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METHOD & IMPLEMENTATION OF DATA FLOW TO IMPROVE QoS IN MPLS NETWORK

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Abstract:
Quality of service (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 link load and bandwidth consumption. It uses a routing scheme that satisfies expected demand and minimized link utilization of system. It works on reliability by limited usage of bandwidth. Results are presented to demonstrate the effectiveness of system. The efficient QoS model provides better control and administration of network traffic. 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.

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1. INTRODUCTION

MPLS is one of the standards which is growing at a faster rate and acts as an Internet standard. This is used to increase the speed and scalability in network. It also provides different service capabilities within internet. Now a days, MPLS VPN is becoming a modern technology that replaces other WAN's systems for internet. In past, they were using ATM or frame relay networks for WAN system. Some using layer 2 network and some are using layer 3. Layer 3 provides better security than layer 2. In layer 3 network, it differentiates complete VPN network from other networks.

In MPLS model, the main requirement of the system is high QoS value. The better QoS refers to provide efficient control of traffic in network but it provides limitation for using resources of network as per requirement for various applications. MPLS is a network that is useful in direction-finding, switching and transferring of packets through a network to provide requisite services in network. The MPLS network makes their decisions about traffic management in network. This is useful for running different types of traffic like audios, videos over a network. Figure 1 provides traffic management for customer traffic in MPLS VPN.

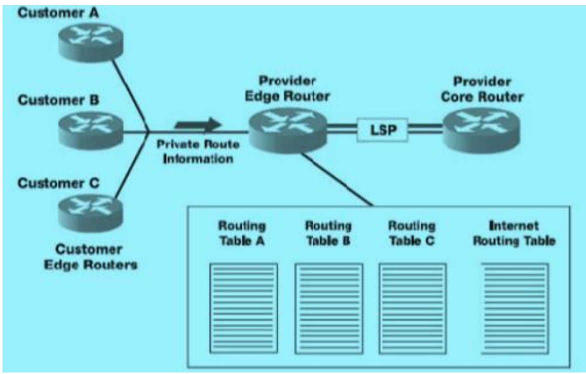

Fig. 1. Provider Edge/Customer Edge Router Relationship in a MPLS VPN

The major issue related to network is fault tolerance which is an important factor for QoS. The network must provide better utilization of bandwidth with minimum delay. This helps to improve survivability of network. MPLS network also provides restoration of signal that makes this network useful for network users.

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In MPLS Network, many techniques are available at network layer for recovery purposes. We know that MPLS works in between layer 2 and 3. So, it becomes useful to work at these layers for recovery. There is always a lot of traffic from customer side that provides congestion problem in network layer. So, MPLS is a standard to improve the speed and scalability of network.

The reason why MPLS networks have become so successful is due to the ability of implementing a multi-service network. Having a network infrastructure which consists of a variety of different technologies, while still being maintained by a single standard that provides everything ever needed to control the traffic has no competition. These two requirements impose that to support multicast, one should observe that an LSR is able to select a particular multicast distribution tree based on the following criteria. Firstly, the label carried in the packet (packet has an identity within MPLS domain) and secondly, the interface on which the packet was received.

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 (figure2).

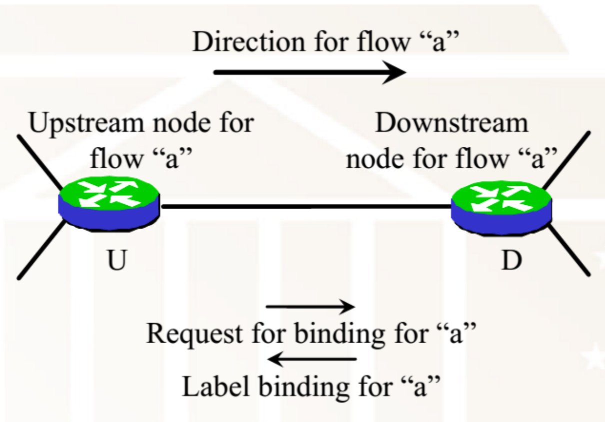

Fig. 2. MPLS signaling

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. The control plane is responsible for the routing information exchanges and the label information exchanges with the adjacent routers.

Link state routing protocols advertise routing information among the routers that are not necessarily adjacent, where-as label binding information distribution is limited to adjacent routers. The MPLS data plane has a simple forwarding engine, based on the information attached with labels. There are two tables on each MPLS router, LIB and LFIB. The data plane uses a label forwarding information base (LFIB) maintained by the MPLS enabled router to forward labelled packets. The LIB table contains all the local labels assigned by the local routers and mapping of the labels that it receives from the adjacent MPLS routers. The LFIB uses a subset of the labels contained in the LIB for actual packet forwarding. The MPLS enabled routers use information in LFIB and label value to make forwarding decisions. Figure 3 shows architecture of MPLS.

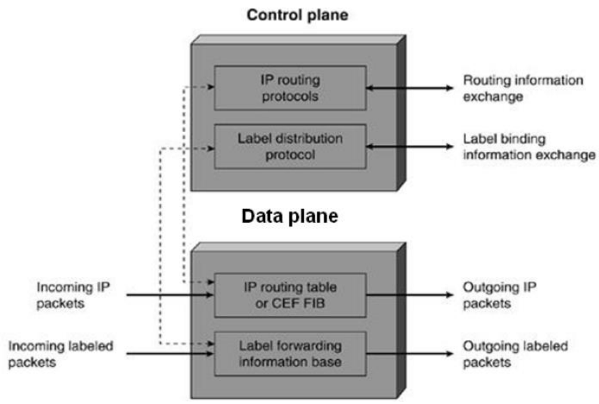

Fig. 3. MPLS Architecture [3]

The rest of paper is organized as: Section II discusses the related work with MPLS networks. Section III describes proposed work and methodology used. Section IV provides results of simulations and finally, section V concludes the work with final remarks.

2. LITERATURE SURVEY

Abdelnour Aldraho and Alexander A. Kist [1] proposed a mechanism to alter network paths dynamically to enable changing topologies. It is based on Multi Protocol Label Switching (MPLS) methodology and proposes flow tracking to maintain transaction state. It causes minimal disruptions to active network connections. They also discusses the underlying optimization problem, proposed Dynamic Topologies using MPLS (DTM) and introduced simulation results to demonstrate the operation of the proposed scheme.

Amund Kvalbein et al. [2] presentd a new recovery scheme called Multiple Routing Configurations (MRC). To assure fast recovery from link and node failures in IP networks. The proposed scheme guarantees recovery in all single failure scenarios, using a single mechanism to handle both link and node failures, and without knowing the root cause of the failure. MRC is strictly connectionless, and assumes only destination based hop-by-hop forwarding. MRC is based on keeping additional routing information in the routers, and allows packet forwarding to continue on an alternative output link immediately after the detection of a failure. It can be implemented with only minor changes to existing solutions. The performance of MRC has been analyzed with respect to scalability, backup path lengths, and load distribution after a failure. The simulation results showed that an estimate of the traffic demands in the network can be used to improve the distribution of the recovered traffic, and thus reduce the chances of congestion when MRC is used.

Chin-Ling Chen [3] proposed a new service mapping scheme for achieving the optimal between the number of service classes supported and the label space available. Features comparison of proposed service-mapping schemes is also provided. The proposed approach also combines the techniques of (IPv6) and labeling protocol. By using (IPv6) packet header, the sender issues a triggered packet to establish label switch path (LSP) between label switch routers (LSR) in DiffServ domain.

Jorge Crichigno, Joud Khoury and Nasir Ghani [4] presented a routing scheme for MPLS networks with probabilistic failures. The proposed scheme simultaneously maximizes the expected satisfied demand and minimizes the maximum link utilization of the network. It is the first approach to jointly address the traffic engineering and the routing through reliable paths problems. In addition to the optimal routing algorithm, they also present a lower complexity heuristic algorithm based on Linear Programming and Yen's algorithm.

Olexandr Lemeshko and Tatiana Vavenko [5] proposed the mathematical model of multipath routing with load balancing in the MPLS network. The model described the processes of routing and distribution links resource.It also taken into account the characters of links (duplex, half-duplex or simplex links) and prevented the effect of packets looping.

Azeddien M. Sllame [6] described modeling and simulation tools used to evaluate MPLS based networks. Three tools GNS3, OpenSimMPLS and OPNET were used to design and evaluate the performance of MPLS networks. GNS3 can help in designing and modeling computer networks where as OpenSimMPLS can make the designing more interactive. Wireshark can also be used to enhance the protocol investigation process. OPNET was used to examine the performance of MPLS network on VOIP application.

Olexandr Lemeshko and Kinan Arous [7] Proposed a fault-tolerant routing model for unicast flows in MPLS-network. The flow-oriented model is 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 as link, node and path protection. The model also described three different types of condition of the links overload prevention for different variants of channel resource use.

Ivana Hucková and Martin Hrubý [8] focussed on traffic engineering in MPLS networks to provide required quality of service. They proposed an online TE server to optimize the data flow in the network and maximize the utilization of the network resources. The implementation results prove the efficiency and optimal resource utilization in the network provided by the proposed TE server.

From the literature surveyed it can be gathered that mechanisms have been developed to enhance the quality of service in MPLS network. Different traffic engineering schemes has been suggested and implemented to evaluate the performance of MPLS network.

3. PROPOSED MPLS NETWORK SYSTEM

The objective of the traffic engineering technique is to improve the performance of the operational network at the resource level as well as the traffic level. Parameters such as packet loss, delay, jitter, and throughput are used to measure the network performance. 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. So much work has been done in this area to improve the quality of service of the MPLS network by optimizing the QoS parameters such as bandwidth optimization, low packet loss ratio, low delay and jitter. In this work, we have designed a mathematical model for the efficient use of the bandwidth required by an MPLS routing path. The effective bandwidth required by any transmission path is dependent on some factor like packet loss, transmission delay at each link etc. So effect of these parameters on bandwidth requirement is also considered in this work. A distributed LSP scheme has been proposed to reduce the spare bandwidth demand in MPLS networks. The main idea of the proposed D-LSP scheme is to partition traffic into multiple LSPs, each of which is established on a distinct link disjoint route between each pair of end nodes.

The effective bandwidth for a system can be given by as follows:

$$w_i^{eff}(n_i) = \frac{(\alpha b(1-P) + \rho n_i d) r n_i}{\alpha b(1-P) + d n_i} \quad (1)$$

d = desired queuing delay;
ε = packet loss ratio;
b = mean burst length;
P = packet flow source use;
n_i = number of flows;
$\alpha = \log\left(\frac{1}{\varepsilon}\right)$;
$l(k)$= number of lost packets measured in the k^{th} time interval; and,
$\hat{\alpha}(k)$ = number of total input packets in the same interval.

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 4 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.

In this work an effective routing algorithm for management of packet flow in MPLS networks has been proposed. Figure 4 demonstrates the basic mechanism used in this work for improving quality of service in the network. Quality of service offered by any network depends on many factors as link load, bandwidth consumption, delay, jitter, packet loss etc. An efficient routing algorithm will offer minimum distance to data flow from source and destination. In this work minimum hope routing technique is proposed. Two lable edge routers (LERs) are used to manage the flow of packets from source to destination.In traditional methods the packets will route to next nearest node on the basis of source and destination address attached into the header of particular packet. This may cause congestion in the network. To prevent congestion,the proposed mechanism calculate the load of the network and decides two paths having equal load between them. The path having minimum hope count is selected as final path for the flow of packets.In this way congestion between nodes can be avoided. Shortest path selection of the proposed method improves the bandwidth utilization in the network as well as link load.

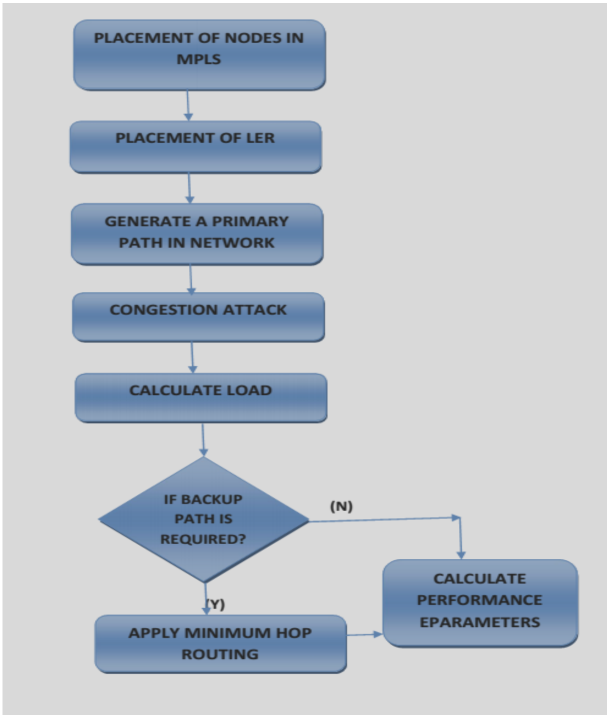

Fig. 4. Proposed method

4. RESULTS AND DISCUSSION

MPLS integrates the performance and traffic management of level layer 2 (L2) with the scalability and flexibility of routing on layer 3 (L3). Therefore, it is seen as the protocol of (L2.5) level. Conventional routing is based on the exchange of the information about the availability of the network, as packet travels through the network; each router extracts the information relevant to forwarding from (L3) headers. This information is then used to index the routing tables to determine the next hop for the packet.

This is repeated at each router in the network. At each hop in the network, the optimal forwarding packets must be re-established.

The main concept of MPLS is to add labels in each packet. Based on these labels the packet forwarding through the network is done. However, the label summarizes essential information for routing the packet through MPLS domain. Hence, MPLS is a technology that accelerates and directs the flow of network traffic and makes it easier to manage. As we know that better QoS is the main priority for the network service providers. As MPLS is a differentiated and scalable framework which can provide effective bandwidth requested for any application. So we have designed such a model which can fulfil the entire requirement needed by network consumers. The network consists of 30 nodes and two LERs as shown in (figure 5). All links were setup as duplex with some initial delay and using Drop Queuing, which serve packets on a First Come First Serve (FCFS) basis.

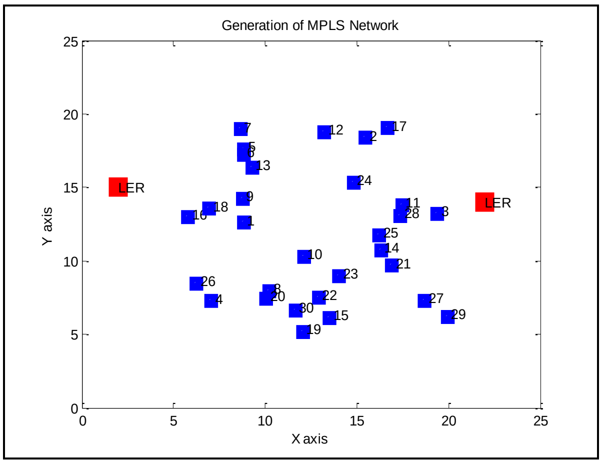

Fig. 5. Generation of MPLS Network using MATLAB

The shortest possible path in a network with n nodes is one hop; the longest possible path (without loops) is (n-l) hops. The number of packets that belong to a particular flow and traverse the network at one time depends on packet inter arrival times and network latency. To estimate the impact of changes to topologies, it is assumed that propagation and transmission delays are the same for all links. The shortest path algorithm calculates the shortest path using the number of routers as the cost function. Dijkstra's algorithm is called the single-source shortest path. It is also known as the single source shortest path problem. It computes length of the shortest path from the source to each of the remaining vertices in the graph. Dijkstra's algorithm uses the greedy approach to solve the single source shortest problem. They provide communication by minimum hop routing technique. Information is securely transferred from sender to the receiver. From the results shown below we can conclude that for the same number of traffic volume, bandwidth required is more in case when queuing delay is less. It is one of the major factors which limit the performance of any service providing network. Figure 6 provides the relationship of bandwidth consumption with respect to packet flow. The bandwidth consumption increases with increase in packet flow. Similarly Queuing delay also effects bandwidth consumption in a network. Greater the Queuing delay more will be the bandwidth consumption as indicated by (figure 7).

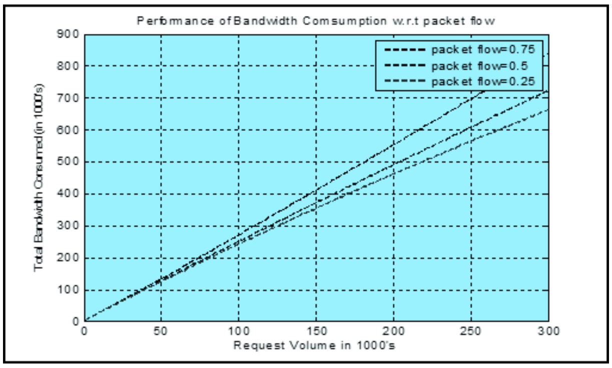

Fig.6. Performance of Bandwidth Consumption w.r.t Packet Flow

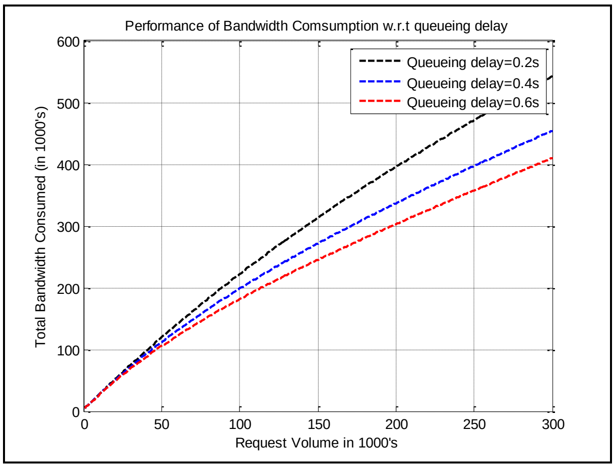

Fig. 7. Performance of Bandwidth Consumption w.r.t Delay

The proposed method resulted in lesser number of nodes for transmitting data from source to destination by providing shortest path as shown in (figure 8). This results in reduction in Link load as indicated in (figure 9).

Figure 8 shows the selection of shortest path based on minimum hope routing from source to destination. It can be concluded that proposed scheme resulted in minimum number of nodes offered for the packet flow in the network.

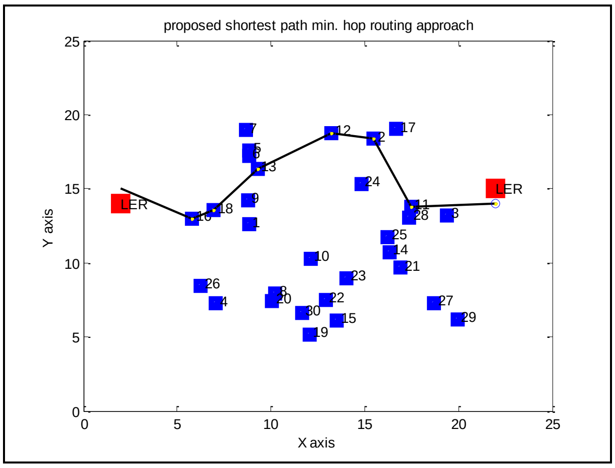

Fig. 8. Proposed Minimum Hop Routing In MPLS System

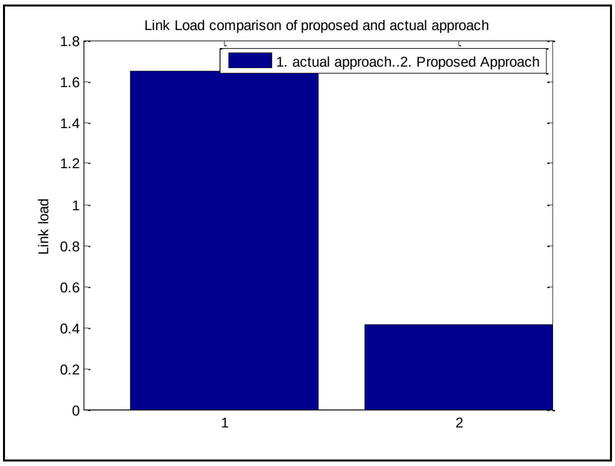

Fig. 9. Performance of MPLS Network in terms of Link Load Parameter

5. CONCLUSION

MPLS has been developed for supporting traffic engineering and quality-of-service (QoS) guarantees in Internet backbone networks. These networks provide connection-oriented data transfer services based on label switched paths (LSPs) established between label edges router (LER) pairs. In this work, it presents a Rerouting model in MPLS Network for reducing traffic. The efficient QoS model provides better control and administration of network traffic. 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. The performance of bandwidth consumption is shown w.r.t delay produced. The link load of proposed approach is also better.

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