algorithm. Finally, numerical results were presented to demonstrate the effectiveness of both our optimal and heuristic algorithms.

Some [6] proposed that Telecommunication infrastructure consumed large amounts of energy, but was often under-utilized. Dynamic Topologies referred to networks that were able to change the number of active nodes and links to adapt the network to traffic requirements. Such strategies can reduce energy consumption and the related Green House Gases emission footprint considerably. Dynamic Topologies using MPLS proposed to maintain a number of active topologies and path sets. This allowed the change between topologies without major rerouting of traffic and related impacts on established flows. This study detailed strategies to adapt topologies and investigates the impact of topology changes on individual UDP and TCP flows and the ability for power saving.

III. BASIC MPLS NETWORK

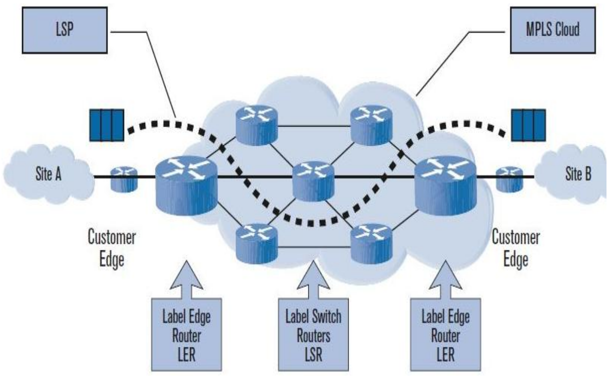

Figure 2: Basic MPLS Network Architecture [2]

In MPLS, transmission occurs on label-switched paths (LSPs). LSPs are a sequence of labels at each and every node along the path from source to destination. LSPs are established either prior to data transmission or upon a certain flow of data. The labels, which are underlying protocol specific-identifiers, are distributed using distribution protocol (LP) or RSVP or piggybacked on routing protocol like border gateway protocol (BGP) or OSPF. Each data packet encapsulates and carries the label during their journey from source to destination shown in figure. High speed of data is possible because fixed-length labels are inserted at the beginning of the packet and can be used by hardware to switch packets quickly between links.

1. Label Switch Routers

A label switch router (LSR) is a router that supports MPLS.

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These routers have ability to understand the MPLS labels and they can receive and transmit labelled packets.

2. Label Edge Router
LER is a device that operates at the edge of the access network and MPLS network. LERs supports multiple ports connected to dissimilar network (such as ATM, frame relay) and forward this traffic on to the MPLS network after establishing LSPs, using label signalling protocol at the ingress node. Ingress LER's receiving an unlabeled packet, insert a label in front of packet and send it to a data link. After that traffic is distributed back to the network at the egress node. Egress LER receives a labelled packet and removes the label and sends it to data link.

3. Label Switch Router
An LSR is a high speed router device in the core of MPLS network that participate in the establishment of the LSPs using the appropriate label signalling protocol and high speed switching of the data traffic based on the established paths Label switch path (LSP) is the path that a packet passes through from ingress LSR to the intermediate LSR and then the egress LSR.

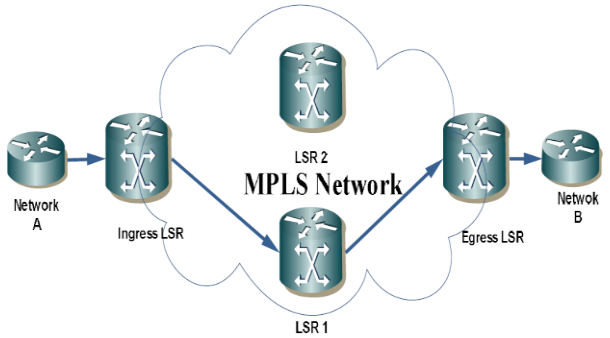

Figure 3: Label Switch Path Illustration [2]

The following steps must be taken for a data packet to travel through an MPLS domain.

- Label creation and distribution
- Table creation at each router
- Label-switched path creation
- Label insertion / table lookup
- Packet forwarding

The source sends its data to the destination. In MPLS domain, not all of the source traffic is necessarily transported through the same path. Depending on the traffic characteristics, different LSPs could be created for packet with different CoS (Class of Service) requirement. MPLS label is inserted between layer 2 and layer 3 and is 32 bit long. Figure shows the MPLS routing process in larger networks. There are two types of routers, edge routers and core routers. The routing decisions are made only at the edge routers and the core routers forward packets based on the labels.

These two functions provide fast forwarding method of packets. In figure 3, PE1 and PE2 routers are edge routers and P is a core router. The IP packet with IP address 10.1.1.1 goes to the PE1 (MPLS enabled router), the PE1 router perform routing lookups and attaches a label 25

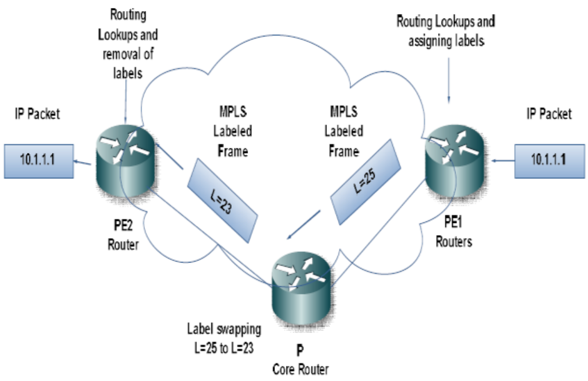

Figure 3: Procedure of MPLS Operation [5]

and sends it to the core router P. The core router then swaps the label with new label 23 and sends the packet to PE2 edge router. The PE2 router performs routing lookups and removes the label and sends it to the destination as a simple IP packet. The packet will then go through the path called the Label Switched Path (LSP).
Once LIB (label distribution protocol) and FEC (forward equivalence class) tables are built, MPLS routing and forwarding is a straightforward process:

- At the LER, incoming packets are inspected and are labelled using the in information found in the FEC tables; the packet is then forward to the next hop.
- When the next hop receives the packet, it inspects the label and compares it to its internal LIB; then it performs the label operation and then forwards the packet to next hop according to the LIB entry.
- The process is repeated until the packet reaches the far end LER; the labels are then removed and the packet is forwarded to its final destination.

IV. PROPOSED MPLS SCHEME FOR REDUCING TRAFFIC

Multi-Protocol Label Switching (MPLS) is rapidly emerging as an Internet Engineering Task Force (IETF) standard intended to enhance the speed, scalability and service provisioning capabilities in the Internet. MPLS can be considered a technology that has brought an oriented connection for IP protocol. Therefore, network services and applications can exploit all of the advantages of MPLS. High QoS requirement is one of the major issues for network service providers. The main QoS parameters are bandwidth optimization, low packet loss ratio, low hop count and low link load etc. For this, it introduces the concept of fast re-routing to bind the restoration latency in MPLS networks. This routing algorithm computed primary and backup paths to optimize the restoration latency and the amount of bandwidth used.
QoS is the mechanism of the network to provide different service level to a different traffic type as business need. Service providers offer their network service with quality. They define a Service-Level Agreements (SLA). SLA provides the details of all QoS parameters. It defines the parameters such as end-to-end delay, end-to-end jitter,

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packet loss. QoS is not single device functionality and it is an end to end mechanism. It provides the intelligence to network devices to treat the different application's traffic as their defined service level by SLA.

QoS combines different technologies together such as classification, marking, scheduling, queuing, bandwidth allocation, and prioritization that are commonly used to provide a scalable end to end service. QoS is a generic term. It provides the different level of treatment to the different types of traffic or applications that flows over network. Quality of service is required to provide the well management of network resources that makes the sophisticated usage of resources and gives comfort to network user. Business networks are widely expended with different types of applications. These applications have different network requirements. It needs to lead for different administrative policies that control applications as per their requirements individually. QoS within a network is essential to meet the requirements of today's converged networks. QoS provides the different levels of service for business critical application and delay-sensitive applications.

QoS is to manage the following network elements:

- Bandwidth: Maximum amount of data that can be carried.
- Delay: The time to send data from source to destination.
- Jitter: Variation in delay.
- Reliability: Packet loss.

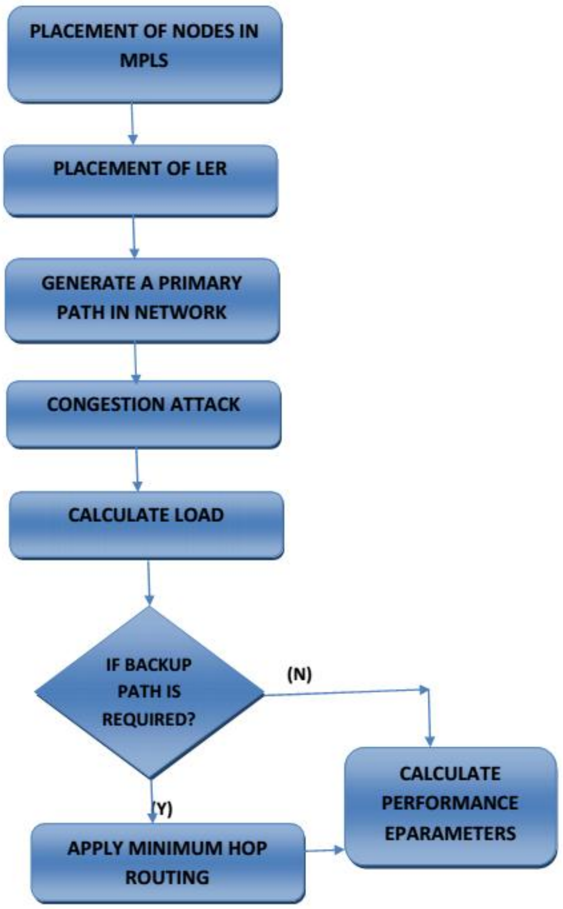

Figure 4: Proposed Steps of System

Issues to Address for Quality of Service

Converged networks support different types of application such as voice, video, critical data, browsing, and network management. Different applications have different level of sensitivities and different requirement. These applications run on same infrastructure so it is a challenge to fulfil the requirement of application as per requirements. Some applications are delay sensitive, some application requires more bandwidth, some applications require constant amount of bandwidth and some applications require less packet loss (reliability). For example voice over IP (VOIP) applications are delay sensitive and run smoothly on maximum 150ms to 200ms end-to-end delay. On the other hand file transfer protocol (FTP) is not delay sensitive and jitter also does not effect on it. Some applications are TCP-based.

If TCP segment is dropped, source retransmits that segment after the time out. TCP based applications can tolerate on packet drop. Some applications use UDP and have no acknowledgement mechanism. These applications cannot tolerate on packet drop such as VOIP (video over IP), online gaming. Converged network run different applications simultaneously. It is necessary to handle all applications individually and use some mechanisms that handle applications properly according to its nature. There are four major challenges in converged campus network:

- Bandwidth
- Delay
- Jitter
- Packet loss
- Fault tolerance

All the mentioned QoS parameters are explained further in detail:

1. Bandwidth

The amount of data that can be transmitted over link is bandwidth. On the network IP Packets travel though the best route. Maximum bandwidth of the route is equal to smallest value of bandwidth on route.

2. Delay

End to end delay is the total time that a packet takes from source to destination.

End-to-end delay is sum of all the following delays.

- Processing delay
- Queuing delay
- Serialization delay
- Propagation delay

3. Jitter

Variation in delay is jitter. Packets for the same destination may not arrive at same rate. Campus network run different applications simultaneously. Jitter can occur due to different traffic load on different timings. For voice and video it is necessary to receive the packets at same sequence to achieve good quality.

4. Packet Loss

Packet loss occurs due to the low buffer space. When the buffers space of the interface full then packets are dropped. Packet loss creates extended delays and jitter. Packet loss can be controlled by applying some techniques such as

Tail Drop, Random Early Detection, Weighted Random Early Detection and Traffic Shaping and Policing.

5. Fault Tolerance

It is one of the most important QoS parameter which should be considered for better network functionality. It may occur any type of failure due to any hardware or software failure during data transmission. So at that time network should be able to respond immediately to that fault so that there is no interruption in the data forwarding process. By using fault recovery techniques we can make MPLS network fault tolerant. Recovery time should be minimum as possible so that there is no loss of data packet during the fault condition. After the computation of recovery path or if the path is pre-computed by protection switching technique, path can be place locally or globally. For better restoration, restoration latency should be minimum as possible.

V. CONCLUSION

In this work, it presents a review on Rerouting model in MPLS Network for reducing traffic. The efficient QoS model provides better control and administration of network traffic. QoS combines different technologies together such as classification, marking, scheduling, queuing, bandwidth allocation, and prioritization that are commonly used to provide a scalable end to end service. Solution of routing problem with help of proposed model allows providing the distribution of traffic between source- and destination-node so that delays along every path are equal between each other. Depending on the parameters of the model it is possible to implement different schemes of reservation: link, node or path protection.

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