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Enhancement & Performance of Quality of Service based on MPLS

Juhi Singh[1],Alok Kumar Srivastava[2],Shrawan Kumar[2], Vinay Shukla[2*]
[1]NIELIT,Lucknow UP INDIA 226010
[2] Department Of Computer Science & Engineering
Institute Of Technology & Management Chehari, Maharajganj UP INDIA 273303

Abstract **-** MPLS is enhanced technology to improve the Quality of service parameters. In the paper the study of Quality of Service performance is done over NON-MPLS based and MPLS-based Network on the UDP and TCP data packet type. Also the study has been done by varying the packet size of the UDP and TCP data showing the comparison of the performances. Various parameters of the quality of services as throughput, packet delivery ratio, and total packet loss are taken and analysis has been done with the x-graph and NS2 on the same network using NON-MPLS and MPLS-based network. The main focus of the paper is improved analysis on the QoS with the advanced technologies in which the MPLS and supporting traffic engineering is one of them. The protocol used to implement the newly proposed MPLS technology are LDP and CR-LDP providing comparative study with the conventional NON-MPLS based network that uses default protocol OSPF.

Keywords **–** MPLS, QoS parameters, UDP, TCP, simulation, LDP, CR-LDP.

I. INTRODUCTION

There is growing interest in deploying Quality of Service in the enterprise environment. While common applications such as file transfer or web access do not need Quality of Service (QoS) mechanisms in most environments, but popular voice encoding algorithms might need support from QoS mechanisms in some network environments [1]. Quality of Service (QoS) is one of the decisive factors in selecting the desired Web service for the requester where data, voice, and video all traverse the same network infrastructure [2]. Within a conventional network, Quality of Service (QoS) is the most important implementation consideration. QoS is a networking term that specifies a guaranteed network data performance level. In practical terms, QoS is a mechanism to assure that any type of data traverse the network with minimum delay. It is therefore not surprising that effort has been devoted to the implementation of protocols to support the heterogeneous Quality of Service (QoS) requirements of applications at the level of the network infrastructure [3].

MPLS technology has enhanced the QoS techniques to improve the routing of packets from source to destination optimizing the QoS parameters. The MPLS technology supports the QoS between the network and data link layer by routing of packets with the fast switching techniques.

II. BACKGROUND

Network quality of service is evaluated by measuring four key parameters: bandwidth, end-to-end delay, jitter, and packet loss. **Reliability** is a characteristic that a flow needs. It means that lack of reliability is losing a packet or acknowledgement. **Latency** is the flow characteristics means the delay in the packet transmission. **Jitter** is the variation in the end-to-end delay for the packets belonging to the same flow that is sequential packets. **Bandwidth** typically specified in kilo or megabits per second (kbps or Mbps), is measured as the average number of bits per second that can travel successfully through the network [4]. Previously the works done on quality of service techniques i.e. Intserv[9], Diffserv[10] involved over NON-MPLS network were based on proactive routing protocol like OLSR and its effects are elaborated by stating how to improve the quality of service parameters. The following provide QoS guarantees: Integrated Services (IntServ) application that requires some kind of guarantees has to make an individual reservation RSVP[7,8]. The enhancements in QoS will enable a better mobile user experience and will make more efficient use of the wireless channel. The Integrated Services (Intserv) architecture provides Quality of Service (QoS) for end to end delivery to applications over heterogeneous networks. To support this end-to-end model over a wide variety of different types of network element [5,6].Differentiated Services (DiffServ) categorizes traffic into different classes, also called class of service (CoS), and applies QoS parameters to those classes. Multiprotocol Label Switching (MPLS) tagging each packet to determine priority [14].

MPLS stands for "Multiprotocol" Label Switching, multiprotocol because its techniques are applicable to any network layer protocol. But we focus on the use of IP as the network layer protocol router which supports MPLS is known as a "Label Switching Router", or LSR. MPLS is based on the concept that the forwarding of the packet based on LABEL not on the IP addresses that’s why it is called labeled switching. Aggregation as diffserv is provided with the concept of Forward Equivalence Class (FEC) that classify the packets according to the labels attached [11, 12, 13].

III. LITERATURE SURVEY

As a packet of a connectionless network layer protocol travels from one router to the next, each router makes an independent forwarding decision for that packet. That is, each router analyzes the packet’s header, and each router runs a network layer routing algorithm. Each router independently chooses a next hop for the packet, based on its analysis of the packet’s header and the results of running the routing algorithm. Packet headers contain considerably more information than is needed simply to choose the next hop. Choosing the next hop can therefore be thought of as the composition of two functions. The first function partitions the entire set of possible packets into a set of "Forwarding Equivalence Classes (FECs)". The second maps each FEC to a next hop. Different packets which get mapped into the same FEC are indistinguishable. All packets which belong to a particular FEC and which travel from a particular node will follow the same path or if certain kinds of multi-path routing are in use, they will all follow

In conventional IP forwarding, a particular router will typically consider two packets to be in the same FEC if there is some address prefix X in that router's routing tables such that X is the "longest match" for each packet's destination address. As the packet traverses the network, each hop in turn reexamines the packet and assigns it to a FEC. As compared to conventional network MPLS network gives better throughput performance on the wired network[18,19]. MPLS performance improves the QoS supporting the traffic engineering reducing the delay and improves throughput[20,21].

IV. IMPLEMENTATION

Our simulated results are provided in Figures below on the variation in network packet size with TCP and UDP traffic on NON-MPLS based and MPLS based network. To evaluate the behavior of simulated intrusion based on quality of service, we considered the performance metrics of packet loss, throughput, packet delivery ratio and total delay.

PDR=(∑CBR packets received by sinks/∑ CBR packets sent by source) Equation 1

PACKET LOSS= PACKET SENT- PACKET RECEIVED (SOURCE TO DESTINATION) Equation 2

To calculate network performance, we simulate QoS parameters in NON-MPLS based and MPLS based network in large number of nodes and connections with the help of Network Simulator 2. We set the parameters for our simulation as shown in

Table 1. X-graph is used for plotting the result in form of graph in NS2[21]. The simulation parameters are shown below.

Table 1 Simulation parameter

Simulator	NS-2.34
Simulation time	8 sec
Number of nodes	12
Topology	750m x 750m
Routing Protocol	OSPF in NON-MPLS LDP/CR-LDP in MPLS
Traffic	CBR/FTP
Source Node	Node 0
Destination Node	Node 11
Source Node for creating Congestion	Node 1
Start time of packet transition from Source Node 0	0.5 sec
Start time of packet transition from Source Node 1	1 sec

In this section we present a set of simulation experiments to evaluate throughput, packet loss, packet delivery ratio, and delay on NON-MPLS and MPLS based one of a set of paths associated with the FEC. The main idea of Multi Protocol Label Switching (MPLS) is to assign a short, fixed-length identifier, called label, to a packet to simplify and speed up the packet forwarding process in data networks implementing the hop by hop routing [15,16], where LDP protocol is used for label distribution over the nodes[17]. MPLS also support the traffic engineering as re-routing and aggregation that is CR- LDP[18.19].

network. First we had explained MPLS network in detail how the packets are transferred over the network via simulation in NS-2. We have generated a small size network with 12 nodes in a flat grid of 750m x750m, where the nodes from Node 2 to Node 10 are converted into LSR (Labeled Switch Router) for the MPLS network. We have made analysis on the packets with the source Node 0 and destination Node 11. Meanwhile the transmission of these packets from Node 0 to Node 11 we are sending other sequence of packets from Node 1 to Node 11 so as to introduce the traffic congestion after 1 seconds. Initially we had made study on the packet type CBR then in the next part we had made study on the FTP packet type. And in the third case we are sending both types of data through same path. Figure 1 shows the snapshot of initially network. Sequence of snapshot is shown at different instance of types of packet flow. Three scenarios have been taken for analysis.

Scenario 1: When both Source Node sends UDP packets.

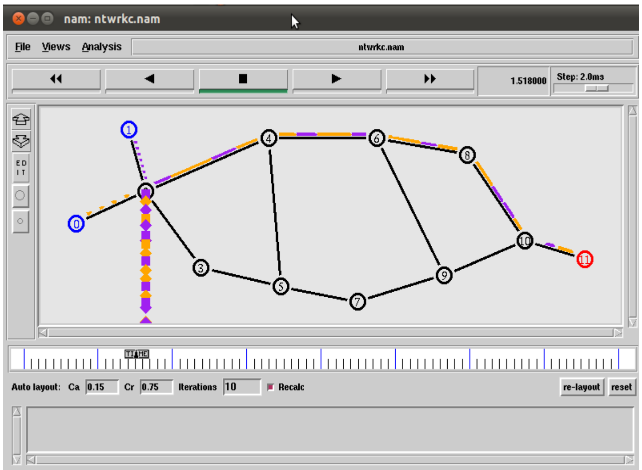


Figure 1 Packet dropped

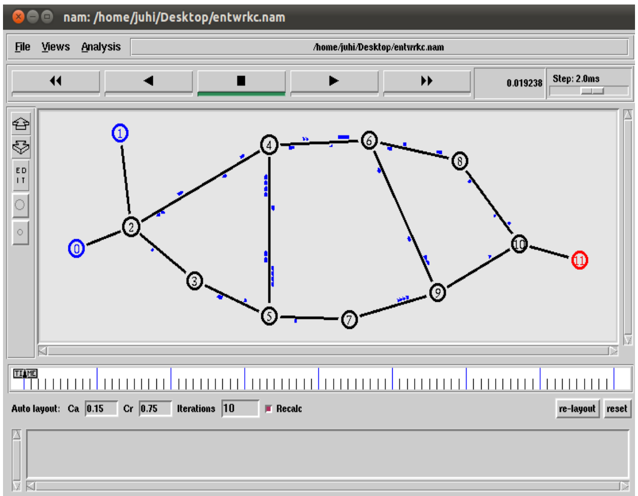


Figure 2 LDP message packets over the network

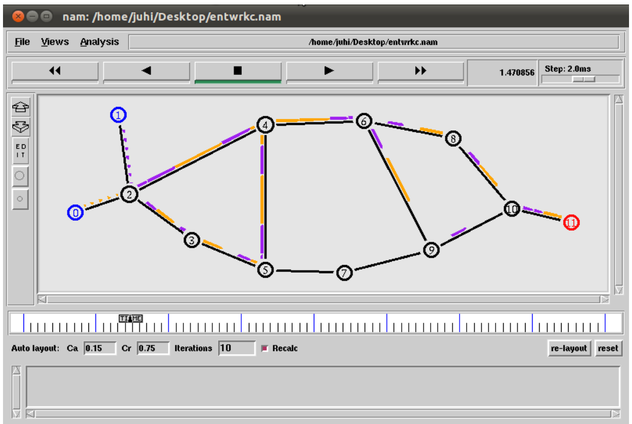


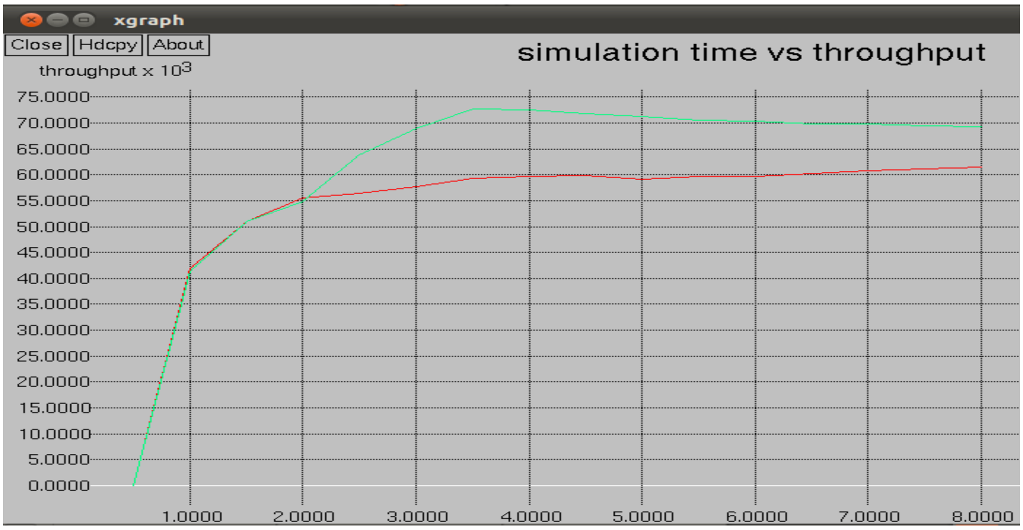
Figure 3 Re-routing of packets

We have taken different scenarios of defined parameters for our simulation with different packet size. Then the same parameter is used to evaluate the performance on MPLS network. The metrics are used to evaluate the performance are throughput, packet-loss, packet delivery ratio and total delay. Then we compare the results of these two simulations to understand the network and node behaviors over NON-MPLS and MPLS based network. The result of the simulation shows that the packet loss increases sharply with increase in packet size in the NON-MPLS network compared to MPLS network. And when there is no congestion the total delay of MPLS is less compared to NON-MPLS while the total delay is more in MPLS when the congestion increases due to re-routing.

Throughput Performance

Table 2 Throughput performance of S1

UDP1 Packet Size with Interval=0.003	NON-MPLS based Network UDP0 Packet Size=500 bytes Interval=0.005 sec			MPLS based Network UDP0 Packet Size=500 bytes Interval=0.005 sec		
	Packet Send	Packet Received	Throughput (Mbps)	Packet Send	Packet Received	Throughput (Mbps)
100	1500	1393	87.0	1489	1424	89.0
200	1489	1097	68.5	1489	1204	75.2
300	1492	983	61.4	1492	1108	69.2
400	1492	674	42.1	1492	796	49.7
600	1486	545	34.0	1486	676	42.2



NON-MPLS MPLS

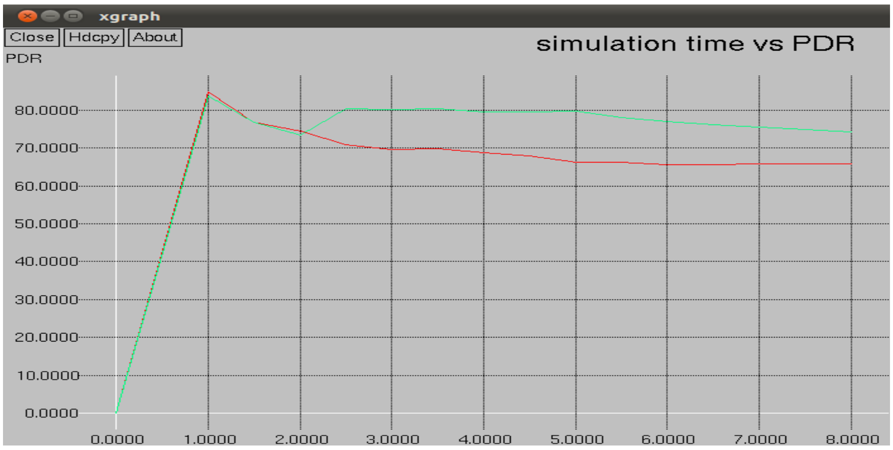
X-AXIS 1unit=1sec Y-AXIS 1unit=5Mbps

Figure 4 Packet Size vs Throughput when both UDP

PDR Performance

Table 3 PDR performance of S1

UDP1 Packet Size with Interval=0.003	NON-MPLS based Network UDP0 Packet Size=500 bytes Interval=0.005 sec			MPLS based Network UDP0 Packet Size=500 bytes Interval=0.005 sec		
	Packet Send	Packet Received	PDR %	Packet Send	Packet Received	PDR %
100	1500	1393	92.8	1489	1424	95.6
200	1489	1097	73.6	1489	1204	80.8
300	1492	983	65.8	1492	1108	74.2
400	1492	674	45.1	1492	796	53.3
600	1486	545	36.6	1486	676	45.5

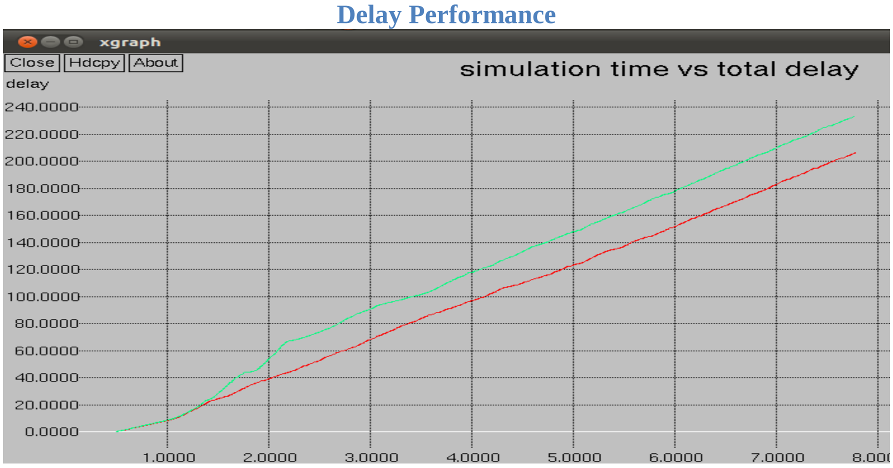


NON-MPLS MPLS

X-AXIS 1unit=1sec Y-AXIS 1unit=10%

Figure 5 Packet Size vs PDR when both UDP

Delay Performance



NON-MPLS MPLS

X-AXIS 1unit=1sec Y-AXIS 1unit=20sec

Figure 6 Total delay when packet size is 300 bytes

Scenario 2: When both Source Node sends TCP packets

Now when we are comparing the FTP packet flow over NON-MPLS network and MPLS based network of same topology the parameters are same in both tough varying the packet size. Since TCP packet are reliable compared to the UDP packets as the next packet is transmitted only when, acknowledgment packet is received. Here we have done analysis of Throughput, Packet Loss, Packet Delivery Ratio, and total delay of the packet. Various studies are done by varying the size of packet but the result is same in each scenario with aprox. 100 percent packet delivery ratio. In both the network the throughput initially increases exponentially with time and then gives the constant throughput. And the total delay is less of the packets in MPLS network than NON-MPLS network.

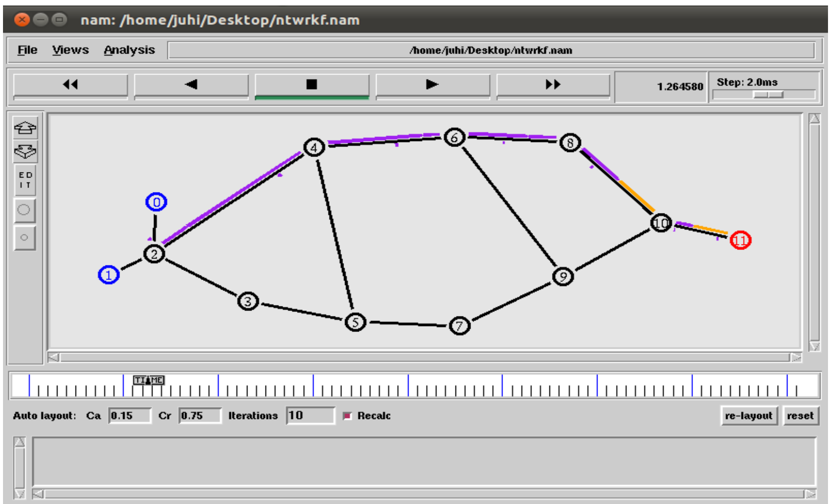


Figure 7 Node 1 sending packets

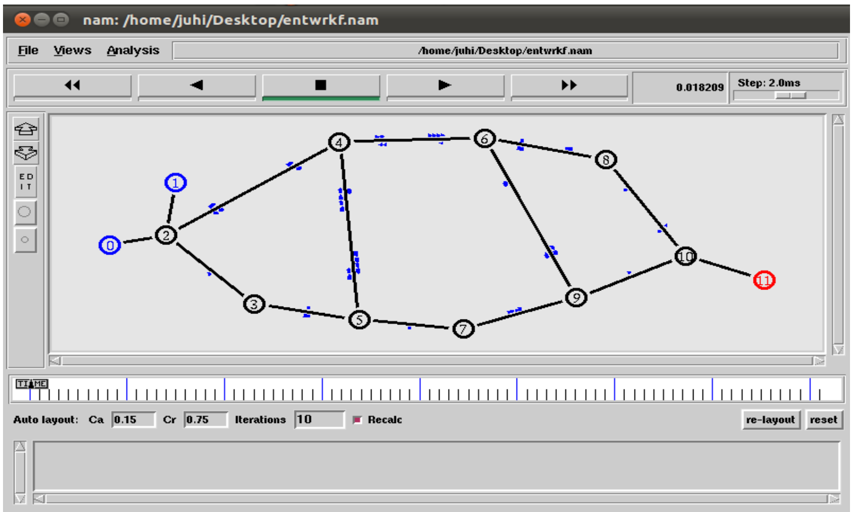


Figure 8 LDP packets

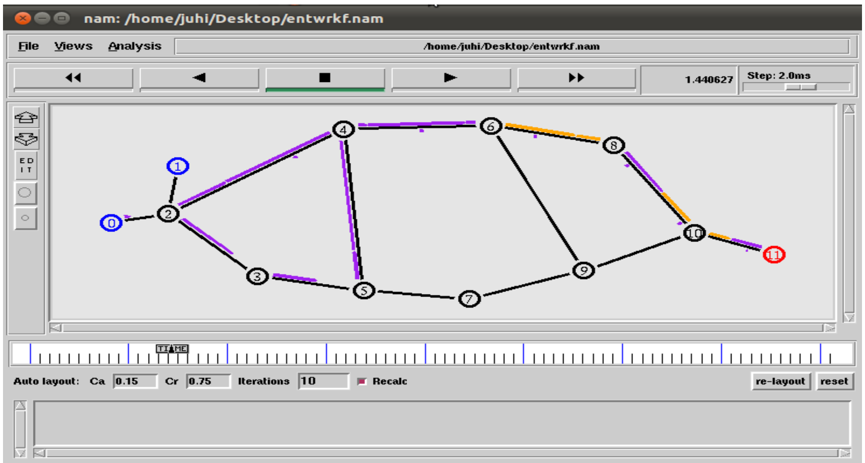
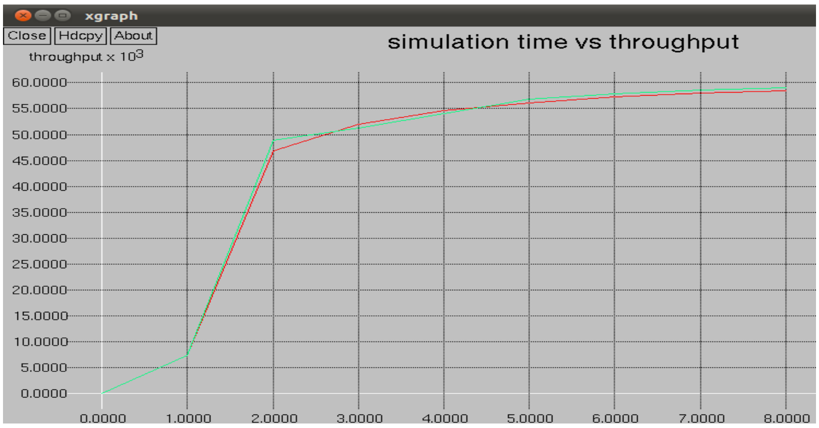


Figure 9 Re-routing of packets

Throughput Performance

Table 4 Throughput performance of S2

TCP1 Packet Size	NON-MPLS based Network TCP0 Packet Size=1000 bytes			MPLS based Network TCP0 Packet Size=1000 bytes		
	Packet Send	Packet Received	Throughput(Mbps)	Packet Send	Packet Received	Throughput(M bps)
100	475	457	57.1	475	461	57.6
200	475	457	57.1	475	461	57.6
300	475	457	57.1	475	461	57.6
400	475	457	57.1	475	461	57.6
600	475	457	57.1	475	461	57.6



NON-MPLS MPLS

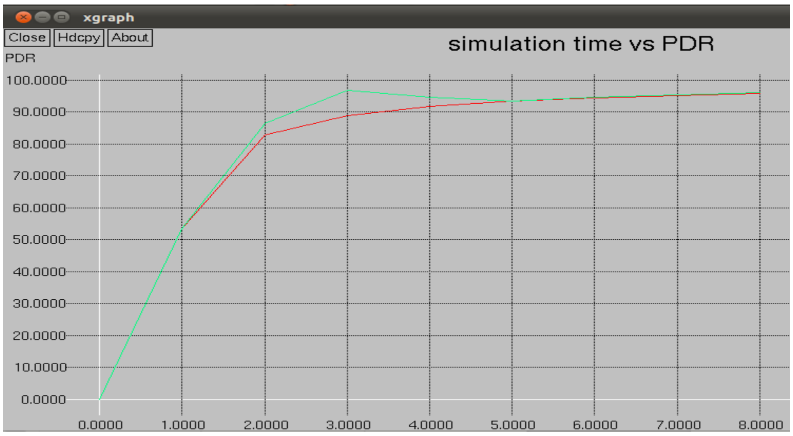
X-AXIS 1unit=1sec Y-AXIS 1unit=5Mbps

Figure 10 Packet Size vs Throughput when both TCP

PDR Performance

Table 5 PDR performance of S2

TCP1 Packet Size	NON-MPLS based Network TCP0 Packet Size=1000 bytes			MPLS based Network TCP0 Packet Size=1000 bytes		
	Packet Send	Packet Received	PDR %	Packet Send	Packet Received	PDR %
100	475	457	96.2	475	461	97.0
200	475	457	96.2	475	461	97.0
300	475	457	96.2	475	461	97.0
400	475	457	96.2	475	461	97.0
600	475	457	96.2	475	461	97.0

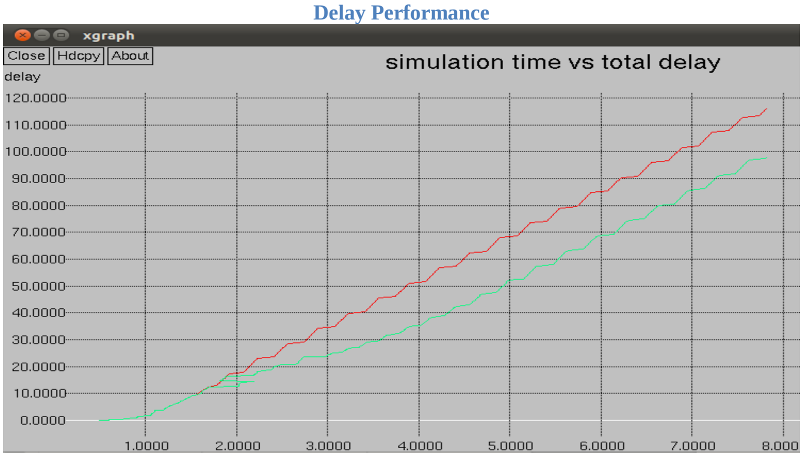


NON-MPLS MPLS

X-AXIS 1unit=1sec Y-AXIS 1unit=10%

Figure 11 Packet Size vs PDR when both TCP

Delay Performance



NON-MPLS MPLS

X-AXIS 1unit=1sec Y-AXIS 1unit=10sec

Figure 12 Total Delay graph of TCP packets.

Scenario 3: When Source Node0 sends TCP packet and Source Node1 sends UDP packets

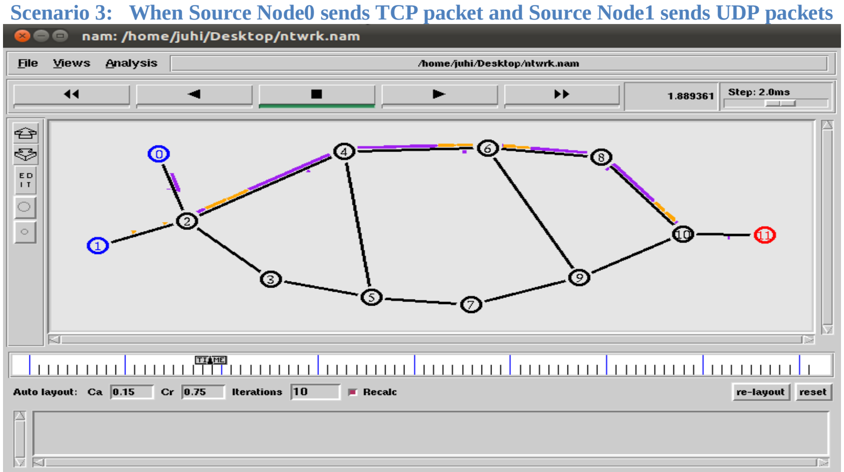


Figure 13 TCP and UDP packets on NON-MPLS nework.

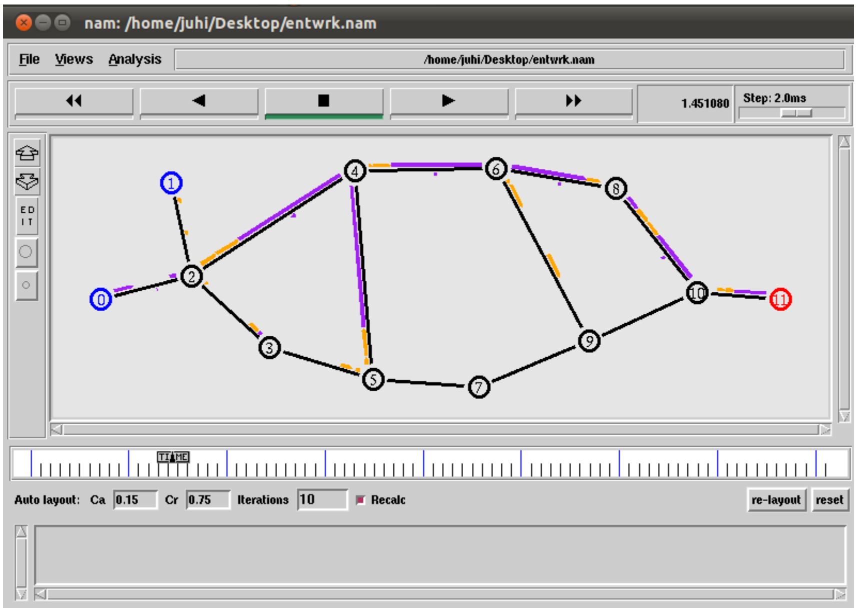


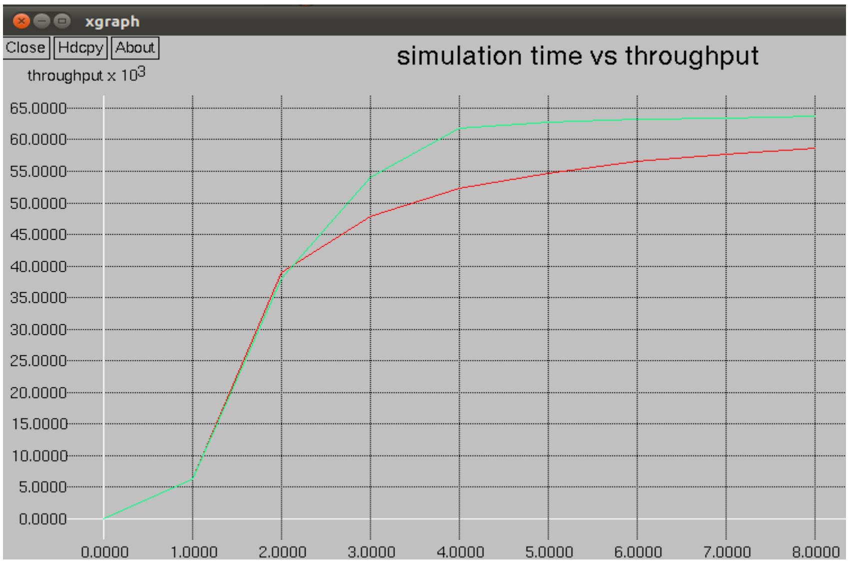
Figure 14 TCP and UDP packets on MPLS network

The next FTP packet type is transmitted over the network from Source Node0 and analysis of these packets is done. While the other Source Node1 sends the UDP packets for congestion. The performance for our simulation with different packet size on both NON-MPLS and MPLS based network. The metrics are used to evaluate the performance are throughput, packet delivery ratio and total delay. The result of the simulation shows that the throughput and PDR of MPLS based network is more compared to NON-MPLS network although increasing the size of UDP packets for congestion; while the total delay in MPLS is less compared to NON-MPLS based network .

Throughput Performance

Table 6 Throughput performance of S3

UDP1 Packet Size with Interval=0.005	**NON-MPLS based Network TCP0 Packet Size=1000 bytes**			**MPLS based Network TCP0 Packet Size=1000 bytes**		
	Packet Send	**Packet Received**	**Throughput(Mbps)**	**Packet Send**	**Packet Received**	**Throughput(Mbps)**
200	601	585	73.1	640	625	78.5
300	475	458	57.2	541	497	62.5
400	342	328	41.0	412	394	49.2
500	231	211	26.3	298	294	36.7
600	117	105	13.1	216	209	26.1



NON-MPLS MPLS

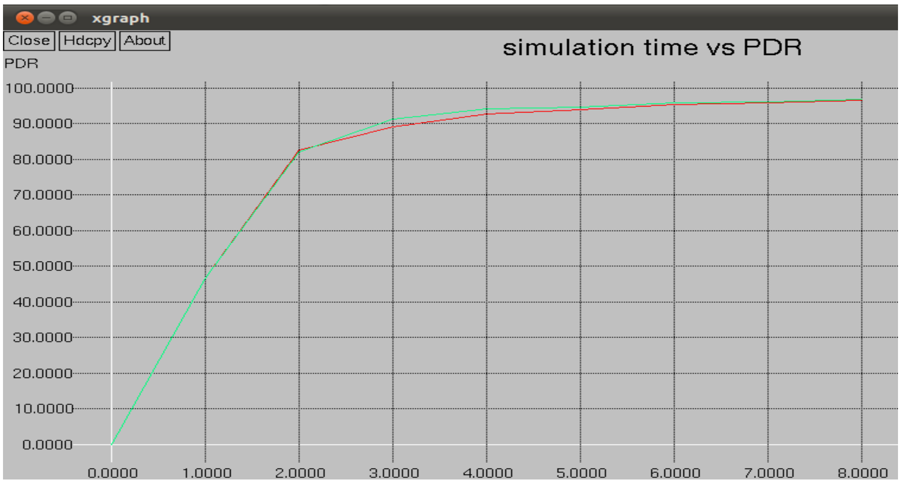
X-AXIS 1unit=1sec Y-AXIS 1unit=5Mbps

Figure 15 Packet Size vs Throughput when TCP and UDP

PDR Performance

Table 7 PDR performance of S3

UDP1 Packet Size	NON-MPLS based Network TCP0 Packet Size=1000 bytes			MPLS based Network TCP0 Packet Size=1000 bytes		
	Packet Send	**Packet Received**	**PDR %**	**Packet Send**	**Packet Received**	**PDR %**
200	601	585	97.3	640	625	97.6
300	475	458	96.4	514	497	96.6
400	342	328	95.9	412	394	95.6
600	117	105	89.7	216	209	96.7

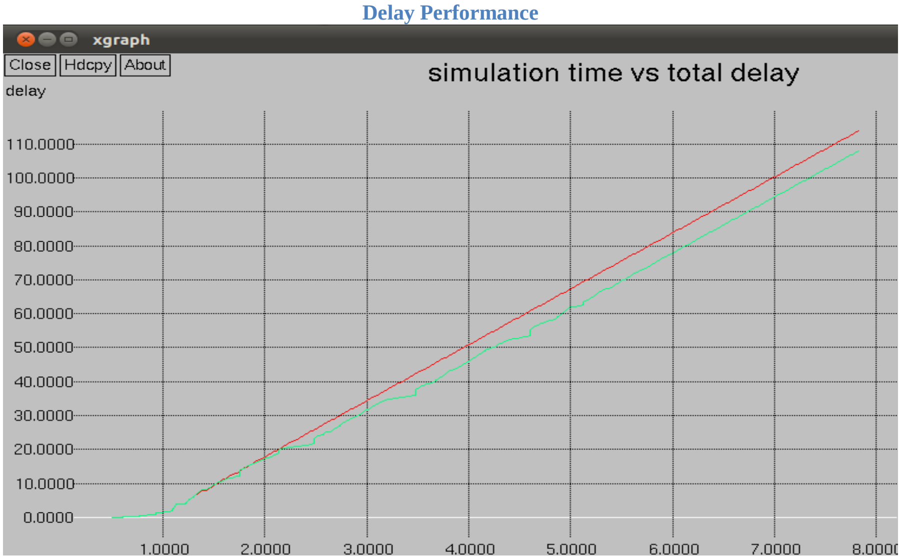


NON-MPLS MPLS

X-AXIS 1unit=1sec Y-AXIS 1unit=10%

Figure 16 Packet Size vs PDR when TCP and UDP

Delay Performance



NON-MPLS MPLS

X-AXIS 1unit=1sec Y-AXIS 1unit=10sec

Figure 17 Total delay when packet size is 300 bytes

V. CONCLUSION AND FUTURE SCOPE

Thus we have analyzed the MPLS technology have improved the Quality of Service over the conventional network by increasing the reliability of packet transmission over the network with high congestion and decreasing the delay in the network with low congestion.

The Quality of Service is compared between NON-MPLS based network and MPLS-based network over UDP packets by means of various performance metrics such as PDR, throughput & packet loss and total delay as well obtained simulation results by varying packet size in the network & found that MPLS network performance that is throughput and PDR is better than NON-MPLS network. And if the size of the packet is decreased both the network tends to similar performance. Total delay in MPLS is less compared to NON-MPLS on the congestion-free network while the total delay increases in MPLS when congestion increases due to re-routing. Whereas TCP packet flow results the same performance over NON-MPLS network and MPLS-based network with less delay both having better reliability than the UDP packet flow. And when both TCP and UDP packets are send the performance of MPLS network has better performance that is throughput and PDR than the NON-MPLS network. And total delay is less in MPLS compared to NON-MPLS network.Various efforts are being made to improve the Quality of Service parameters over the network for reliable delivery of packets. The research on MPLS Technology is still in an early stage that is making scope by supporting traffic engineering MPLS-TE over the wired as well as wireless network. A lot of research is still on the way to reduce the delay and increase the throughput of packet transfer over network. More research can be done on the improving delay, MPLS support over wireless network, integrated approaches to routing security, and data security at different layers.

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