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Performance Analysis of DiffServ and MPLS for IPv4 Network

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***Abstract*—Due to the continuing exponential growth of internet the real time applications such as voice over IP, video conferencing and interactive games require higher bandwidth and guaranteed quality of services. Real time applications can be performed efficiently over the internet by providing guaranteed QOS (Quality of Service). IP based network provides only the best effort service and does not support traffic engineering very effectively. Today, most of the existing QOS mechanisms such as Multi Protocol Label Switching (MPLS) performs traffic engineering, Differentiated Service (DiffServ) provides the scalable Quality of Service (QoS). Combination of MPLS and DiffServ provides guaranteed QoS. The main goal of this work is to analyse the QoS performance for these network in terms of real time applications using OMNET++.**

Keywords— ***DiffServ, MPLS, QoS, OMNET++***

I. INTRODUCTION

Due to the interest of the end users of world wide web and growing popularity of real-time applications, the demand for real time application is increasing in today's world[1]. Therefore there is need to provide guaranteed QoS. DiffServ and MPLS are two existing QoS mechanisms. DiffServ provides more scalable QoS and offers better QoS when compared to the best-effort service. MPLS has load balancing feature. Multiprotocol Label Switching (MPLS) is label switching technology that forwards the data from one node to the next based on 20-bit label of 32-bit MPLS shim header, so that it can avoid routing table lookups to reduce time complexity. There is no need to read the network addresses. Packets are forwarded based only on the labels. Incoming packets are attached a label (attaching and removing label is always done at an edge routers) according to their forwarding equivalence class (FEC). When the packet enters into the network 20-bit label is attached and the packets are assigned to FEC, this is done only once at the edge router. Then the packets are forwarded to the next node by using pushing and swapping operations and finally at an egress router label is popped and forwarded to the destination.

Differentiated services or DiffServ is a simple, scalable and existing QoS mechanism. DiffServ Classifies the packets entering the network, marks, meters, and manages the network traffic. Using DiffServ mechanism we can provide different priorities to different network traffic as voice, video and data, according to the service level agreements (SLA).It uses 6-bit DSCP(Differentiated Service code point) field for packet classification, this 6-bit DSCP field is the first six bits in 8-bit ToS(Type of Service) field of IPv4 header where 2-bits are currently unused. Omnet++ simulator has been used for simulation analysis. Three scenarios are considered in this work and are as follows, Scenario 1- Baseline Network(IPv4). Scenario 2- DiffServ without MPLS in IPv4 Network. Scenario 3- MPLS in IPv4 Network.

II. BASELINE IPV4 NETWORK

In this scenario Packets are forwarded from IPv4 source host to the corresponding IPv4 destination host and best effort policies are considered in this case[1]. In the given Network topology shown in figure 1 all routers are Diffserv and MPLS disabled, that is in this case Load balancing feature is not considered [1].

Figure 1 is composed of four source host's and four destination host's. And it consists of two LSRs(Label Switch Routers) and LERs(Label Edge Routers) of the core network which are interconnected using the ppp (point-to-point) link operates at data rate of 500kbps.

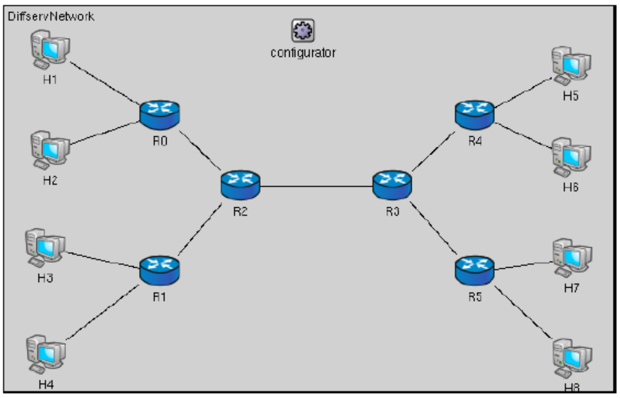

Fig. 1. Network topology

III. DIFFSERV WITHOUT MPLS IN IPV4 NETWORK

The main goal of this scenario is to differentiate the traffic flows of a DiffServ-domain at an edge router. The following configuration is made with scenario 1 in order to configure scenario 2 Traffic classification and marking, scheduling.

Different QoS(Quality-of-sevice) levels can be provided by classifying the traffic at an edge routers. Traffic is classified based on different criteria. After classification, traffic is marked so that required quality-of-service level can be indicated for that traffic. After marking, traffic flows are forwarded depending on basis of corresponding DSCP values[5]. A node allocates resources to behavior aggregates by means of PHB(Per Hop Behavior)[7]. Minimum bandwidth specified for best-effort traffic. The two standard PHB groups are Expedited Forwarding (EF) PHB and Assured Forwarding (AF) PHB[2]. AF PHB group has four AF classes, AF1x-AF4x. In the network topology shown in Fig. 1, AF PHB is used for video traffic and are marked with corresponding AF classes. Voice traffic flows are assigned with EF PHB because it provides low packet drop probability, low packet delay variation and assured bandwidth. WRR(Weighted Round Robin) scheduler is used. IPv4 Network configurator is used, The nodes having a IPv4 network layer (hosts and routers) should be configured at the beginning of the simulation. The configuration assigns IP addresses to the nodes, and fills their routing tables. Packets coming from source host H1 are destined to destination host H5 and form H2 packets are to H6, H3 to H7, and H4 to H8. R0, R1, R4,R5 are edge routers and R2 and R3 are core routers. R0 and R1 are ingress routers where classification, marking, metering takes place. R4 and R5 are egress routers. There are service level agreements (SLA) between the users and service providers, and between the domains that describe the mapping of packets to forwarding classes and the allowed traffic profile for each class[4]. The routers at the edge of the network are responsible for marking the packets and protect the domain from misbehaving. Traffic that are not conformed may be dropped.

IV. MPLS FOR IPV4 NETWORK

In MPLS traffic flows through pre-defined path through the network. [3]. Packets entering the network are forwarded along with a label, which eliminates the need to read its IP address. At each node, the LSR pops the existing label and pushes a new label for the next node. Next node decides how the packet can be forwarded by reading only the label and not network addresses. Performance is guaranteed by these established paths (Label switch paths). By making some traffic follow the non-shortest path through the network congestion can be minimized.

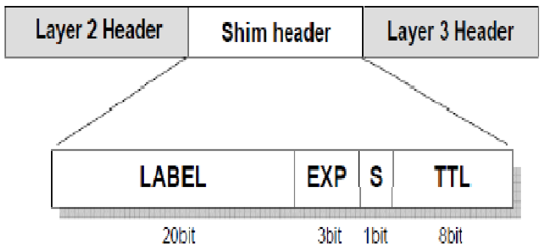

Fig. 2. MPLS shim header

Fig 2 shows MPLS shim header, it is 32-bit long. It consists of 20-bit label value, a 3-bit Exp for experimental use, 1-bit of stack flag, To signify the current label in the stack this bit is used and an 8-bit TTL (time to live) field. Here MPLS integrated DiffServ concept is presented, focusing on E-LSP(EXP inferred LSP) operational procedure. PHB is specified using EXP field. In E-LSP maximum number of classification is less than equal to 8. For more number of classification L-LSP(Label only inferred PSC) can be used. Packets going to a particular destination can grouped and can be assigned to a particular FEC (Forwarding Equivalence Class)[8]. MPLS uses RSVP protocol. Delay-10ms and Datarate-600kbps.Queue type- Drop tail queue. Link used is ppp (point to point).. Then labels are attached to these packets at the edge router(ingress router) i.e R0 and are forwarded according their forward equivalence class. Packets coming from host H1 are sent to host H5 and packets coming from host H2 are sent to host H6. For all the Hosts are assigned with IP address to manually assign path as MPLS uses pre-defined path. Next the labels are attached at LER (label edge router). Based on these labels forwarding decisions are made by Label switch routers, so that there is no need to read its IP address[6]. When a packet reaches an egress router label should be popped. Finally at an egress router label is removed and forwarded to the destination.

V PERFORMANCE ANALYSIS

Simulation study is undertaken on Omnet++ version 4.2.2 using INET 2.1.1. Fig. 3 shows the end-to-end delay for Diffserv Network. And Fig 4 shows end-to-end delay for baseline IPv4 Network. Here ‘0’ indicates voice traffic and ‘1’ indicates video traffic. In figure 4 H1 is marked as AF1, H2 is marked as AF2, H3 is marked as AF3 and H4 is marked as AF4. Therefore end-to-end delay is less for H5 when compared to H6, H7, H8.

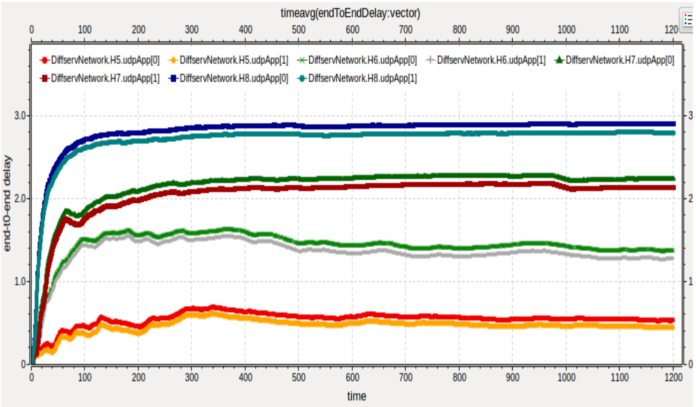

Fig. 1. End-to-End delay for DiffServ Network

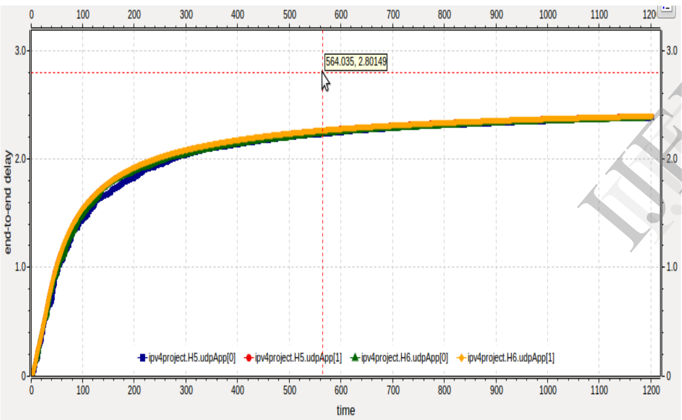

Fig 4. End-to-end delay for baseline Network

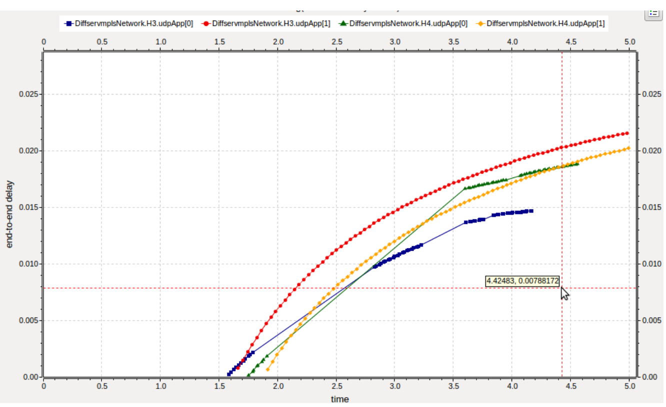

Fig 5: End-to-end delay of MPLS network for 500bytes message length

Fig 4 shows end-to-end delay for baseline network. We can see that end-to-end delay is same for all the hosts as we can not priorities the services. Fig. 5 shows end-to-end delay for MPLS network and Fig 6 queuing time for MPLS network.

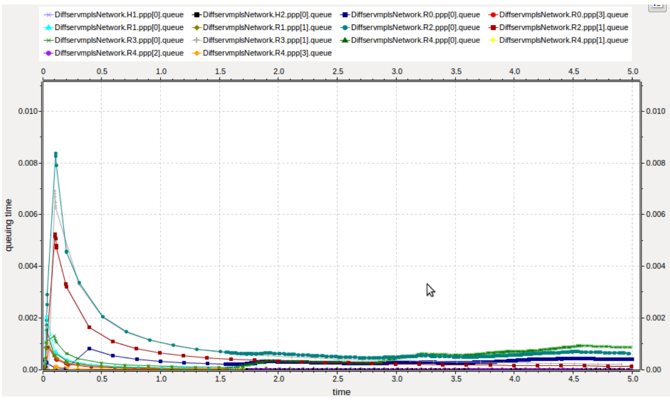

Fig 6. Queuing time for MPLS network

VI. CONCLUSION

As MPLS supports traffic engineering and DiffServ provides scalable quality of service. QoS Performance analysis Diffserv and MPLS is done for different parameters such as packet loss ratio, delay, end-to-end delay, queuing time, different message length etc.

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