Routing Beyond MPLS Domains: Voice over Enhanced IP Network

Amitesh Kumar Singam, Ermias S Kasa, Srinivasan Jayaraman and Wlodek Kulesza

November 3, 2022

Routing Beyond MPLS Domains: Voice over Enhanced IP Network

Amitesh K. Singam, Ermias S. Kasa, Srinivasan Jayaraman and Wlodek J. Kulesza

***Abstract*—With the ever-increasing demand for better quality of service, the traditional IP networks are becoming uncompetitive. Emerging technologies like Multi Protocol Label Switching (MPLS) provide stringent quality of service (QoS) guarantees but it cannot be implemented on the existing IP infrastructure. There is a need to improve the performance of IP networks to support better quality of service in voice traffic environments. We present a paradigm for enhancing the routing capability of IP networks and optimize the existing networks by combining two state of art interior gateway routing protocols OSPF (Open Shortest Path First) a link state protocol and a distance vector routing protocol EIGRP (Enhanced Interior Gateway Routing Protocol). The validation is done by comparing the performance of the developed IP network throughput and end-to-end delay with identical label switched network using OPNET. As the result shows the throughput and end-to-end delay of the developed IP network is approximately same performance as the MPLS network as desired.**

***Index Terms*—EIGRP, MPLS, OSPF, Throughput.**

I. Introduction

THE rapid development of the Internet in the past few years has resulted in making it an indispensable part in our day to day life. Technologies like MPLS have come as a relief providing effective QoS in real time multimedia traffic environment. MPLS is a technology based on integrating the simplicity of layer 3 technologies like Internet Protocol (IP) and service guarantees of layer 2 technologies like Asynchronous Transfer Mode (ATM) [1]. The existing IP network provide best effort service, thus assurance of good service level in voice traffic environments has become difficult with limited MPLS domains and long spread IP networks

Interior Gateway Routing Protocol is used to exchange routing information within an autonomous system. EIGRP and OSPF are two popular and widely deployed interior gateway routing protocols. The motive behind enhancing the existing IP network is to extend the rich service features of existing MPLS domains to IP networks.

The analysis is done by simulation using an Optimized Network Engineering Tool (OPNET) Modeller and the result shows that the throughput and the end-to-end delay of the developed IP network perform almost in a similar fashion as the label switched network.

II. Survey of Related Works

Efficiency of an IP network is largely dependent on the routing protocol which decides how a packet is transmitted from source to destination. Since each routing protocol, for instance, EIGRP and OSPF has its own merits hence their combination in a single network gives better network utilization [2]. EIGRP and OSPF are very popular IP Routing Protocols which can be integrated to improve network performance [3]. MPLS cannot totally take over IP but it can be configured by adding a set of rules to IP networks for classifying and policing the traffic. This classification and policing of traffic can be understood as traffic engineering. [4].

III. Problem Statement and Main Contribution

Today’s internet traffic is Multimedia driven which includes voice, pictures, video or a combination of them. Consider a scenario where we have a calling party in MPLS domain and the called party in non MPLS network. The call has a good quality till the end of MPLS domain and its performance deteriorates in IP network due to its best effort service. Due to the problem regarding the quality of service in the IP network the call will drop and the customer will not get the good quality he deserves. This problem is also observed when routing a call through different MPLS domains which provide different service based on type of traffic.

Our research question is how to improve the routing capability in IP networks and how can we bridge the performance variation between IP and MPLS?

One can improve the routing capability by combining OSPF/EIGRP protocols together and analyzing the performance of the IP network. This integration of protocols enables the called party in the IP network routes better and copes up the performance approximately as the MPLS network.

The project is developed using OPNET by configuring OSPF/EIGRP IP network topology and comparing with analogous MPLS network comparison is based on different performance metrics: point-point throughput and end-end delay. Our main goal of the project is to improve the performance of IP networks to the level of MPLS by combining these two protocols and bridge the level of service between MPLS and IP in voice communications over the internet.

IV. Problem Solution

A. Modeling

The integrated IP network presented in Fig. 1 is designed using Cisco 7200 routers and integrating OSPF and EIGRP Routing Protocols in IP networks, with PPPS3 links of 44.7

Mbps data rate in between routers and 10 base T of 10 Mbps between switches, LANs and servers are similar for MPLS networks.

The network architecture for MPLS model as shown in Fig. 2 consists of two label edge routers, which are the ingress and egress, five label switching routers, eight nodes, application definition with voice traffic and profile definition with defining nodes. Configuration of QoS parameters in IP QoS attribute definition is same in IP and MPLS. MPLS attribute definition is configured by enabling parameters like Forward Equivalence Class (FEC), Label switched path (LSP) and Traffic trunk. In order to define nodes, supported profiles should be configured in LANs.

B. Implementation and Validation

The simulation is implemented by comparing the performance of an MPLS network and enhanced IP network in OPNET simulation tool. The evaluation is done by analyzing the performance of EIGRP/OSPF and validating the obtained results with MPLS network. Parameters such as throughput and end-end delay are used for comparison.

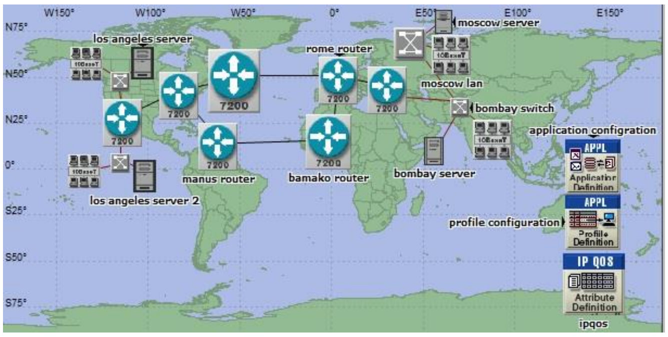

Fig. 1. Model of IP Network

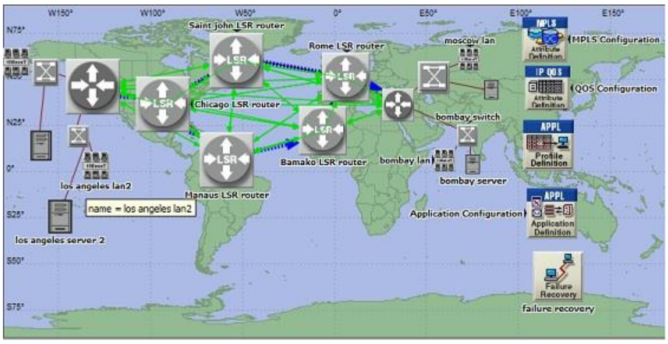

Fig. 2. Model of MPLS Network

TABLE I
THROUGHPUT AND END-TO-END DELAY

Scenario Name	Throughput(bits/sec)	End-to-End Delay
IP Network	31,227	0.142
MPLS Network	31,488	0.137

Fig. 3 shows the point-to-point throughput calculated in the core network. The OSPF/EIGRP network of IP shows approximately same throughput as compared to MPLS network and simulation time is three hours.

The end-to-end delay is the time required to transmit a packet from source to destination. Fig. 4 shows the end-to-end delay calculated in the core network. The measured parameters such as end-to-end delay and point-to-point throughput results are tabulated in Table I.

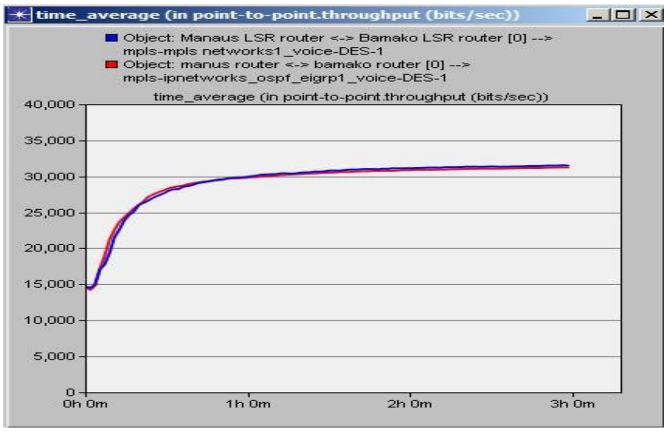

Fig. 3. Point-to-Point Throughput

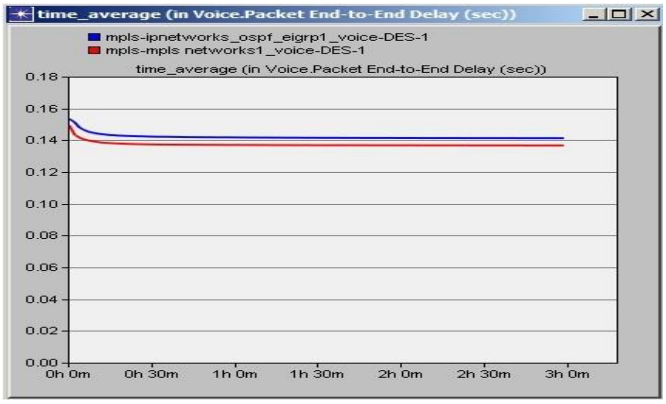

Fig. 4. End-to-End Delay

V. CONCLUSION

The performance of the enhanced IP network is on par with the MPLS network in terms of throughput and delay parameters. This model can be applied in existing IP networks to support voice traffic with performance levels almost equal to that of MPLS Domains.

For future work, combination of two routing protocols like OSPF and Intermediate System to Intermediate System (IS-IS) or EIGRP and IS-IS and make advanced protocol to future enhance the IP networks.

REFERENCES

[1] K.S.Chu and C.J.Moon, "Analysis of MPLS Signaling Protocols and Traffic Dissemination in OSPF and MPLS", *in First Asia International Conference on Modeling & Simulation*, Phuket, Mar.2007, pp.276-281.

[2] S.G. Thorenoor, "Dyanamic Routing Protocol Implementation Decision between EIGRP, OSPF, RIP Based on Technical Background Using OPNET Modeler," *in International Conference on Computer and Network Technology*, Apr. 2010,vol.1,pp.191-195.

[3] M.N.Islam and M.A.U Ashique. (2010). Simulation Based EIGRP over OSPF Performance Analysis. [online]. Available FTP: http://www.bth.se/com/mscee.nsf/attachments/4983_Thesis_Report_pdf/$file/4983_Thesis_Report.pdf.

[4] D.E.Comer, *Internetworking with TCP/IP, Principles, Protocols and Architecture*, 5th ed. Vol.1, Pearson Prentice Hall, 2006.

Amitesh K. Singam was born in Hyderabad, India in 1987. He has completed his Bachelor Degree in Electrical and Electronics Engineering, from JNTU (Jawaharlal Nehru Technological University) in 2008. Now he is studying his master's programme in Electrical Engineering with Specializations in Telecommunication from Blekinge Tekniska Hogskola (BTH), Sweden. His Area of Research Interest includes Networking and Wireless Communication.

Ermias S. Kassa was born in Addis Ababa town, Ethiopia in 1986. He completed his BSC in Electrical Engineering from Haramaya University in 2008. From Sept. 2008 till Aug 2008, he worked as a Radio Technician and Air Traffic Engineer in Addis Ababa City Administration and Mass Media Agency. Currently he is undergoing a Master's programme in Electrical Engineering with the emphasis on Telecommunication at Blekinge Institute of Technology (BTH), Karlskrona, Sweden. His research interest is on Wireless Communication.

Srinivasan Jayaramam was born in Hydrabad in 1986. He has completed sixteen years of education with a bachelor's degree in Electronics and communication from JNTU (Jawaharlal Nehru Technological University) and related project experience at Anzac private limited and ITE (Institute for Electronics and Telecommunication Engineering). He is pursuing a master's in Electrical Engineering with emphasis on Telecommunication at Blekinge Institute of Technology, Karlskrona, Sweden. He is a member of IEEE, IETE and was elected as the Vice President for ISTE (Indian Society for Technical Education) student chapter during under graduation. He wishes to pursue research oriented study in the field of telecommunications with an ultimate goal of settling in academia. His research interest is Traffic Engineering for future Internet and telephony.

Wlodek J. Kulesza received the M.Sc. and the Ph.D. degrees from Lodz University of Technology, Poland, and a docent degree from Linköping University, Sweden. In 2001 he became Professor in Measurement Science at the University of Kalmar, Sweden. Since 2005 he has held a Professor position at the School of Engineering in the Blekinge Institute of Technology, Sweden.
His current research interests are multi-sensor systems and wireless sensor networks.
IEEE member since 1995.