Interpretation of MPLS Enabled Network with QOS Model

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Abstract- This paper presents the interpretation of simple IP network, MPLS enabled network, MPLS VPN network, MPLS VPN with QoS enabled network in the form of Delay, Jitter and Packet loss. The analysis shows that the network with simple IP network will have more delay, jitter and packet loss. Without QOS model in MPLS VPN network the delay, jitter and packet loss are rising with increase of traffic on the network. With the QoS model it provides almost constant delay, jitter and packet loss.

Keywords- Multiprotocol Label Switching, Virtual Private Network, Quality of Service

[1] INTRODUCTION

Multi Protocol Label Switching (MPLS) is a technology to overcome the problems of traditional IP routing and to make routing fast, manageable and able to carry heavy traffic, and accept new routing architectures. MPLS is a modern technique for forwarding network data. In a MPLS network packets are assigned labels and the labels are used to make forwarding decisions without IP lookups at each node. It is called multi protocol because it supports any layer 3 network protocols. MPLS work between layer 2 and layer 3 which is called layer 2.5 technologies. MPLS provides the scalability for the Virtual private networks (VPNs) and support for end to end quality of service (QoS) [1]

[2] MPLS WORKING

Figure 1 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.

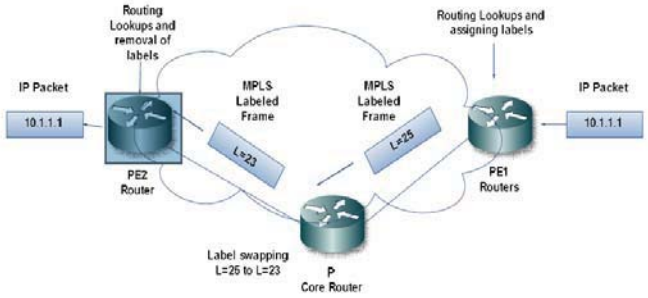


Figure1: Working of MPLS

[3] MULTIPROTOCOL LABEL SWITCHING AND VIRTUAL PRIVATE NETWORKS

A virtual private network is a network that connects private networks over the public network. VPNs provide connectivity on OSI layer 2 and layer 3. Service providers use VPNs to interconnect different sites that belong to same corporation. A requirement of a corporation's private network is that all their customer sites VPNs remain separate from the other corporation VPNs [2]. At the IP layer, VPN models might require that different VPNs are required to connect with one another and also provide connectivity to the internet. MPLS VPN provides this functionality.

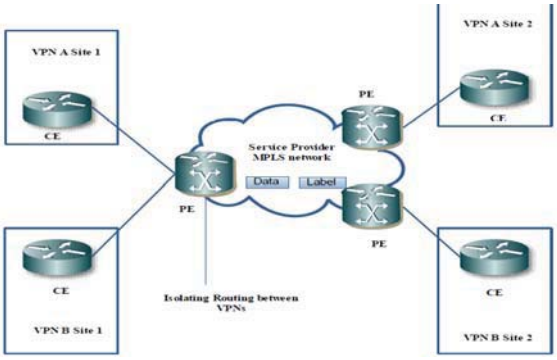


Figure2: MPLS VPN Model

[4]QUALITY OF SERVICE

QOS is the mechanism of the network to provide different service level to a different traffic type as business need. [3] Service providers 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, packet loss. 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 [4].

QOS is to manage the following network elements.

Bandwidth: Maximum amount of date that can be carried.

Delay: The time to send data from source to destination.

Jitter: Variation in delay.

Reliability: Packet loss.

[5] QOS MODEL

A. *Best-Effort Model*: In this model no QOS is configured. All the traffic is treated in the same manner and all are equally important

B. *Integrated Services (IntServ) Model*: It was the first model developed to achieve the end to end QoS. Basic idea was to reserve network resources for applications

C. *Differentiated Services (DiffServ) Model*: It overcomes the limitations of IntServ model. It does not require end to end resource reservation, no need of signaling, and no need to maintain per flow status.

[6] MPLS ENABLED NETWORK

In the MPLS enabled network the packet will transmit in the form of packet enabled with simple IP network. And it ensures that there is end to end delivery of packet and there is no loss of packet and delay. Figure3: shows network

with MPLS configuration. P shows the provider router, PE is the provider edge router and R is the customer edge router. In MPLS enabled network we have to route the packet with different protocols like OSPF, Static routing and BGP. Static route will route the packet from one source to the destination specified. In this the destination IPs are given and packet is delivered to only the specified destination.

In the MPLS enabled network the routes need to advertise their route to their neighbor and we use border gateway protocol at the border areas to route the packet. Provider router ensures the delivery of labeled packet with OSPF protocol. In the MPLS enabled network if we want to send packet from one source to the destination then packet is labeled by a label at the customer edge router, provider edge will receive the packet and it removes the label coming from source side and it attaches the new label depending upon the condition whether to put the new label or not. After receiving the label it transmit it to the next specified router of destination. At the receiving end the received router will receive the labeled data and it removes the label and simple IP network is transfer to the destination.

Protocols Used: It consist of protocols

1. OSPF protocol is used between the Provider router and Provider Edge router. And in this it is necessary to enable MPLS.

2. BGP is Border Gateway Protocol and it is used between the Provider Edge router and Customer edge router to transmit data from source to destination.

3. Static routing is established between the VPN and customer edge router. It ensures that data will go to that destination only, which is defined by static routing.

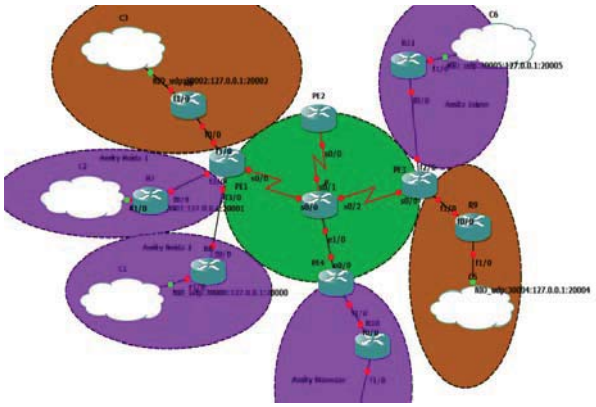


Figure3. MPLS Enabled Network

[7] RESULTS OF TEST AND MEASUREMENT

7.1Simple IP Network

In the first case we have a simple IP Network in which we only used the EIGRP routing protocol for end-to-end connectivity and the value of delay, jitter and packet loss with respect to packets per second are shown in table 1.

Table1: Simple IP Network

PPS	Delay	Jitter	Packet Loss
3000	0.000289	0.000037	0
6000	0.000531	0.000062	0.09616
9000	0.000835	0.000533	1.9767
12000	0.001377	0.001203	2.3996
15000	0.001641	0.001481	2.975
18000	0.002025	0.001729	6.6693
21000	0.002135	0.001934	19.4549
24000	0.002439	0.002065	40.7475

27000	0.002557	0.002065	40.7299
30000	0.002721	0.002161	40.0657

7.2MPLS Enabled Network

In the second case we configured a MPLS enabled network in the service provider domain (P1, P2, PE1 and PE2.) and took the results of delay, jitter, and packet loss as shown in table 2.

Table2: MPLS enabled network

PPS	Delay	Jitter	Packet Loss
3000	0.00029	0.000042	0
6000	0.000339	0.000084	0
9000	0.000735	0.000197	4.2952
12000	0.000709	0.000287	6.4653
15000	0.000976	0.000255	5.7508
18000	0.001104	0.000485	8.3088
21000	0.001599	0.000774	13.6772
24000	0.001868	0.000966	14.8716
27000	0.001976	0.001471	17.2672
30000	0.002079	0.001598	20.2599

7.3MPLS Enabled VPN Network

In the third case we configured MPLS VPNs on PE1 and PE2 routers and take the results of delay, jitter, and packet loss as shown in table 3.

Table3: MPLS Enabled VPN Network

PPS	Delay	Jitter	Packet Loss
3000	0.000337	0.00006	0
6000	0.00034	0.000063	0
9000	0.000528	0.000189	3.9402
12000	0.000675	0.000306	6.5109
15000	0.000874	0.000486	11.67
18000	0.000982	0.000657	12.8327
21000	0.001421	0.001043	15.65
24000	0.001599	0.001189	18.8876
27000	0.001816	0.001685	21.0337
30000	0.002248	0.001753	20.9839

7.4MPLS Enabled VPN with QOS

In the fourth case we configured the MPLS VPN with a DiffServ QoS model and took the results in two different ways.

i. Results from Three Traffic Generator:

TGN is an internetworking operating system (IOS) based program that runs on a pagent router (Cisco traffic generator). It is used to generate different kind of traffics patterns. We use it to generate continuous IP traffic

stream. It is required almost all header fields Information to generate traffic. Table 4 shows the results in MPLS VPN with a DiffServ QoS model and this traffic is generated by CE1, CE2 and one external router.

Table4. MPLS VPN with DiffServ Enabled Network Environment Values*3

PPS	Delay	Jitter	Packet Loss
3000	0.00088	0.000119	0
6000	0.000887	0.000115	0
9000	0.000883	0.00012	0
12000	0.000888	0.000123	0
15000	0.00089	0.000124	0
18000	0.000883	0.000118	0
21000	0.000893	0.000124	0
24000	0.00088	0.00012	0
27000	0.000896	0.000129	0
30000	0.000896	0.000126	0
150,000	0.000906	0.000121	0
300,000	0.000903	0.000125	0

ii. *Result from One Traffic Generator*:

Table5 shows the Results of MPLS VPNs with a DiffServ QoS model enabled network environment. This traffic is generated from one external router.

Table5. MPLS VPN with DiffServ Enabled Network Environment Values*1

PPS	Delay	Jitter	Packet Loss
3000	0.000653	0.000056	0
6000	0.00065	0.000065	0
9000	0.00066	0.000061	0
12000	0.000662	0.000061	0
15000	0.000649	0.000057	0
18000	0.000656	0.000058	0
21000	0.000651	0.000058	0
24000	0.000651	0.000059	0
27000	0.000657	0.000058	0
30000	0.000655	0.000059	0
150,000	0.000655	0.000059	0
300,000	0.000655	0.000059	0

[8] RESULT ANALYSIS

In order to analyze results, we gathered the values of delay, jitter, and packet loss from our results at one place and made the comparison in different cases

8.1 Delay

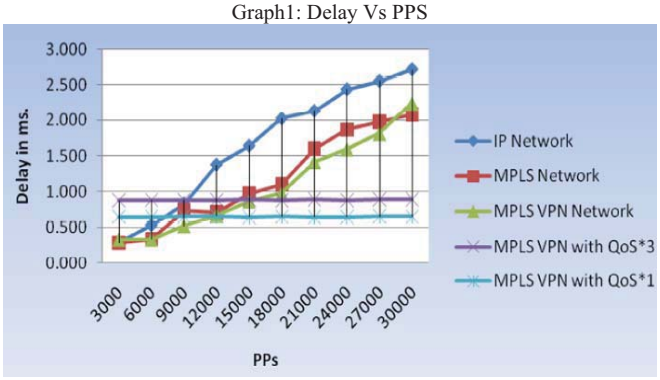
Table 6 shows the details of delay values in different network cases. This table shows PPs against the delay in milliseconds. Traffic load starts from 3000 PPs and continues in increment of 3000 PPs ending up at 30,000 PPs.

Table6: Delay Comparison

PPS	Delay in ms.				
	IP	MPLS	MPLS VPN	MPLS VPN with QOS*3	MPLS VPN with QOS*1
3000	0.289	0.29	0.337	0.88	0.653
6000	0.531	0.339	0.34	0.887	0.65
9000	0.835	0.735	0.528	0.883	0.66
12000	1.377	0.709	0.675	0.888	0.662
15000	1.641	0.976	0.874	0.89	0.649
18000	2.025	1.104	0.982	0.883	0.656
21000	2.135	1.599	1.421	0.893	0.651
24000	2.439	1.868	1.599	0.88	0.651
27000	2.557	1.976	1.816	0.896	0.657
30000	2.721	2.079	2.248	0.896	0.665

Graph 1 shows delay versus PPs, as we see in the simple IP network case the delay is increasing with the traffic increase on the network. We can see in graph 1 that the simple IP network case has more delay compared to the MPLS network or the MPLS VPN enabled network. When we configure DiffServ QoS model over MPLS VPN the delay value is almost constant for different traffic load (PPs).In MPLS VPN with QoS*3 case the average packet delay is 0.9ms. In MPLS VPN with QoS*1 case the delay is almost 0.65ms.

Graph1: Delay Vs PPS



8.2Jitter

In table 7 values of jitter in different cases are gathered to make a more effective analysis. In table 7 all the values are shown with respect to PPs. PPs start from 3000 and goes up till 30,000 with the increment of 3000PPS each time. In the MPLS VPN with QoS*1 jitter varies between 0.056ms to 0.059ms.

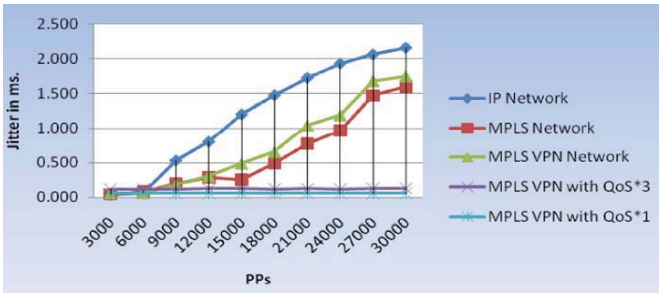
Graph 2 shows jitter versus PPs, as we can see in the case of simple IP network jitter increases with traffic load. When we configured the DiffServ QoS model over MPLS VPN the jitter value is almost constant for increasing PPs.

Table7: Jitter Comparison

PPS	JITTER in ms.				
	IP	MPLS	MPLS VPN	MPLS VPN with QOS*3	MPLS VPN with QOS*1
3000	0.037	0.042	0.06	0.119	0.056
6000	0.062	0.084	0.063	0.115	0.065
9000	0.533	0.197	0.189	0.12	0.061
12000	0.804	0.287	0.306	0.123	0.061
15000	1.203	0.255	0.486	0.124	0.057
18000	1.481	0.485	0.657	0.118	0.058
21000	1.729	0.774	1.043	0.124	0.058
24000	1.934	0.966	1.189	0.12	0.059

27000	2.065	1.471	1.685	0.129	0.058
30000	2.161	1.598	1.753	0.126	0.059

Graph2: Jitter Vs. PPS



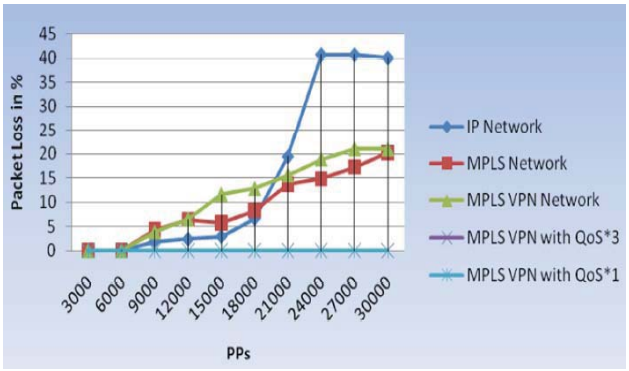
8.3 Packet Loss

Table 8 show details of packet loss in different network cases. Table 8 represents the values of packet loss by percentage against PPs. In the MPLS VPN with QoS*3 and MPLS VPN with QoS*1 cases packet loss is 0%.

Table8: Packet Loss Comparison

PPS	Packet Loss %				
	IP	MPLS	MPLS VPN	MPLS VPN with QOS*3	MPLS VPN with QOS*1
3000	0	0	0	0	0
6000	0.09616	0	0	0	0
9000	1.9767	4.2952	3.9402	0	0
12000	2.3996	6.4653	6.5109	0	0
15000	2.975	5.7508	11.67	0	0
18000	6.6693	8.3088	12.8327	0	0
21000	19.4549	13.6772	15.65	0	0
24000	40.7475	14.8716	18.8876	0	0
27000	40.7229	17.2672	21.0337	0	0
30000	40.0657	20.2599	20.9839	0	0

Graph3: Packet Loss Vs. PPS



Graph 3 shows the relationship between packet losses in percentage with respect to PPs. In the case of a simple IP network packet loss is higher than for the MPLS enabled network and MPLS VPN enabled network. Graph 3 clearly

shows that after configuring DiffServ QOS model packet loss is 0% independent if the traffic is generated from three routers or from one router.

[9] CONCLUSION

MPLS is a fast packet switching technology and reduces the end-to-end delay. The DiffServ QoS model is more effective and scalable than the IntServ QoS model. We can get better results in MPLS VPN network environment by using a DiffServ QoS model. Without DiffServ QoS model in MPLS VPN network environment delay, jitter, and packet loss are rising with the increase of traffic on the network. With the configuration of DiffServ QoS model, it provides almost constant delay, jitter, and packet loss in all different traffic loads bounded by the limitations. Limitations are considered by the means of allocated resources for specific traffic class. Scalable video and audio service with good quality, over the enterprise network using MPLS VPNs together with DiffServ QoS model, can be provided.

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