Performance Measure of MPLS and traditional IP network through VoIP traffic

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***Abstract*— In present time, Internet is playing a important role in most of the people‘s life because of large variety of services and applications offered by Internet. The growing number of Internet users built the popular services telephone and television to utilize the Internet as a medium to arrive their users. These services are offered by convergence of data and voice communications across single network infrastructure. Offering the real-time applications on Internet is a critical task for the traditional IP networks as it utilizes best-effort services which doesn‘t offer guarantee of services and Traffic Engineering (TE). Furthermore, IP networks provide least predictability of services which is unacceptable for the applications i.e. multimedia and telephony services [1].**

Keywords: MPLS, IP networks, VOIP

I. INTRODUCTION

Multi-Protocol Label Switching (MPLS) is an growing technology which plays a significant role in the fourth generation networks by offering TE and Quality of Service (QoS). MPLS networks offer high performance packet control and forwarding mechanism, which routes the packets depending on the labels [2]. It overcomes the restrictions i.e. high packet loss and excessive delays of IP networks by offering congestion control and scalability. Because of low packet loss and low latency during routing of packets MPLS is taken ideal for VoIP applications. We talk about the serious issues that required to be faced by computer networks to transfer the VoIP applications. It offers the explanation about the routing mechanisms, functionalities and design parameters of the IP and MPLS networks. Furthermore, a short explanation of MPLS signaling protocols i.e. Resource Reservation Protocol (RSVP) and Constraint-based routing-Label Distribution Protocol (CR-LDP) and are talked about which are utilized for implementing Traffic engineering in MPLS networks.

II. VOICE OVER INTERNET PROTOCOL (VOIP)

Real-time applications i.e. video and voice across Internet build it the most cost-effective and desirable service to everyone. The VoIP is also called as Internet Telephony, where the communication data packet is transmitted by utilizing Real Time Protocol (RTP). RTP composed of data and a control part. The control part is called as Real Time Control Protocol (RTCP) [12]. VoIP is transported by utilizing the combination of UDP/IP/RTP protocols. Though TCP/IP is a reliable communication protocol, it is not utilized in real-time communications because of that its acknowledgement/retransmission characteristic may cause to additional delays [14].

III. IP NETWORK

Internet Protocol (IP) permits a global network among an endless mixture of transmission media [1] and systems. The primary function of IP is to route the data from the source node to destination node. Data is built as a collection of packets. All the packets are transported via multiple networks and a chain of routers to arrive the destination node. Router takes independent decision on every incoming packet on the internet. When a packet arrive a router, it sends the packet to the adjacent hop based on the destination address existed in the packet header. The process of propagating the packets through the routers is performed until the packet arrive the destination.

IV. MPLS NETWORK

Multiprotocol Label Switching (MPLS) offers high performance forwarding and packet control mechanism for propagating the packets in the data networks [2]. It has developed into an significant technology for efficiently operating and handling IP networks due to its high capabilities in offering virtual private network (VPN) and traffic engineering services [9]. It is not a substitute for the IP but an addition to IP architecture with involving new applications and functionalities. The primary functionality is to add a short fixed-label to the packets that come into MPLS domain. Label is positioned between Layer2 (Data Link Layer) and Layer3 (Network Layer) of the packet to make Layer 2.5 label switched network on layer 2 switching functionality without layer 3 IP routing [9]. Packets in the MPLS network are routed depending on these labels.

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V. OPNET MODELER

OPNET offers various modules for the simulation consisting a huge number of the network elements and protocols [15]. It has received popularity in academic world as it is provided to institutions free of cost. The customers don't require to have deep programming knowledge to employ OPNET. The customer can directly focus in constructing and examining model for simulation. The primary feature of OPNET is that it offers several real-life network topology abilities that build the simulation environment close to reality [13].

Network Design: The simulation of both MPLS and IP networks are deployed in the OPNET Simulator 14.5. The simulations composed of two scenarios with taking the same network configuration.

- Scenario 1 on the basis of MPLS network with TE.
- Scenario 2 on the basis of IP network without TE.

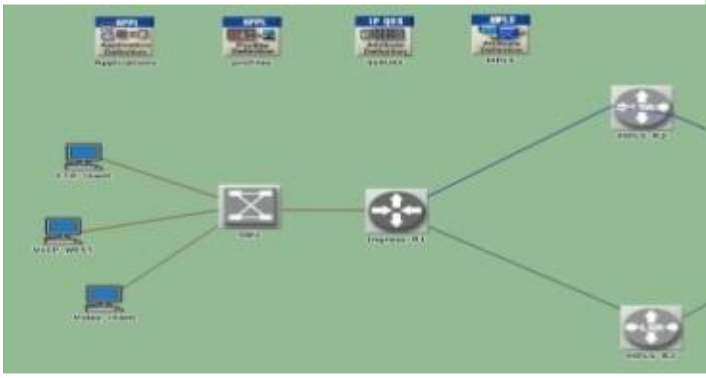

Figure 1 MPLS Simulation Model

Fig.1 depicts the MPLS network based scenario which contains following network elements

- Two LERs (Ingress_R1 and Egress_R4)
- Two LSRs (MPLS_R2 and MPLS_R3)
- Two VoIP stations (VoIP_West and VoIP_East)
- Two switches (SW1 and SW2)

100Mbps links and DS3 links (44.736 Mbps) are utilized for respectively linking all the routers linking workstations to the two switches. TE is carried out in the above simulation model by utilizing CR-LDP signaling protocol, which is set up in OPNET by describing FECs in MPLS definition attribute and also adjust LDP parameters in the routers. The CR-LSP which is demonstrated can be seen in the Figure.5 as a blue colored link from Ingress_R1 to Egress_R4 by router MPLS_R2. When the network congestion happens, the traffic conducted along CR-LSP route is evenly scattered in the MPLS network. This reduces the affect of the network congestion and enhances the efficiency in using the network resources. In this scenario VoIP traffic is routed from VoIP_WEST to VoIP_EAST. The VoIP calls are demonstrated by configuring the profile definition attributes and application. We simulate both networks MPLS and IP in order to receive packet voice jitter, end-to- end delay, packet sent and packet obtained values. In the MPLS network model (depicted in Fig.1), two paths are available which are Ingress_R1<->MPLS_R2<->Egress_R4 and Ingress_R1<->MPLS_R3<->Egress_R4. Both paths are on the same distance from source node to destination node. When the packets are propagated, an IP network utilizes only one of the routes and doesn't consider the other route, as both are shortest routes. Since TE is demonstrated in the MPLS network, the network load is evenly distributed and builds MPLS an effective technology. In IP network model (Fig.2) the two routes are described as IP_R1<-> IP_R2<->IP_R4 and IP_R1<->IP_R3 <-> IP_R4.

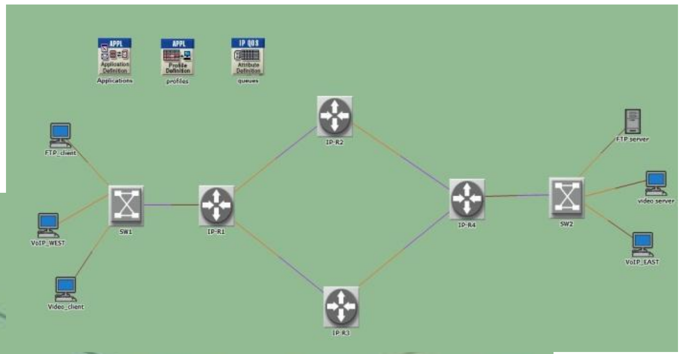

Figure 2 IP Simulation Model

Fig.2 depicts the simulation scenario depend on the traditional IP network without Traffic Engineering. In this scenario MPLS routers are substituted with general IP routers. MPLS definition attribute, thus is not assumed and the packets are propagated utilizing OSPF protocol (which doesn't assume capacity constraints). The VoIP traffic is transported between the VoIP_East and VoIP_West and the process for determining VoIP calls is same to that of MPLS scenario.

VI. RESULTS AND ANALYSIS

Comparison of Performance Metrics The results are depicted in the Fig.3, Fig.4, Fig.5 and Fig.6. They are respectively linked with metrics exhibition in both traditional IP and MPLS networks based scenarios. We realize that there is an enhancement in the performance when the VoIP traffic is transported utilizing MPLS technology. For every scenario the simulation time is 420 seconds. The VoIP traffic begins at the 100th second and terminates at the 420th second of the simulation time. In both scenarios VoIP calls are summed up at fixed time intervals i.e., for every two seconds. The summation of VoIP calls are initiated from 100th second till 420th second of simulation.

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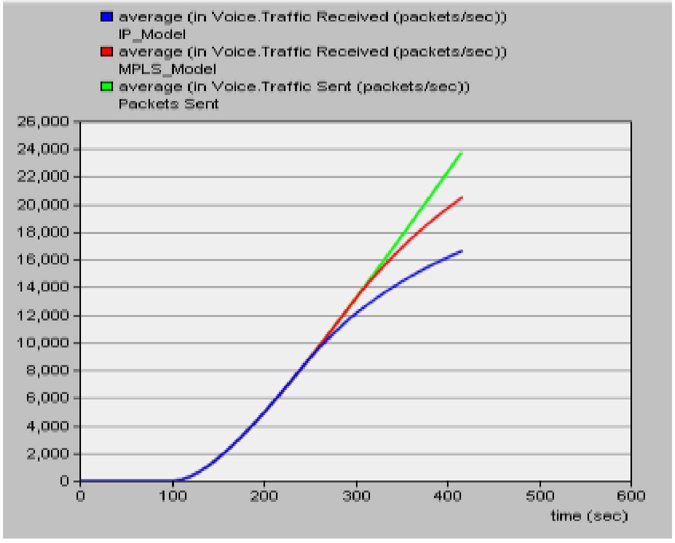

Figure 3 Voice Packet Send and Received

The Fig.3 provides the mean number of packets received and sent in both traditional IP and MPLS networks. Simulation result indicates that MPLS model provides more throughput as compared to the IP model. The two scenarios are simulated by taking the background traffic (described in section 4.2.1). Fig.3 depicts that voice packets start to drop from 240 second in the IP network, while from 300 second in MPLS network. In the simulation, the early packet loss in IP network shows that it cannot demonstrate the VoIP calls with suitable quality after 240 seconds.

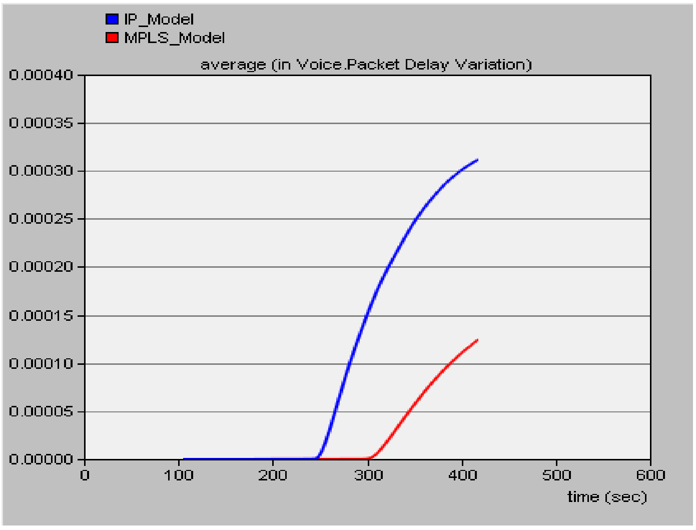

Figure 4 Voice Packet Delay Variation

The VoIP calls demonstrated after 240 seconds possess packet drop. This lead loss of results and information in voice skips and voice breaks. The voice packet drop in MPLS network begins at 300 seconds. MPLS sends the packets with lower delays and high transmission speed. There is TE deployed in the MPLS network which temporarily decreases the congestion. Because of these factors the packet loss in MPLS networks begins at 300 second while in IP network the packet loss begins at 240 seconds, this enhances the throughput in the MPLS network. The Fig .4. depicts the voice packet jitter of IP and MPLS network model. It is observed that voice jitter begins to increase at 240 sec in IP network. In opposite, it is at 300 second for MPLS network. It is realized from the above fig that there is an increment in the jitter for MPLS and IP model around 300 and 240 second respectively. This is because of that, at this time there is a voice packet loss which can be observed from the Fig.3. This variation at these time periods can be viewed for the left performance metric. The voice packet delay variation depicted in Fig.5 has same variations in graphs as described here.

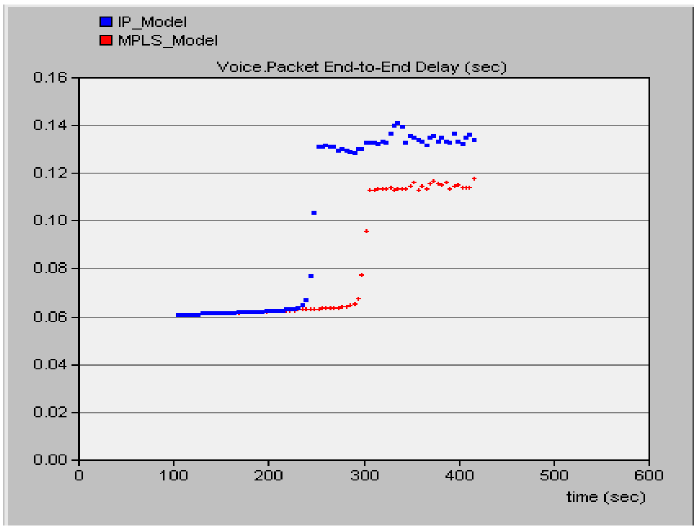

Figure 5 Voice Packet End-to-End Delay

The Fig.5 depicts the packet end-to-end delay of IP and MPLS network model. As described in the above section, the end-to-end delay in a network is not suggested to enhance above the threshold value of 80 milliseconds. So that demonstrated VoIP calls are of suitable quality.

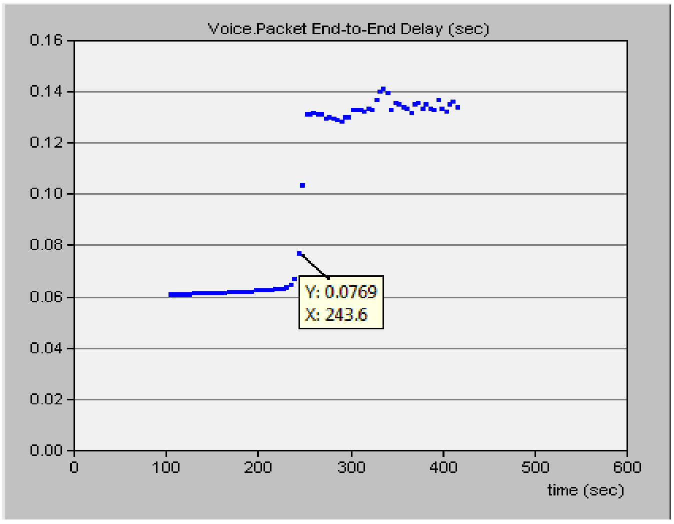

Figure 7 IP Networks End-to-End Delay

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From the Fig. 6 it is observed that end-to-end delay in IP network increases the threshold at 240 sec. while for MPLS network it arrives at 300 seconds. The IP network arrives the threshold former than MPLS network; this is because of TE is demonstrated in MPLS network. From the Fig.7 it is observed that in traditional IP network the end-to-end delay spans the threshold value of 80ms at 243 seconds, while in MPLS network the end-to-end delay spans threshold value at 298 seconds depicted in Fig 8.

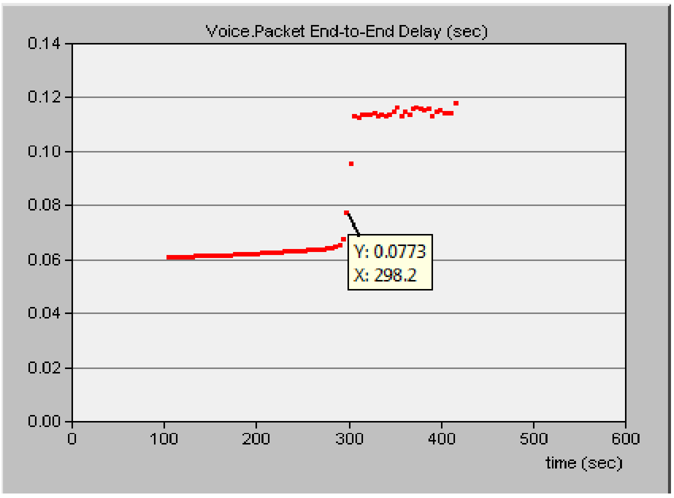

Figure 8 MPLS networks End-to-End Delay

CONCLUSION AND FUTURE WORK

The primary aim of the paper is based on the performance measure of MPLS network and traditional IP network in respect of VoIP traffic. The performance measurement is carried out by introducing a method in OPNET to calculate the least number of VoIP calls that can be kept in the IP and MPLS networks. The performance measurement in both networks is done by concentrating on the performance metrics i.e. voice packet delay variation, voice packet jitter, voice end-to-end delay, Voice packet send and obtained. Our research began by literature review done on the state of art on MPLS, IP and TE. The literature review supported us to reply three of our research questions. Depending on the simulation results it can be observed that MPLS offers best solution in implementing the VoIP application (Internet Telephony) in comparison of traditional IP networks due to the following causes.

Routers in MPLS considers less processing time in routing the packets, this is more appropriate for the applications i.e. VoIP which exhibit less tolerant to the network delays. Demonstrating of MPLS with TE reduces the congestion in the network. TE in MPLS is implemented by utilizing the signaling protocols i.e. RSVP and CR-LDP. MPLS endures least delay and offers high throughput in comparison of traditional IP networks.

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